

# CONTROLLING INNOVATION, INNOVATING CONTROL

ACCOUNTING FOR INNOVATION IN THE  
FIELD OF UNIVERSITY-INDUSTRY  
INTERRELATIONS IN THE UK

Veronica Casarin

Cardiff University  
Cardiff Business School, Accounting and Finance Section

A Thesis Submitted in Fulfilment of the Requirements for the Degree of Doctor of  
Philosophy of Cardiff University

February 2016



## Declaration

This work has not previously been accepted in substance for any degree and is not concurrently submitted in candidature for any degree.

Signed .....Veronica Casarin.....

Date ..... 26/02/2016.....

### Statement 1

This thesis is being submitted in partial fulfillment of the requirements for the degree of PhD

Signed .....Veronica Casarin.....

Date .....26/02/2016.....

### Statement 2

This thesis is the result of my own independent work/investigation, except where otherwise stated.

Other sources are acknowledged by footnotes giving explicit references.

Signed .....Veronica Casarin.....

Date .....26/02/2016.....

### Statement 3

I hereby give consent for my thesis, if accepted, to be available for photocopying and for inter-library loan, and for the title and summary to be made available to outside organisations.

Signed .....Veronica Casarin.....

Date .....26/02/2016.....

## Acknowledgements

There are a number of people and institutions that have supported me throughout this journey. I am deeply grateful to my primary supervisor Prof. Keith Robson for his support, encouragement, and guidance during the research process and for the time he devoted to reading and discussing my thesis. I would like to thank Prof. Mahmoud Ezzamel, Prof. Stephen Walker, Prof. David Marginson, and Dr. Nina Sharma, who acted as members of my supervisory panel and provided me with invaluable advice. My gratitude also goes to Carla Edgley for her pastoral support, particularly in my final year. I would like to thank Nina Sharma and Patrick Wylie for giving me the opportunity to run the tutorials for their Management Accounting courses.

This PhD project has been kindly sponsored by the Accounting and Finance Section - Cardiff Business School (CARBS). Further financial support was also provided through CARBS PhD Enhancement Fund and the Interdisciplinary Perspectives on Accounting Group (IPARG). To these institutions goes my most gratitude. I would also like to thank the PhD Director, Prof. Helen Walker, and Lainey and Elsie from CARBS PhD Office for the support they have provided along the way.

Parts of this work have benefitted from presentations at seminars and doctoral colloquia. In this respect, I would like to thank participants to the 29<sup>th</sup> EAA Doctoral Colloquium, and participants to the AOS workshop held in Galway (Ireland) in 2013 for their insightful comments on my work. I would like to thank HEC Paris – Département Comptabilité et Contrôle de Gestion– for hosting me as a visitor and for giving me the opportunity to present at their seminar series. A most special thanks goes to my respondents for their time, the insights and the material they provided me with.

A most special thanks is to Prof. Fabrizio Panozzo, who first introduced me to social studies of accounting.

I would like to express my deep gratitude to my family and friends for always being by my side to support and encourage me. *A mamma e papà un grazie che difficilmente può bastare, ma c'è ed è profondo.* Thank you to Roberto and Diana, I learnt from both of you that sailing away from the safe harbor can be a difficult but

life-enriching journey. My sweetest thank you is to Benedetta and Riccardo, for all the wonderful tales and for bearing with a faraway aunt.

My happiest thank you is to the international gang of friends who turned my years in the ‘Diff into a lovely collection of stories that I will fondly remember. Particularly, thank you to Luis, Renuka, Manasi, Mark-Oliver, Sanley, Javier, Iris, Tiago, Camila, Jingqi, Yang, Iram, Anna, Ricardo, Stéphane, Ahmed, and Marco.

Finally, I would like to thank Linda and Malcolm for their kind support and all the happy gatherings which I looked forward every time.



## Abstract

The thesis examines the role of accounting in configuring innovation as the driver of economic progress in modern Britain. Set against a context of changing governmental rationalities and greater attention of economic theory upon issues of R&D productivity, University-Industry interrelations have come to represent, since the 1980s, a laboratory where British government has experimented with programmes for both promoting and decentralising innovation, while maintaining at a distance control through mandated calculations and calculative devices. The thesis brings accounting into the discussion of how private and public agencies of governance steer innovation by exploring the paradoxical phrase: “controlling innovation, innovating control”. The phrase questions the extent to which accounting discipline and practices have changed in order to keep pace with the progressive economic and social agenda of innovation.

By means of an in-depth study of accounting practices, corroborated by forty semi-structured interviews, the thesis explores the action of controlling innovation across three main sites where university-industry interrelations are enacted, namely technology transfer, technology incubation, and corporate R&D. Drawing on the concept of *socio-technical agencement* (Callon 2005) the thesis seeks to identify and analyse the economic agencies that configure and assemble innovation as an actor capable of influencing government policies, corporate strategies, and universities’ mission. The thesis shows that controlling innovation involves calculative action that is mainly *distributed* across accounting devices (e.g. Discounted Cash Flow, R&D budget, and input-output performance indicators), non-accounting devices, and human entities. Drawing on, and expanding, the work of Beunza & Garud (2007) on *calculative frames*, the thesis finds patterns of regularity occurring in the mechanisms through which economic action within innovation is organized and distributed. The thesis also accounts for the tensions arising in the negotiation of different versions of the value of innovation. Finally, while controlling innovation is performed through a variety of accounting devices, the thesis shows that such devices are not new to the accounting discipline and practice, but rather are traditional accounting tools that *adapted* to the innovation rationale in virtue of their fluid and combinable properties.

# Table of content

Declaration .....	ii
Acknowledgements .....	iii
Abstract .....	v
Table of content.....	vi
List of figures .....	ix
List of tables.....	x
List of abbreviations.....	xi
<b>INTRODUCTION</b> .....	<b>1</b>
<b>CHAPTER 1 A LITERATURE REVIEW ON ACCOUNTING, IMMATERIALITY AND THE STRUCTURES OF INNOVATION</b> .....	<b>11</b>
Introduction.....	11
1.1 The problem of immateriality and the roles of accounting .....	13
1.2 The <i>organisational structures</i> of innovation: networks and inter-firm relations in the accounting literature.....	23
1.3 The <i>accounting structures</i> of innovation and creativity: management control systems ...	29
Conclusion .....	32
<b>CHAPTER 2 ECONOMIZING INNOVATION THROUGH ACCOUNTING: THEORY AND METHODS</b> .....	<b>37</b>
Introduction.....	37
Part 1: Theoretical framework: the study of economization across academic literatures.....	38
2.1 Translating innovation into economic value through accounting .....	38
Part 2: Methodological considerations and research methods .....	73
2.2 Researching innovation as a socio-technical phenomenon .....	73
2.3 Discussing the relation between theory and evidence: <i>maximal</i> and <i>minimal</i> interpretation.....	84
Conclusion .....	92
<b>CHAPTER 3 LINKING SCIENCE, ECONOMY, AND THE STATE: THE EMERGENCE OF UNIVERSITY-INDUSTRY INTERRELATIONS</b> .....	<b>94</b>

Introduction.....	94
3.1 The role of economic theory in the linking of technology progress, economic growth, and governmental concerns.....	98
3.2 Science policy and the emergence of technology transfer and incubation programmes in the UK.....	106
Conclusion .....	118
<b>CHAPTER 4 THE MULTIPLE ROLES OF ACCOUNTING IN THE RE-ORGANISATION OF DRUG DISCOVERY AND DEVELOPMENT ACTIVITIES AT BIGPHARMA1</b>	<b>121</b>
Introduction.....	121
4.1 Re-configuring the problem of drug discovery pipeline productivity into an organisational problem.....	123
4.2 Accounting devices in the transition to Drug Discovery Centres and Therapeutic Areas	128
4.3 From <i>discovering</i> to <i>incubating</i> innovation: accounting devices within Incubator#1 ....	140
Conclusion .....	149
<b>CHAPTER 5 EMBODYING TENSIONS THROUGH ACCOUNTING: THE CASE OF TECHNOLOGY TRANSFER IN THE UK</b>	<b>154</b>
Introduction.....	154
5.1 Framing science through technology transfer.....	155
Conclusion .....	184
<b>CHAPTER 6 CALCULATIVE FRAMES: THE ROLE OF ACCOUNTING IN FRAMING UNIVERSITY INCUBATION PRACTICES IN THE UK</b>	<b>188</b>
Introduction.....	188
6.1 Exploring the origin and nature of differences in incubation practices .....	189
6.2 Accounting, framing, and the multiple values of incubating innovation.....	197
Conclusion .....	218
<b>CHAPTER 7 CONTROLLING INNOVATION, INNOVATING CONTROL: SOME REFLECTIONS</b>	<b>225</b>
Introduction.....	225
7.1 Controlling innovation.....	228
7.2 Innovating control.....	246

<b>CONCLUSION</b>	<b>252</b>
<b>APPENDICES</b>	<b>260</b>
Appendix 1 .....	261
Appendix 2 .....	262
Appendix 3 .....	265
Appendix 4 .....	266
<b>BIBLIOGRAPHY</b>	<b>267</b>

## List of figures

Figure 2.1: Maximal interpretation in the interpretive epistemic mode.....	87
Figure 2.2: Excerpt from analysis spreadsheet (#20).....	91
Figure 3.1: The innovation eco-system.....	103
Figure 3.2: A timeline of key events, science policies and programmes.....	108
Figure 3.3: The relationships between the DTI and its Research Establishments ...	114
Figure 4.1: A visual representation of the stages of drug discovery and development .....	125
Figure 4.2: A visual representation of the drug discovery process.....	125
Figure 4.3: A timeline of the re-organisation of drug discovery at BigPharma1.....	127
Figure 4.4: Transforming the drug pipeline into a “value chain” .....	134
Figure 4.5: Constructing the “autonomy” of Drug Discovery Centres as biotech businesses.....	139
Figure 4.6: Inscribing the tension between the financial sustainability frame and the innovation/quality frame.....	149
Figure 5.1: The patenting process flow.....	165
Figure 5.2: “Quality profile” under RAE 2008.....	176
Figure 6.1: Relationship between inputs, outputs and outcomes.....	193
Figure 6.2: The logical framework.....	196

## List of tables

Table 2.1: List of participants and interviews' length .....	81
Table 4.1: A characterisation of accounting devices in Drug Discovery Centres, Therapeutic Areas, and Incubator#1 .....	153
Table 5.1: Example of revenue sharing agreement.....	162
Table 5.2: Excerpt of measures of economic impact under REF 2014.....	175
Table 5.3: Components and weights in HEIF 3, 4, 5 .....	181
Table 5.4: Higher Education Statistics Agency measures of external income/performance under HEIF 3, 4, 5 .....	182
Table 5.5: Characterising Technology Transfer through accounting devices.....	186
Table 6.1: RDA activity indicators .....	194
Table 6.2: Indicators reported by Incubator#4 to the Local European Funding Office .....	204
Table 6.3: Mapping out incubation metrological framework .....	219
Table 7.1: Socio-technical agencements of innovation.....	231
Table 7.2: The consequences of controlling innovation .....	241
Table A- 1: Example of interview schedule.....	261
Table A- 2: Example of invention disclosure form.....	262
Table A- 3: Criteria perceived by academics to be important for academic promotion .....	265
Table A- 4: Example of capitalisation table.....	266

## List of abbreviations

CEO:	Chief Executive Officer
CFO:	Chief Financial Officer
CRO:	Contract Research Organisation
DCF:	Discounted Cash Flow
ERDF:	European Regional Development Fund
HE-BCI:	Higher Education Business Community Interaction Survey
HEFCE:	Higher Education Funding Council for England
HEI:	Higher Education Institution
HEIF:	Higher Education Innovation Fund
HEROBC:	Higher Education Reach-Out to Business and the Community
HESA:	Higher Education Statistics Agency
IP:	Intellectual Property
LEFO:	Local European Funding Office
MBO:	Management by Objectives
MCS:	Management Control System
OST:	Office for Science and Technology
R&D:	Research and Development
RAE:	Research Assessment Exercise
REF:	Research Excellence Framework
SMART:	Specific, Measurable, Assignable, Realistic, Time-related

# INTRODUCTION

---

---

To what extent has accounting agenda *progressed* toward the so-called “innovation economy” and “knowledge society” (Drucker 1993)? Since the second half of the 20<sup>th</sup> century, the British economy has been the object of a growing number of policies and programmes aimed at promoting innovation while addressing issues of economic growth and national competitiveness (DIUS and BERR 2008). Increasingly, innovation is pictured as a major economic actor capable of *driving* entire economies toward the much sought-after economic growth, while informing corporate strategies, universities’ missions, and other domains of economic life. Parallel to the construction of innovation as an economic driver, the past three decades have witnessed the expansion of innovation measures, national and global indexes, and surveys aimed at measuring, managing, hence *controlling*, innovation as a phenomenon.

Seemingly, *controlling* innovation while promoting innovation has become the mantra of a society that is constantly oriented not only to investing on innovation (and knowledge) in order to progress, but also to realizing the economic effects of innovation. Nevertheless, the rationalistic aspiration of a modern society that relies on *instrumental* knowledge in order to progress offers only a partial explanation for the variety of collective efforts performed to both promote and control innovation. Traditionally, studies in economics have focused on the *effects of* innovation on economic growth, in so taking for granted the agentic content of innovation, i.e. what gives innovation the capacity to influence the courses of action of other actors in the economy (e.g. government, corporations, universities, and scientists). Similarly, traditional accounting concerns for realising the value of innovation and for managing innovation through the structures of accounting have often been casted in normative terms (Davila 2010; Davila and Ditillo 2013; Edvinsson and Malone 1997), in so overlooking the *content* of the economic action involved in innovation



as a socio-technical phenomenon. This thesis advances that in order to understand the social and technical phenomenon that is innovation and its effects, we need to attend to the accounting infrastructure that contributes to configuring and assembling innovation as major economic driver and economic actor. It is by seeking and identifying the content of innovation in the circumstances of action that we can account for the varieties of arrangements that fall beneath the umbrella of innovation.

This thesis positions the analysis of the calculative and economic content of the agencies of innovation within social studies of accounting. For the latter advance that accounting does not merely constitute a neutral device through which the supposed reality of innovation is realised (Hopwood and Miller 1994), but rather is capable of configuring domains, creating spaces of possibilities within which economic action can be exerted by individuals, organisations, and the State. Based on this view of how accounting shapes economy and society, the thesis advances that it is both by measuring the value of innovation and by managing it through accounting devices and principles that the economic entities of innovation comes into being.

While investigating the content, forms, and effects of the accounting involved in configuring the economic agencies of innovation this thesis aims to address the paradox presented in the title of the thesis: “controlling innovation, innovating control”. The phrase aims to provoke a discussion as to whether the ‘progressive’ agenda of accounting has moved toward developing ‘new’ ideas and instruments for measuring, managing, and ultimately controlling innovation. Investigating the nature of and the conditions for accounting changes triggered by the innovation phenomenon is important because it allows us to identify: a) the forms of accounting mobilised in the action of controlling innovation and b) the qualities/properties of accounting tools that are involved in innovation. In short, the thesis aims to explore how accounting has become what it was not in the name of innovation (Hopwood 1987). Whether new economic rationales, with innovation being a case in point, trigger changes or adaptations in the accounting discipline and practice (Andon, Baxter, and Chua 2007; Briers and Chua 2001; Robson 1991) and what makes such changes possible are issues that this thesis aims to contribute to. With regard to this, there has been a wide debate over the recent years, in both academic and practitioner oriented literature (Granstrand 2000; Edvinsson and Malone 1997; Romer 1998), as to whether accounting has to ‘invent’ new tools in order to measure and manage the knowledge base of organisations. Innovation has been often represented in academic

and policy-oriented literature as a *problem* for accounting because of the challenges it poses in terms of measurement and coordination (NESTA 2008). In an effort to trace the multiple modalities of *problematizing* innovation, Chapter 1 attends to the different styles of problematizing innovation that have emerged in the accounting literature of the past three decades. The literature review identifies *immateriality* and *accounting and organisational structures* as two distinctive styles of problematizing the relation between innovation and accounting. On the one hand, the literature on immateriality has frequently discussed the problem of realising and visualising the value of the immaterial resources of the firm. Within this stream of research, the debate usually centres on whether the supposed mathematical and logical rigour attributed to accounting numbers is challenged by more narrative forms of disclosing the immaterial resources of the firm (Mouritsen, Larsen, and Bukh 2001a). On the other hand, the literature on accounting and organisational structures (e.g. management control systems, networks, etc.) has debated for long time whether management accounting and control systems contributed to hindering or enabling innovation and whether traditional management accounting systems have been supplanted by ‘new’ forms of accounting and control (Davila 2010). Within those studies focusing on organisational structures such as networks and inter-firm relations, the debate usually revolved around the roles and types of accounting in networks, but without paying specific attention to innovation contexts (Håkansson and Lind 2004).

Although these literatures do address the relation between innovation and accounting, the fundamental question of how different forms of accounting contribute to configuring economic action within the realm of innovation, and the consequences of such configuring, remains relatively unexplored. More needs to be done in terms of understanding the *sources, content, effects* (both intended and unintended), and *distribution* of economic action within the field of innovation. Past accounting scholarship (Burchell et al. 1980; Hopwood 1983) has poignantly observed how accounting devices, far from being neutral, contributes to configuring the objects they aim to measure and control. For this reason, the investigation of how economic action is configured and the role of accounting in this process of configuration is critically important.

*To understand the role of accounting in the dramatic expansion of the innovation-driven economy the thesis aims to address the following questions:*

1. What is the role of accounting in qualifying the entities of innovation as economic?
2. What qualifies an entity as economic in the realm of innovation?
3. What are the effects of this process of qualification/configuring?
4. Since innovation is said to drive economies, then how is the economic action of innovation (and its configuring) to be understood?

In the context of this thesis, *economizing* means to translate the entities of innovation (e.g. new technologies, incubation projects, new scientific ideas, new drugs) into *economic* entities that possess economic value(s), that is into entities that can circulate and be exchanged in the economy precisely because of that economic value(s).

The urge to attend to the origins, content, distribution, and effects of economic action within social and technical phenomena (e.g. financial markets) has been recently put forward by the performativity programme in social studies of science and technology (Callon 1998c; Çalışkan and Callon 2009). Drawing on this approach, the thesis seeks to identify the economic entities of innovation by observing the *practices* of controlling innovation, with no assumptions about content, forms and effects of control. Controlling innovation is analysed in the circumstances of action because this allows tracing how the same types of action and device are performed in different ways, depending on the context in which they are mobilised.

Nevertheless, understanding how accounting economizes innovation depends also on how we conceptualize accounting (e.g. accounting as standard and rational models or as practices). In order to show how different conceptualisations of accounting impact on our knowledge of the phenomenon innovation, Chapter 2 compares, for analytical purposes, different theoretical approaches to studying economization. Part 1 of Chapter 2 discusses how new institutional theory and the performativity programme in social studies of science both contribute to the study of economization. In new institutional theory, accounting models and standards contribute to constructing individuals, organisations, nation states as rational economic actors. Under this conceptualization, accounting models diffuse across society, but while diffusing they remain “the same” and do not adapt or change to local settings. In the performativity programme instead the quality of being economic is highly contingent to the network of people and resources mobilised around the entity to be economized. The conclusion that is drawn at the end of such analytical

comparison is the following. The two literatures centre on apparently different phenomena: the origins of isomorphic and normalising tendency within a field and the origins of multiplicities and differences within and across arrangements, respectively. Chapter 7 will show that at an empirical level such theoretical differences might slightly blur. In this respect, the findings will show that, while accounting materialities play a central role in producing differences and multiplicities within the *agencements* of innovation, patterns of regularity in the processes of distributing calculative action within the field of innovation have also been found.

The research methods deployed in this study are discussed in Part 2 of Chapter 2. The empirical investigation was carried out principally by means of semi-structured interviews conducted across multiple sites. Interview data was integrated by companies' internal documentation and public documentation available from institutional websites. The empirical research focused on the interplays between innovation and accounting in the context of university-industry interrelations in the UK. Since the 1980s university-industry interrelations have been constructed as a laboratory for innovation where the UK government has unremittingly devised and implemented programmes for bringing about the so called *innovation-driven economy* and *knowledge-based society*. Among all these programmes, this study focuses on technology transfer and incubation programmes because the latter represent a significant and growing arena where problematics of economic growth have been linked to innovation.

The linking of economic growth to innovation is not self-evident, but rather the outcome of a number of economic and political conditions, whose understanding helps us contextualise the accounting practices in place within the arena of university-industry interrelations. Put differently, the rise and spread of performance indicators aimed at evaluating research performances of universities was not an event that had necessarily to happen, but rather was the outcome of processes of managerialization and increased accountability toward the use of public spending. Therefore, the reason for attending to the historical and political conditions that gave rise to research commercialisation in the UK is to provide not only a historical background for the thesis, but a plausible explanation for the changes in the type of accounting instruments deployed through time to configure economic action. To this aim, Chapter 3 provides a historical analysis of the economic and political conditions

that have led to the emergence of research commercialisation discourses across the arenas of economic theory and UK policy making. An extensive work of problematization, to which economic theory has largely contributed, took place from 1950s onward and contributed to changing the role of the State within the arena of research commercialization. Chapter 3 shows that a major shift was from direct intervention and control over scientific research toward exerting control at a distance. Instruments of control such as State's rights of first refusal over the inventions developed by public universities disappeared in the 1980s amid the rise of programmes for decentralizing research commercialisation. A progressive shift in the principles for governing the allocation of public funding to science (e.g. the 1971 Rothschild contractor-customer principle) together with regimes of increased accountability created the conditions for the spread of instruments of control such as research assessment exercises.

In an effort to trace the multiple forces that produce changes in accounting for innovation, the empirical chapters, i.e. Ch. 4, Ch. 5, and Ch. 6, take the analysis from the arenas of economic theory and policy making to the arena of organisational practices by observing corporate R&D, technology transfer, and incubation practices respectively. Overall, the three chapters explore the accounting *practices* in place within university incubators, technology transfer offices, and a corporate R&D unit. The objective is to investigate the extent to which accounting operates in contexts where scientific ideas are *discovered, developed, transferred, and incubated*. In other words, the objective is to investigate how the circulation of innovative scientific ideas is influenced by measurement practices. The actions and entities implicated in controlling innovation are analysed according to the following three questions: what is the *content* of economic action within innovation (e.g. within corporate R&D, university technology transfer, and incubation)? What are the mechanisms for attributing economic action within innovation? What are the *effects* of economic action within innovation? Each question then leads to a series of categorizations of economic action that are discussed below. Such categories aim to contribute to the understanding of how the action of *controlling innovation* is configured, that is what its content, mechanisms of attribution, and effects are. First, in relation to the content of action, the analysis focuses mainly on *calculative* action, since this is the form of action in which accounting is mostly implicated. Second, as to the sources and mechanisms of organisation of action, these can vary according to the specific

circumstances of action and can consist in accounting devices, principles, non-accounting devices, etc. In this respect, the thesis mobilises the notion of *calculative frames* to account for regularities in the mechanisms for organising action. Originally developed by Beunza and Garud (2007) to account for the striking regularities observed in the choice of categories, analogies, and key metrics made by financial analysts, the concept of calculative frame developed in this thesis identifies patterns of regularity in the mechanisms for attributing economic action. Third, the effects of economic action are conceptualised in terms of tensions arising between different ways of calculating the value of innovation. By adopting such categorization in the analysis of the empirical evidence presented in Chapters 4, 5, and 6, this study seeks to identify and analyse the economic agencies of innovation. In so investigating the role of accounting in assembling innovation as a major actor of the economy.

In the light of the thematic organization of the empirical chapters above enunciated, Chapter 4 investigates the interplays between innovation and accounting in the context of drug discovery and development activities at a big pharmaceutical company headquartered in the UK. While the national problem of R&D productivity examined in Chapter 3 is made visible within the domain of pharmaceutical industry through the problem of growing failure rates in the development of drugs, Chapter 4 explores how BigPharma1 has translated the problem of drug development failure rates, i.e. R&D productivity, into a problem of how to re-organize their R&D efforts. Consequently, in the past two decades the organisation underwent waves of organisational reforms aimed at re-structuring their R&D activities. The chapter explores how the enactment of organisational forms arising from such restructuring (i.e. Drug Discovery Centres, Performance units, and Incubator#1) was made possible by multiple accounting devices, such as wish lists, budgets, financial attrition, discounted cash flow, financial models, and performance indicators. Overall, the chapter shows how accounting devices made it possible to translate innovative scientific ideas into economic entities, that is into entities that are expressed according to categories of cost and value. The chapter shows how financial and non-financial resources could be mobilised precisely because of the economic visibility granted by accounting to scientific discovery.

While Chapter 4 analyses the processes of economizing drug discovery and incubation from the perspective of the private corporation, Chapter 5 maintains the focus on the accounting practices mobilised to economize innovation programmes,

but shifts the perspective from the corporation to universities and technology transfer offices within universities. The underlying idea is that, while shifting the observations from private to public contexts, the content, sources, and effects of economic action are likely to change. The empirical evidence presented in Chapter 5 shows how universities concerns for commercialising research have been translated into performance indicators aimed at making the innovativeness and inventiveness of the research base visible. The chapter shows how, following chains of calculations, innovation performances of individual universities become linked to the allocation of public funding. A central role here is played by the formula-based funding device. The latter functions through a system of weights that are imposed on different sources of universities' performance (e.g. research impact, external incomes). The chapter discusses both the effects of measuring innovation performances through indicators and the effects of linking funding to performances.

While maintaining the focus on the role of accounting in controlling innovation in the context of universities' commercialisation practices, Chapter 6 takes the analysis to the arena of technology incubation programmes. Compared to technology transfer offices, which operate predominantly in the context of universities, the technology incubators observed in this study are characterised by multiple stakeholders from both public (e.g. universities, government) and private (e.g. corporations) sectors. Realizing the value of incubation programmes is often presented as a problematic exercise because of the variety of concerns at play within each setting. The distribution of such concerns across multiple calculative frames (e.g. public intervention, quality, and investment frames) and the role of accounting in translating them into numbers is the focus of the chapter. Accounting devices constitute spaces in which different calculative frames come to confront and compete with each other, giving rise to tensions and paradoxes.

In discussing the findings from the empirical chapters, Chapter 7 addresses the following question: to what extent has accounting innovated in order to control innovation? The question aimed to trigger a discussion of the types of action involved in controlling innovation and the types of accounting devices mobilised therein. Drawing on the notion of economic agency put forward by Callon (2005), Chapter 7 offers first an analysis of the forms of economic agencies involved in controlling innovation by categorizing action in terms of the sources, content, and effects. There is no a priori assumption of what constitutes controlling innovation.

On the contrary, the source/content/effect categorization is based on observing the circumstances of action. Second, the chapter discusses whether the forms of accounting mobilised to control innovation are new to the accounting discipline and practice, or whether it is more the case that traditional forms of accounting have adapted to new accounting rationales, i.e. innovation, and how they adapted.

The findings related to the action of controlling innovation indicate that the latter involves a range of calculative actions, i.e. monitoring, assessing, budgeting, evaluating innovation, which are performed in a *distributed* fashion. Public R&D programmes, financial models, and budgets are not merely neutral devices, but rather have the capacity to organise and influence the myriad of entities participating in the collective actions of monitoring, budgeting, forecasting, and assessing innovation. Depending on the specific arrangements, the mechanisms for organising and distributing action are found in the interaction between different types of entities. In this respect, interactions have been found to occur between managerial principles and accounting devices, between accounting principles and non-accounting devices, and between accounting devices and principles. Furthermore, regularities have been found in the mechanisms for distributing action, which tend to recur across different arrangements. Such regularities have been conceptualised as *calculative frames* (Beunza and Garud 2007). The thesis found that, in the context of the exchange of money (e.g. public or private investments) for value, different calculative frames can overlap and give rise to tensions between different forms of value (e.g. value performed in terms of jobs creation, value performed in terms of research publications, etc.)

The findings presented in the second part of the discussion chapter show that the forms of control deployed in the context of innovation are not new to the accounting practice and discipline. Devices such as discounted cash flow formula, R&D budget, financial attrition, and input-output performance indicators are, after all, traditional accounting tools which, in the circumstance of action, *adapt* some of their features to new rationales such as innovation. However, the findings show that the process of adaptation is made possible by a number of qualities/properties of accounting tools, namely *fluidity* and *combinability*. Furthermore, such qualities of accounting devices make it possible interactions among the heterogeneous entities composing/assembling innovation. While contributing to create such tensions,



however, accounting can also mediate them by creating spaces of calculability (e.g. ratios, weights) where actors can negotiate their respective interests.

Finally, while emphasizing how this study centres on the assembling of innovation by means of multiple economic agencies, and should not be understood as a comparative study, the concluding chapter presents the main contribution and implications of the thesis and sketches avenues for future research.

# CHAPTER 1 A LITERATURE REVIEW ON ACCOUNTING, IMMATERIALITY AND THE STRUCTURES OF INNOVATION

---

## Introduction

It has been more than thirty years since the call of Burchell et al. (1980) to study the roles that accounting plays at both societal and organisational level. Today the urge to investigate the contingent forces (or programmes) that inspire and shape *changes, progress* and *innovations* in accounting ideas and practices finds a compelling field of analysis in the programmatic and calculative impetuses towards the construction of an *innovation-driven* and *knowledge-based* economy.

As Burchell et al. (Ibid.) suggested, the pressure for change is not an inherent mission or essence of accounting. Accounting change is rather the outcome of a process of co-production of multiple and often distant social, institutional and organisational forces. What has come to be seen as a problem in accounting for innovation and how the ‘progressive’ agenda of accounting for innovation has been shaped, are the result of a process of *problematization* carried out at different locales and propelled by distant actors within society. At the heart of such problematizing activity there lies a conceptualization of knowledge as *instrumental to* the achievement of wider economic and social goals (Drucker 1993) such that some scholars advanced the idea of a shift toward a form of capitalism called *intellectual capitalism* (Granstrand 2000).

This chapter will explore the sources of innovation problematization that can be found in academic work. The way in which innovation and knowledge are often

framed within such domains points to two aspects at least<sup>1</sup>. One has to do with the immaterial quality of the objects to be measured and the other one with the structures that enable and constrain innovation as a space (e.g. management control systems, markets and networks of innovation, and inter-organizational relations) (Fincham and Roslender 2003).

The domains where these forms of problematization first appeared are located at the margins of accounting practices and pertain to academic disciplines such as *knowledge and innovation management* and *economics*. Another arena where the problematization of innovation has taken place is within political institutions (e.g. national and international policy making and regulation) and will be explored in Chapter 3. Regulators and policy makers can determine matters of urgency within the political and scientific agendas and influence other domains. Priority setting in *science budget* has been historically an area of wide political debate (Stichweh 1994) and tends normally to have consequences beyond the arena of policy-making itself (e.g. corporations, public and private research laboratories etc.).

How these forms of problematizing innovation have come to inform accounting thought, and how accounting has contributed to their development are questions investigated in this review chapter. How the problems of measuring immateriality and providing the structures for innovation have been treated in the accounting literature is therefore the object of this review. The review will analyse the accounting literature that has investigated the challenge of measuring the value of innovation on the one hand, and the challenge of structuring the space of innovation on the other hand.

In reviewing such literature, emphasis will be given to a number of aspects. First, the review will investigate the extent to which the selected studies have analysed the roles of accounting within organizations and whether such roles have provided a base for change in the practice. Second, the review will discuss whether the selected studies have investigated the sources of emergence of accounting roles (e.g. organizational, institutional, or social). Third, the review will investigate the extent to which the accounting literature has addressed the dialectic relation between

---

<sup>1</sup> Sources of representation can be multiple: scientific domains, policy making arenas, professional bodies, etc. The two aspects of the problematization highlighted here are indeed only two aspects. These do not exclude the future analysis of further ways of problematizing innovation.

accounting roles and accounting practices (and in turn accounting change) in the specific context of the so called *knowledge-based* society and *innovation-driven economy*.

The chapter is organized as follows: the accounting literature addressing the issue of measuring (and managing) immateriality is first presented. The discussion will include accounting studies on intangible assets and intellectual capital carried out at level of organizational practices and those carried out at a more institutional and societal level. Then studies on the structures of innovation such as networks and management accounting systems in creative and innovative settings will be presented. Finally, the chapter will discuss the extent to which the existing styles of problematizing innovation in accounting has addressed the issue of whether and how accounting has progressed in order to account for innovation.

## **1.1 The problem of immateriality and the roles of accounting**

The problem posed to accounting while dealing with innovation and knowledge is often presented as a problem of measurement and control over the immaterial resources of an organization (van der Meer-Kooistra and Siebren 2001). Accounting's mission of providing information for decision making while applying mathematical and logical rigour started to be challenged in the 1990s by discourses concerning the immaterial quality of knowledge. The problem of measuring knowledge and innovation was said to lie in the immaterial qualities of the objects to be measured (e.g. knowledge, skills, etc.). Measuring knowledge was in turn motivated by the aspiration toward "realising the true value" of firms (Edvinsson and Malone 1997). The issue of immateriality gained visibility in the context of the huge market-to-book ratios found in some industries during the 1990s. Where market-to-book ratio was regarded by some scholars (Lev and Zarowin 1999; Stewart 1997) as a measure of companies' intellectual capital. As Stewart (1997) stated "*everything left in the market value after accounting for the fixed assets must be intangible assets*" (Ibid., p. 224).

The studies reviewed under this section all engage with the emergence and operationalization of a category that since the late 1990s has contributed to the

framing of innovation and knowledge in organizations, i.e. “Intellectual Capital” (Edvinsson and Malone 1997; Sveiby 1997). The latter is not usually regarded as an accounting concept or ‘invention’ as such, despite the term ‘capital’ might resemble familiarity with conventional accounting terms. Its roots trace back to fields like knowledge management, human resources management and management of information technology.

The remainder of the section will review first the accounting literature that has investigated how a non-accounting idea, such as Intellectual Capital, has become part of organizations’ managerial practices and reporting. Then we look at how in turn the accounting imperative (Burchell et al. 1980) of providing useful information for decision making on the basis of mathematical and logical rigour has been challenged by a new narrative. Second, the section will explore the extent to which the accounting literature has investigated how social and institutional contexts have contributed to shaping the roles of accounting in the so called knowledge-based and innovation-driven society.

### **1.1.1 The sources of accounting roles and accounting change: intellectual capital statements as an organisational practice**

A first group of studies (Mouritsen, Larsen, and Bukh 2001b, 2001a; Larsen, Mouritsen, and Bukh 1999) contends that intellectual capital (IC) statement represents a *new* tool for communicating to stakeholders the attempts of the management and employees to create value and to be a ‘capable’ firm. In these studies it is contended that intellectual statements are *new* tools because of three aspects (i.e. the role of accounting numbers, the referents of IC narratives, and the concept of *value*) that will explicated in the following.

A first element of novelty emphasised in this literature lies in the role of accounting numbers. At the level of practices the role that accounting numbers play in IC reporting is different from the role that they usually play in the context of financial reporting. By studying intellectual capital reporting practices at Skandia, i.e. one of the earliest companies to develop intellectual capital supplements to financial reporting, Mouritsen et al. (2001b) show how the innovative character of such tools lies in the network of story-lines, sketches/visualizations, and

numbers/indicators. Looking more closely, of the 87 indicators reported in Skandia's supplements, 46 are financial. Mouritsen et al. hence suggest that such indicators are relatively routine and that there is nothing that makes them intrinsically related to intellectual capital. What makes them extra-ordinary is the way in which they are brought into a story line and made relevant to Skandia's knowledge narrative. In intellectual capital statements there is not a set formula or an integrated model culminating in one number that can be said to quantify intellectual capital. What counts is not the ability to quantify intellectual capital, nor is the mathematical rigor behind the indicators. What counts –the authors point out- is rather the presence of a numerical component in the intellectual capital statement which can be mobilized at any time in order to legitimise managers and show how “serious” they can be about the future knowledge strategies of the firm. In other words, intellectual capital functions as an accountability and reputation device.

Elsewhere, Larsen et al. (1999) emphasized how intellectual capital statement is not about quantifying intellectual capital. Intellectual capital statements are not measuring devices. Rather the object of IC statements is the set of knowledge management activities. The cases analysed by Larsen et al. encompass a range of knowledge management objects which are mobilized through IC statements' sketches, numbers and narratives. One case, for example, is the story of a recombination and modularization through IT and therefore a story of structural and organizational capital. Another case is centred instead on human capital and its re-qualification in order to be able to invent and develop relations with customers and technologies. Once more, far from being measuring devices, IC statements provide a tool for managing knowledge inside the organization.

A second element of novelty brought about by intellectual capital statement is related to its referents. A number of studies have suggested how, at the level of practices, intellectual capital statements are tools of communication mainly oriented to *internal* stakeholders (e.g. employees) rather than external stakeholders. In this regard, Mouritsen et al. (2001b) point to the *nature* of intellectual capital statement as an accounting mechanism employed to mobilize, persuade, and motivate the individual employee to render knowledge to the firm and in turn help management to achieve the strategic objectives. Far from being neutral devices, intellectual capital statements have a *performative* effect because they construct the reality they aim to represent (Mouritsen 2006). Similarly, Johanson et al. (2001) found out that the

management control of intangibles through organizational routines and activities has an instrumental role in mobilizing change within the organization.

Overall, the studies above show that the referents of IC statements can be only understood in the local settings where the intellectual capital reporting is developed. For example, in the three cases that Mouritsen et al. (2001a) investigate, management action ties (the narrative of) knowledge to different referents. As a consequence the ways in which numbers, sketches and narratives are combined depend on the *priorities* characterizing each setting. In the first of the three cases investigated the referents of knowledge are persons. In the second case the referents of knowledge narrative are efficient and high quality processes. In the third case the referent is the collective ability to create solutions.

A third element of change operates at a more conceptual level and is related to the concept of *value* embedded in IC statements. According to some scholars (Mouritsen 1998; Mouritsen, Larsen, and Bukh 2001b) there are fundamental differences between *value* as conceptualised in financial accounting and finance theory and value/valuing as conceptualised in the intellectual capital approach. Value as conceptualised in finance theory is mainly concerned with the past and valuing coincides with assigning numbers mostly based on historical costs of acquisition. The attempt to account for immaterial assets has resulted in the creation of a new accounting category such as *intangible assets* whose recognition and measurement are regulated under the IAS38 accounting standard.

Nevertheless, intangible as defined in accounting standards represent only a little part of the immaterial resources of the firm, the authors hold. In finance theory valuing means predicting the future cash flows of the firm and discounting them to the present. In this respect the authors point out that the “*number is not based on the verifiability found in receipt, but more in the trustworthiness of the procedures that the financial analysts make use of*” (Mouritsen et al. 2001b, p. 402).

Under the intellectual capital approach valuing is future oriented too, but it does not present the net present value of the firm as a pre-given. The authors argue that valuing is more concerned with *moving value and increasing it*. In other words valuing is about identifying the mechanisms through which value is created and transformed, rather than culminating in one single number. The intellectual capital statement is a network of narratives, sketches and numbers which far from having a

logical/mathematical closure are rather “composed and bundled” in order to create value.

A second group of studies is, however, critical of the role that accounting numbers has come to play in the context of intellectual capital statements and question whether accounting for IC is really something ‘new’. At a more conceptual level Roslender and Fincham (2001) question whether the intellectual capital (and related statements) really represents a progress in the accounting agenda, or whether contemporary accounting practices for IC are only variants of pre-existing models. To address this point, the authors observe how the one-page, non-financial supplements constituting the so called Skandia Navigator (i.e. Skandia Group’s intellectual capital model) can be viewed as a variant of the Balance Scorecard (Kaplan and Norton 1992). Roslender and Fincham (2001) illustrate this point showing that both the Navigator and the Balance Scorecard identify a number of focus areas or perspectives and, for each of them, a small number of key strategic indicators. Navigator and Balance Scorecard are both part of the same financial management paradigm that in recent history has aimed to impose structure of metrics on objects, with intellectual capital being the latest of such objects (Roslender and Fincham 2001). In this sense, one can argue that Navigator device borrows existing accounting tools, i.e. Balance Scorecard, while imbuing them with new rationales such as innovation.

In a similar vein Mårtensson (2009) discusses how the attempts to quantify human qualities and the idea of balance embedded in the balance scorecard and in the IC statement are not entirely new. More specifically Mårtensson offers an historical reflection on the rationales that has characterized the era of political arithmetic in the 17th century on one hand, and the contemporary practices of intellectual capital and human resources accounting on the other hand. She observes how the ideas of balance and quantification of human qualities seem to characterize the era of political arithmetic as well as contemporary management control models such as human resource costing and accounting (Gröjer and Johanson 1991), balance scorecards (Kaplan and Norton 1992) and intellectual capital (Edvinsson and Malone 1997). The aspirations driving contemporary measurement exercises are directed toward increasing organizational transparency to reveal where value creation takes place, Mårtensson suggests. Whereas political arithmetic aspired to the construction of an effective and rational society.



The idea that human qualities' quantifications are antecedent to the emergence of IC resonates with the hypothesis put forward by Roslender et al. (2001) according to which accounting for IC might be suffering the same fate as the project of Human Resource Accounting. The latter, Roslender et al. argue, progressively ended up being "imprisoned within the paradigm underpinning financial accounting and reporting" (p. 389) and subjected to "the prevailing financial mind set of periodic reporting, short termism and a "hard" accounting calculus" (p. 389). Accounting – and the critical accounting agenda- can have a role in avoiding such fate, the authors suggest. Hence, the authors argue for the importance of paying attention to how intellectual capital might account for itself. By empowering the employee through emancipative accounts of her lived organisational experience, organisations could manage more effectively their intellectual capital. Mechanisms of self-appraisal such as employee's accounts of the sacrifices, costs, benefits, and promises related to programs of skills development could constitute a contribution to changing direction in IC accounting practices, the authors argue.

In summary, the past two decades have witnessed the emergence of a number of studies that have analysed the accounting practices underlying the problem of measuring immaterial resources *within* the organisation. In this regard Intellectual Capital statements constitute an example of how metrics and indicators are used in conjunction with narratives and sketches and act as reputational devices. Parallel to such developments, proposals for employees' empowerment and employees' self-accounts in ever more individualized organizations, where the individual gains a stage role, begin to emerge in the accounting agenda.

Overall, the reviewed studies on immateriality show how contentious the idea of novelty surrounding Intellectual Capital Statements can be, and how organisations come to attach different roles to the same accounting tool (e.g. IC statements as reputational devices or as a tool for internal communication, etc.). By preparing and presenting IC statements, organisations are not just implementing essentialist ideas of accounting and innovation, but they continuously negotiate meanings and attach them to practices.

Intellectual Capital accounting is only one amongst the accounting tools that has come to be linked to the ideas of knowledge-based and innovation-driven society. IC reporting is only the latest accounting *technology*, where R&D accounting, human resources accounting, and human resources costing are other illustrative examples.

The history of quantification of immateriality –as Mårtensson (2009) reminds us- is older than IC developments and is characterized by cycles of failures and successes. These cycles are also reflected in the discursive patterns observable within the accounting literature (e.g. Human Resource accounting, R&D accounting, Intellectual Capital accounting, etc.). As Burchell et al. (1980) suggest, to better understand the development of the relation between accounting discourses and accounting practices we need to attend not only to practices *within* organisations, but also to their social and institutional context. To this aim the next section will review those accounting studies that have discussed the practices and concepts around immateriality and innovation within *institutional* and *social* domains.

### **1.1.2 The sources of accounting roles and accounting change in social and institutional domains: the emergence of R&D accounting**

“Given that the sources of accounting change were increasingly distant from the arenas in which the new practices were to function, there was no reason to expect why those rationales which had been used in the initial justification and development of any change should provide effective rationales for its public implementation. For in a social context, public actions need to have either a political means for their enforcement (Moonitz, 1974) or a wider social significance and legitimacy (Posner, 1974)”

(Burchell et al. 1980, p. 9)

This section will discuss how the accounting literature has investigated the institutional and social forces that contributed to shaping ‘new’ practices for measuring, managing, and reporting the immaterial resources of firms. As discussed in the previous section, example of such practices are IC statements and accounting for Research and Development (R&D).

One set of studies has focused on the contingent forces which shaped and gave political significance to accounting for Research and Development (R&D). In this regard, Robson (1994) explores how the desires for economic growth and competitiveness emerged in the post-war United Kingdom, in the context of the neo-

liberalist pressure for privatizing previously nationalized services and industries. The concern for economic growth and competitiveness was linked to discourses about science and technology through the development of R&D statistics. The latter made it possible to identify a gap in R&D levels between the UK and other countries (e.g. Japan and Germany). The gap constituted a *problem* that needed to be addressed by leveraging science and technology investments in the private sector while furthering ideals of deregulation and responsabilization. As Robson points out:

“Science and technology came to be perceived as a private sector problem, and the solutions proposed aimed at the self-regulation or responsabilization (Foucault 1982, 1988) of managers by “revealing” and rendering calculable R&D practices at the level of organization.” (1994, p. 166)

The problem of science and technology shifted to the private sector, where managers were to be made *responsible* for R&D within the organisation/firm. Tools for calculating science and technology activity at organisational level were also devised:

“The development of ‘stable and combinable mobiles’ representing R&D has created the space within the organizations for the calculation of science and technology, and given or created visibility to such practices within the organization” (Ibid., p. 167)

Accounting for R&D provided the link between science and economy, by installing calculative devices (R&D expenditures, etc.) within organisations. Chains of calculations, Robson (1992) argues, increasingly surrounded the practices of science and technology with the aim of making them calculable and governable.

In an effort to trace the origins of R&D calculative devices beyond the arena of UK policy making, Robson’s (1993a) study shows how the definition of R&D was initially proposed by the OECD in the “Frascati Manual” (OECD 1963), and only then translated into the arena of accounting standards in the UK. The standardization of R&D definition and its modalities of collection (OECD 1997) provided visibility to R&D activities in the UK and made it possible to make international comparisons. The level of R&D (expressed as percentage of R&D expenditure on Gross Domestic Product) became itself an issue to be concerned about and became intertwined with problems of economic growth and competitiveness.

Further explorations of the institutional and social context of accounting for R&D are provided in the comparative work of Willmott et al. (1992). Their analysis centres on the regulation of the disclosure and treatment of R&D in the financial

statements (i.e. accounting for R&D) in four advanced capitalist countries (the UK, Germany, Sweden; the US) and aimed to investigate the processes of accounting regulation and the processes of social and political regulation generally. The authors mainly draw on the corporatist framework and on the role of accounting in constructing and mediating different interests. Their findings reveal how the different and complex institutional arrangements in place within each of the four advanced capitalist countries investigated, differences which in turn can be ascribed to different cultural historical and socio-political structures, ended up in a process of convergence toward the final outcomes. Nevertheless, the authors argue that national corporatist arrangements are not enough to explain such process of convergence, which rather might be explained in the light of the “forces of internationalization (of capitalism)” (Ibid., p. 50).

However, the analysis of social and institutional contexts of innovation is not limited to accounting for R&D. There have been in fact attempts to account for IC practices beyond the space of the firm. Fincham and Roslender (2003) analyse the status of development of IC practices in the UK as compared to those contexts where IC was first advanced (e.g. Denmark, Sweden etc.). They also draw linkages between knowledge management repertoires and accounting, calling for more dialogue between the two fields in order to tackle the measurement, management and reporting of IC holistically.

Fincham and Roslender’s study looks also at the origins of IC conceptualization and set its emergence in the context of wider changes in the economy and society and in accounting’s neighbour disciplines. The ‘cultural’ turn in business and management, the shift to the information society and a new economy are central, they argue, in understanding the origins of IC practices. Other scholars in the field of economics (Granstrand 2000), similarly to Fincham and Roslender’s discussion, point to a shift towards intellectual capitalism, defined as a mode of capitalist economic system where:

“The basic capitalist institutions (private property rights, private profit motives, competitive markets and free enterprises) in which productive assets and processes, as well as commercial transactions and products, are predominantly intellectual or non-material rather than physical in nature” (Ibid., p. 1063)

Overall, a systematic historical analysis of the emergence of intellectual capital in locales distant from where practices are implemented is missing. As it is also missing in the literature an account of the contingent network of mediators and intermediaries (Latour 2005; Miller and O'Leary 2007) that has connected different arenas where intellectual capital discourses and practices take place.

In summary, many studies have offered a rich account of the organisational practices which mainly go under the umbrella of *intellectual capital*. The accounting literature provides also a number of studies on the historical and contingent emergence of R&D discourses and practices within regulatory and institutional arenas (Robson 1993a, 1994). What seems to be missing is an investigation of how these different locales become (or do not become) connected and form *assemblages*. In Miller and O'Leary's (1994) words:

“it is through the relations formed between the local conditions and those that are distant that the assemblage begins to form, not as a hierarchically ordered entity but as a complex of relays and relations that link together events on the same horizontal plane” (Ibid., p. 131)

This gap in the literature could be addressed by tracing the connections between social, institutional and organizational locales that form accounting problematics. It is in such domains that the forces that shape the progress of accounting agenda toward accounting for innovation need to be jointly investigated.

After discussing immateriality as a form of problematizing innovation in the accounting literature, the chapter now turns to discuss another form of research problematization focused upon the *structures* of innovation. There seem to be at least two types of structure that are often discussed in the literature, i.e. organisational and management accounting structures. In the past decades, an emerging trend in sociologically-oriented studies of organisations has regarded 'new' organisational forms, such as networks and inter-firm collaboration, as a locus of innovation and creativity (Powell, Koput, and Smith-Doerr 1996b). Networks and inter-firm collaboration have been investigated also in the accounting literature. The next section will argue, however, that the accounting literature has not focused very much on networks understood as organisational structures of innovation. The second type of structure often discussed in the accounting literature consists in management accounting and management control tools. The focus in this type of literature is

usually on the role of management accounting tools in enabling or constraining creativity and innovation.

The remainder of the chapter will discuss how accounting and other organisational structures are mobilised in the study of innovation. The literature has showed increasing interest for topics such as networks and inter-firm relations. While sociological literature has explored the interplay between innovation and network structures (Powell, Koput, and Smith-Doerr 1996b; Powell et al. 2005), the accounting literature has studied predominantly networks in contexts different from innovation (e.g. postal systems, public sector, corruption, port industry, etc.). Another recurrent trend in the accounting literature, while exploring the structures of innovation, centres on the enabling and constraining properties of management control systems. Where traditionally past literature saw management control systems as an obstacle to innovation, more recent trends have re-considered the role of management accounting and control and stressed instead their enabling properties.

## **1.2 The *organisational structures* of innovation: networks and inter-firm relations in the accounting literature**

Beyond the accounting problematization of innovation in terms of measurement challenges, innovation is often problematized in a sense of posing coordination challenges to the participants involved in its production and diffusion. Markets and hierarchies are said not to be the only forms under which economic transactions take place and innovation is certainly an area in which the dichotomy market-hierarchy is most challenged (Powell 1990; Powell, Koput, and Smith-Doerr 1996b). In management and practitioner oriented work, networks and collaborative models of innovation gained momentum in the early 2000s with the work of Henry Chesbrough on *open innovation* (Chesbrough 2003).

The accounting literature has been discussing network and inter-organisational relations since Hopwood's call (1996) to go beyond the "vertical imperative" (Ibid., p. 589) and investigate accounting in the lateral and horizontal processing of information. This resulted in a relative burgeoning of studies which questioned the role of management accounting within networks and inter-firm relations. Within this

group of studies, attempts to conceptualize accounting in network as a field of study in its own right have been put forward (Håkansson, Kraus, and Lind 2010). The line of enquiry mostly featured within such literature investigates the accounting practices that are deployed in network forms of organisation, and questions whether *new* forms of accounting are emerging from the field.

In order to account for these trends in the literature, a number of scholars reviewed the literature on networks and inter-organizational relations. Caglio and Ditillo (2008) conducted an extensive review of the literature on inter-firm collaboration. The authors classified the past research in the area of inter-firm relationships on the basis of the inter-organizational *control solutions* (Ibid., p. 866) discussed in the literature. They organized the literature according to the object of analysis: control archetypes (e.g. market, hierarchy, and network), management controls, cost and accounting controls. Other literature reviews were also conducted in order to analyse the state of the art in relation to management accounting in *horizontal organizations* (Chenhall 2008).

Nevertheless collaborative forms and networks in accounting literature have seldom been studied with specific regard to “innovation” as a phenomenon. Much of the accounting literature has looked at the role of accounting within networks in the context of corruption (Neu et al. 2012), health service providers (Lowe 2000), consultancies services (Mouritsen and Thrane 2006), international postal system (Richardson and Kilfoyle 2009), inter-firm collaboration (Håkansson and Lind 2004), port industry (Marques, Ribeiro, and Scapens 2011), and public sector (Barretta and Busco 2011) etc. None has specifically studied networks as forms for organising innovation.

The next two sections will gather and review a number of studies focusing on accounting in networks and inter-firm relations. Attention will be paid to a number of aspects. First, the next sections will discuss the extent to which accounting studies have investigated the changes in accounting practices brought about by the emergence of networks. Second, the next sections will discuss the extent to which the accounting literature has analysed the contribution of accounting practices to shaping the idea of network and coordination within networks. Third, the next two sections will explore the extent to which the accounting literature has looked at the social and institutional conditions that led to the emergence and development of new organizational forms.

## 1.2.1 The roles of accounting in networks and inter-firm relationships

The majority of accounting studies on network addresses, more or less explicitly, the question of whether network arrangements require a change in accounting practices so that the traditional accounting mission, i.e. providing useful information for decision, can continue to be fulfilled. The critical mass of these studies focuses on the accounting practices performed by organisations (i.e. predominantly firms) within networks. Other than accounting change, another recurrent theme within such studies is related to the co-existence of competition and collaboration forces, and the distribution of market, hierarchy and network structures within the same field. The remainder will review the studies at the intersection between accounting change and networks and explore whether and how these studies have studied innovation as a phenomenon.

While investigating the role of accounting in alliances and close cooperation between companies, Håkansson and Lind (2004) conducted a case study research of the interrelations between Ericsson and Telia mobile, their respective sub-units, and other related parties. As accountancy has been developed in accordance with the hierarchy-market dichotomy, the authors advance the hypothesis that there must be a need to change accounting when used in networks. However, their findings support Tomkins's argument (2001) whereby existing accounting techniques are still adequate in business alliances and networks. In fact, as the authors emphasize, no need for more formalized accounting information about the relationship or the counterpart seemed to arise in the Ericsson-Telia alliance. Another interesting aspect highlighted in Håkansson & Lind's study is that the same sub-unit did not always represent the interest of the parent company when interacting with different parties. In this sense, accounting helped to create a decoupling between the organizational boundaries as defined by the ownership structure and the boundaries of the actual alliance. In relation to the theme of collaboration and competition, the author emphasize that inter-firm relations should not be considered as a totality, rather they can entail different coordination mechanisms, i.e. market, interrelations amongst sub-units, and hierarchy.

Consonant with the findings of Håkansson and Lind (2004) and Tomkin (2001) concerning the absence of 'new' or 'more' accounting in network, is the study



conducted by Richardson and Kilfoyle (2009) on the changes in the governance structure of the international postal system between 1840 and 1875. Markets are based – the authors argue- on contracts between parties and the latter entail a great deal of mundane transaction costs to define and measure the goods and services exchanged and compensate the parties accordingly. Accounting information performs the role of mundane transaction costs in market settings. When the form of governance changes from market to other forms (e.g. networks), the role and the amount of accounting required might decrease, the authors suggest. In the case of the international postal system, changes in the governance were concerned with reducing transaction costs. This concern determined the transition from a unit (job) costing approach to a batch (process) costing approach. This meant that by using a small number of distance classes -rather than actual mileage travelled by each letter- or by designing the postage as either fully prepaid or fully postage due, the number of accounting entries was reduced and accounting progressively eliminated.

Rather than questioning whether there is more or less accounting in network settings (compared to market settings), Mouritsen and Thrane (2006) trace the changes in accounting roles within networks of partners. The authors find out that the traditional roles of accounting systems, such as ensuring accuracy and perfection, are displaced by the mediating role of accounting systems. The authors argue that previous studies on accounting and network identify accounting controls as distinguished from trust relations, or accounting as contrasted by forms of social control and overall tend to *assume* coordination and integration mechanisms within the network. In contrast, Mouritsen and Thrane aim to show *how* management technologies contribute to develop relations between the partners in the network. In all the three cases presented in Mouritsen and Thrane's analysis, the stable elements of the network are the management control technologies that outlive partners and organize the ways partners can engage with each other. In this sense the network is the management control technologies and not the partners, which instead can come and go. More specifically management control technologies contribute to develop and mobilize complementarities (i.e. customer information, marketing, sourcing, and learning complements) among partners within the networks. In other words, management control mechanisms influence the ways in which partners interact and determine how their obligations, activities, and freedoms are distributed. Complementarities are aided, facilitated and developed by means of two control

mechanisms: self-regulation and orchestration. Self-regulation mechanisms facilitate a smooth running of network interactions by separating financial from knowledge concerns. For example, intellectual property, brand name, and participation fees (i.e. financial concerns) are settled and agreed before interactions on projects and with customers take place. Orchestration mechanisms ensure the creation of a common and network-wide objective (or strategy). In the three cases presented, orchestration was achieved by means of competency map, intellectual capital statement, the construction of events aimed to build relations within the network, the setting up of self-regulating mechanisms during network-wide board meetings.

In conclusion, these studies contribute to analysing the roles played by accounting in networks and/or in the transition to network forms of governance. They look at accounting practices as developed within organizations and across networks. However, the accounting literature on networks and inter-firm relationship has not focused very much on networks understood as organisational structures of innovation.

The next section will consider the accounting literature that goes beyond the practices developed *within* networks and attends to the social and institutional contexts of accounting and networks.

## **1.2.2 The social and institutional context of accounting and networks**

This section questions whether accounting rationales and practices mobilised within networks (e.g. innovation rationale) have been investigated as the outcome of historically contingent social and institutional forces (Burchell et al. 1980). Only a few studies in accounting have paid attention to accounting and networks in their social and institutional contexts. For example, concerned with the *mediating* role of accounting is the study conducted by Miller and O’Leary (2007). Portraying the case of the microprocessor industry, the authors “*argue for greater attention to investment as an inter-firm and inter-agency process, thus lessening the fixation in studies of capital budgeting on the traditional hierarchical and bounded organization*” (Ibid., p. 701). Miller and O’Leary make a case for studying accounting and calculations as *intermediaries* that connect different arenas and social actors and in so doing link science and the economy and ultimately make the construction of markets possible.

The rather invisible linkages connecting the social and institutional contexts of accounting on one hand and the organizational context on the other hand are here made visible through the mediating role of accounting instruments.

Lowe's analysis (2000) is also concerned with bringing the social and institutional context *into* the analysis of accounting change. The paper narrates the story of Health Waikato Hospital (HW) in a problematic stage of its running. Following an operating loss of \$16 million in its first year of operation, which –it was feared- could have compromised the HW's ability to invest in equipment and technology in the following years, the government incorporated the hospital in a workout scheme. As a consequence of such scheme a lot of pressure was put on the regional health providers in order to improve profitability and efficiency performances. In the case presented in the paper, accounting practices within the organisations are *justified* and *developed* by discourses which take place *beyond* the hospital and the network of health service providers strictly speaking and connect to political concerns for efficiency at the level of the government.

Overall, the review of accounting studies that looked at the social and institutional context of accounting in networks suggests that little is known about the interplay between networks as a structure and innovation as a phenomenon. Accounting studies seem to be almost silent on the relation between innovation and network structures, and how the latter contribute to shaping the former. As showed earlier, most part of the literature in accounting analyses networks in contexts different from innovation, such as postal systems, corruption, and public sector.

One has to move from accounting literature to studies conducted in the field of sociology in order to see the theme of network discussed as an emerging structure that shapes innovation (Powell, Koput, and Smith-Doerr 1996b; Padgett and Powell 2012; Oliver 2004). The contribution of this stream of sociological literature to the study of innovation and networks, and the role played by accounting, will be discussed in Chapter 2 as part of a broader discussion on the theoretical perspective adopted in the study of processes of economizing innovation.

Nevertheless, even within this stream of sociological-oriented literature on networks of innovation the focus is not on the role that accounting practices play in configuring innovation. Thus, there seems to be a gap in the study of the triad accounting, network, and innovation. Addressing this gap would allow us to understand the extent to which accounting discipline and practice have changed in

order to keep pace with the coordination and measurement challenges imposed by innovation as a phenomenon.

After reviewing networks and inter-firm relations both understood as organisational structures of innovation, the next section will consider management accounting and control tools as forms of structuring innovation and creativity. This style of problematization often originates from those parts of the accounting literature concerned with the effects that management control systems have on creativity and innovation.

### **1.3 The *accounting structures of innovation and creativity*: management control systems**

Another style of problematizing innovation, other than the problem of realizing the value of immaterial resources of the firm, is in terms of the organisational and management accounting structures that either expand or constrain the space of innovation and creativity. In this respect there are at least two different approaches used in the accounting literature for studying the relation between management accounting structures and innovation/creativity.

A first approach investigates whether management control systems either hinder or facilitate innovation and creativity within organisations. Scholars have studied the effect of management control mechanisms in new product development (Davila 2000) and more generally in activities which combine formal controls and creative tasks (Adler and Chen 2011). Under this approach management control systems (MCSs) are defined following Simons' notion of MCSs, i.e. "*formal, information-based routines and procedures managers use to maintain or alter pattern in organizational activities*" (Simons 1995, p. 5). While innovation, under this approach, is usually associated with "*taking advantage of unexpected opportunities, exceptions, new relationships, uncertain outputs, risk and the possibility of failure*" (Davila, Foster, and Oyon 2009, p. 282). Yet, creativity in this literature is often presented as a driver of innovation(s) and is problematized in terms of how accounting contributes to expanding or contracting it. Where past accounting scholarship considered MCSs as an obstacle to innovation (Abernethy and Brownell 1997; Rockness and Shields 1984), more recent studies have stressed the enabling

role of accounting in 'creative' and 'innovative' settings. In this regard Davila (2010) points to a recent "shift in paradigm" from organizational efficiency to organizational creativity. According to the author, efficiency seems to become integrated with or replaced by concerns for organizational creativity.

According to Davila (2010) the shift from the efficiency paradigm to the creativity paradigm has determined not much a change in management control tools, but rather a change in the use of the 'traditional' management control tools. In this sense, budgets are not to be regarded as blaming devices, but as boundary systems. Yet, behavioural controls are not about limiting opportunistic behaviour, differently they contribute to defining the space of creation (Ibid., p.77).

Elsewhere Davila et al (2009) show how MCSs are vital to start-up growth, and the roles that the MCSs play are different from traditional roles. In this respect, the authors argue, MCSs help provide sense-making and a stable frame of reference, capture learning through time, and coordinate when informal systems break down, and legitimize the company. Davila et al provide a framework for analysing the roles of MCs in innovation. They classify the types of control systems in relation to the source of innovation (top management, rest of the organisation) and the type of impact on strategy (radical, incremental innovation).

Davila and Ditillo (2013) investigate the types of management control system adopted in working environments characterised by creative projects aimed at developing stylistic innovation. They find that traditional controls were integrated with mechanisms peculiar to creative settings, such as directional controls and inspirational controls. Directional controls were relevant in *defining* the creative space and the interfaces between the creative department and the rest of the organisation. The creative space was defined by means of accounting (e.g. *expenses budgets* and *cost cards*), behavioural and personnel (e.g. *collection brief*, *collection calendar*, and *selection of designers*) mechanisms. The authors find that directional controls configured the organizational setting to stimulate creative people, in contrast with past literature that saw direct controls as tools addressing goals divergence and executing pre-defined plans. Davila and Ditillo also observe that directional controls provide the *structure* of the creative processes while *enhancing* the novelty of the end results. Inspirational controls (e.g. ideational, aesthetic, and social networking controls) instead had the role of *guiding* the creative process in a sense of balancing

inspiration, compatibility of ideas, and external constraints, ultimately stimulating people “to create novel concepts that fit together” (Davila and Ditillo 2013, p. 3).

The common thread linking these studies is the way of conceptualizing the relation between managing accounting and controls and innovation. Management controls are said to *enhance*, *guide*, and *stimulate* the innovation and creativity process. Or conversely management controls are said to *hinder* and *constrain* innovation and creativity. Either way, the mutual production between structures (accounting tools) and the phenomenon observed is not investigated.

A second approach found in the accounting literature that studies the structures for innovation and creativity sheds light on the processes of co-production between accounting as a structure and innovation as a phenomenon. The processes of mutual shaping between the structures of accounting and innovation have been studied by Christner and Strömsten (2015). The authors investigate the process of new product development in the context of a biotechnological innovation (i.e. the Pyrosequencing technology). They trace the accounting devices mobilized along the different stages of technology development from the emergence of the scientific idea to the formation of a commercial company which then went public. The authors show how devices such as *market share*, *Internal Rate of Return (IRR)*, and *market valuation* (by means of discounted cash flow) contributed to *mediating* and forging linkages between scientific and economic ideas, and different actors (e.g. venture capitalists, scientists, and managers) and their concerns. Christner and Strömsten’s study shows how accounting devices can shape technology trajectories and in so they *enable* particular developments while *constraining* alternative courses of actions in new product development.

Other studies such as Revellino and Mouritsen (2009) contribute to the enabling/constraining debate around management control systems in the context of innovation, by looking at the development of a technology –Telepass: a smart system of electronic toll collection in Italian motorways. Telepass functioned through communication between a terminal installed on board of vehicles and the ground machinery integrated in the facilities of the toll collection booths. The system was proposed to regulate traffic and toll-collecting operation while promoting fast, smooth, safe, and informed mobility. Revellino and Mouritsen show that there were a number of technical and organizational trials that the technology had to face throughout its development. In each trial management control tools, such as “toll

collection dashboard”, “sales volume”, “mapping external contributions” and “Total Quality System”, were deployed in order to enroll stakeholders into fast, smooth, safe, and informed mobility programmes. In so doing management control tools contributed to the shaping of the innovation by relating organizational and social concerns (or challenges) to the technology.

Elsewhere Revellino and Mouritsen (2015) expanded the Telepass story to show how calculative practices, such as calculations about labour productivity and road safety acted as *engines* for the progressive construction of the innovation and the transformation of the company from service provider to financial institution. By accumulating knowledge and traces about motorists’ behavior, toll booth workers’ behavior, etc. the technology did not simply ‘record’ reality as camera would do. Differently the technology acted as an engine that lured actors into doing things (e.g. motorists reducing speed, weakening of collectors, increasing power of IT engineers etc.) and in so doing the technology performed certain ideas of safe, smooth and informed mobility.

Overall, what seems overlooked in the literature that explores the accounting structures of innovation (and creativity) is a discussion of what is known about innovation as a socio-technical phenomenon. The reviewed literature on the accounting structures of innovation sheds light on whether MCSs hinder or enable innovation. Such literature also provides insights on *how* management tools contribute to constructing and performing the object they aim to represent (e.g. innovations, new products, etc.). However, the questions of what configures innovation as an economic actor capable of driving an economy and influencing government policies, corporate strategies, and university’s mission seems to be overlooked. In other words, the economic content of innovation as a social and technical phenomenon and how innovation is *enacted* through accounting devices across different sites are issues to be further investigated.

## Conclusion

What do we know about the social, institutional, and organizational conditions and forces that made accounting *progress* toward the so called “innovation economy” and “knowledge society”? What do we know about the emergence and functioning of the metrological infrastructure that sustains and mediates the programmatic and

collective endeavours toward the knowledge-based and innovation-driven society)? In order to address these questions, the chapter has reviewed the accounting literature on innovation, or rather, it has reviewed how the accounting literature has contributed to problematizing and shaping the agendas underlying the innovation economy and knowledge society. Work conducted by past accounting scholarship has been collected and organised according to the different styles of problematization that usually characterise the wider notions of “innovation economy” and “knowledge society”.

The chapter has identified two main styles of problematizing and framing innovation within the accounting literature. One is the problem of immateriality (e.g. value creation, intangibles, R&D, intellectual capital), while the other is the problem of structures and their effects on innovation. Where structures are to be understood both as organisational structures (e.g. networks) and management accounting structures (e.g. management control systems) which can potentially enable or constrain innovation and creativity as a space. The chapter was structured around a group of accounting studies on immateriality and a group studies on accounting and organisational structures. These two groups were then analysed according to their focus on the institutional, social and organizational aspects of accounting and their focus on the sources of accounting *change*.

The first group of studies has addressed the role of accounting in measuring, managing and reporting intellectual capital, R&D and intangibles. They have done so either by looking at organisational practices like intellectual capital statements, or by investigating the institutional and social conditions at the origins of such practices. The findings from these studies reveal that intellectual capital statements constitute an example of how the mathematical and logical rigor traditionally associated with the accounting model has been supplemented with more ‘loose’ and narrative forms of reporting. At the same time metrics and indicators are employed in conjunction with narratives and sketches and fulfil the role of reputational and accountability devices. Besides, proposals for employees’ empowerment and employees’ self-accounts in ever more individualized organizations, where the individual and his knowledge both gain a stage role, begin to influence the accounting agenda.

While accounting literature does provide a number of studies on the historical and contingent emergence of R&D discourses and practices within wider regulatory and institutional arenas, a systematic historical analysis of the emergence of intellectual



capital in locales (e.g. economic theory) distant from where practices are implemented seems to be missing. What also seems to be missing in the literature that problematizes innovation in terms of immateriality, is an account of the contingent network of mediators and intermediaries or *assemblage* (Latour 2005; Miller and O'Leary 2007, 1994) that keep connected and aligned the different arenas where the practices and concepts related to R&D and Intellectual Capital are at work.

The second group of accounting studies has looked at the *structures* which characterise innovation and creativity. One type of structure emerging from the literature is mainly organisational and comprises networks and various forms of inter-firm collaboration (e.g. consortia, alliances etc.). Another type of structure emerging from the literature consists in management accounting and management control tools in creative contexts.

In relation to accounting studies of networks, none of the gathered studies has specifically studied networks as a form of structuring and coordinating *innovation*. Rather, existing studies have focused on corruption, postal transactions, public sector etc. Overall the research agenda of the existing studies in accounting and networks seems to be twofold: on one hand there are studies concerned with the nature (and the quantity) of accounting information employed within networks, on the other hand there are studies more concerned with the role that accounting plays in making/mediating network of firms.

Nevertheless, we know little about the conditions that led to the emergence of networks as “new” forms of structuring and organising innovation. More research needs to be done on networks and innovation as the outcome of processes of co-production at play across social, institutional and organisational arenas. In addition, more emphasis needs to be put on the effects of accounting in networks (e.g. decoupling between the formal representation of networks and their actual functioning).

Besides, the literature on the role of management accounting and management controls in enabling and constraining innovation (and also new product development and creativity) overlooks the fundamental issue of what constitutes innovation as a social and technical phenomenon. What is the role of accounting in configuring and assembling innovation as an economic actor capable of influencing universities' mission, corporate strategies, and government policies?

Since different forms of measuring and managing innovation have origins and sources that can be distant in time and space, then accounting practices might be influenced by (and also influence) different ways of framing innovation (e.g. innovation as financial sustainability, innovation as quality, innovation as public intervention). Different ways of problematizing innovation, other than immateriality and accounting/organisational structures, might emerge also at practice level. Therefore, research needs to be conducted in order to investigate the roles of accounting within and beyond different social, institutional and organizational locales in which innovation is implicated.

The proposition that this thesis aims to explore is whether accounting has innovated in order to measure, hence control, innovation as a phenomenon. *To understand the role of accounting in the dramatic expansion of the innovation-driven economy the thesis aims to address the following questions:*

1. What is the role of accounting in qualifying the entities of innovation as economic?
2. What qualifies an entity as economic in the realm of innovation?
3. What are the effects of this process of qualification/configuring?
4. Since innovation is said to drive economies, then how is the economic action of innovation (and its configuring) to be understood?

The thesis investigates the mutually constitutive relation between accounting and innovation by looking at the different modalities of configuring innovation in economic terms, as they are enacted across social, institutional and organizational locales.

The empirical focus of this thesis is on the development and enacting of University-Business interactions and more specifically on technology transfer and incubation programmes. As Chapter 3 will discuss, University-Industry interrelations in the UK have been constructed as a laboratory where the UK government has unremittingly devised and operationalized programmes for bringing about the innovation-driven economy and knowledge-based society. University-Industry interrelations resemble a laboratory whose survival and functioning rely on the coordination of a heterogeneous network of multiple actors (e.g. government, university, and industry), their aspirations, accounting practices, economic and social imperatives and technological artefacts.

The next chapter (Chapter 2) will discuss the theoretical tools and concepts employed to identify and analyse how accounting is involved in configuring innovation in economic terms. *Economizing* innovation is understood here as a multiple process during which accounting contributes to translating innovative scientific ideas into goods or services that can be exchanged and circulate in the economy. To the aim of identifying the entities of innovation that are being economised, the thesis proposes to change the focus from the study of the economy to the study of what is regarded as economic in the realm of innovation. This approach allows us to gain insights on the different practices that lead to the construction of economic markets. In this sense, social studies of science help to map out the differences and multiplicity emerging while calculating innovation and their consequences too. The performativity programme (within social studies of science) in this respect has long argued for the distributed and inherently variable configuration of economic agency. Their conceptualization of accounting as central in formatting different forms of economic agency seems therefore central to the investigation of different ways of measuring and organising innovation. This implies that accounting has a role in creating different modes of thinking about (and practicing) innovation in economic terms. The thesis argues that such differences matter because, in turn, they co-produce the content of innovation as a phenomenon.

The next chapter will also discuss how the process of rendering innovation actionable and thinkable in *economic* terms also presents patterns of regularity in the principles and devices that organise economic action within the field of innovation. In this respect new institutional theory provides the mechanisms (e.g. isomorphism) for interpreting such patterns. The next chapter will the theoretical and methodological issues and research methods involved in the study of economizing processes in innovation. The methods section will motivate and discuss how this thesis has investigated innovation across multiple sites, by means of semi-structured interviews with managers and scientists, while maintaining a non-essentialist view of what constitutes accounting and “a constructivist symmetry” in the treatment of innovation and accounting (Power 1996, p. 3).

# CHAPTER 2 ECONOMIZING INNOVATION THROUGH ACCOUNTING: THEORY AND METHODS

---

## Introduction

What is the role of accounting in translating innovative scientific ideas and technologies into goods and services that can circulate, be exchanged, and acted upon? The thesis investigates the entanglements between innovation, as a phenomenon, and the economy by attending to the role that accounting plays in economizing innovation. As highlighted by Çalışkan and Callon (2009, p. 391), in order to understand economization processes one has first to identify the entities that have been economised. In the context of this thesis, economizing means to translate the entities of innovation (e.g. new technologies, incubation projects, new scientific ideas, new drugs) into *economic* entities that possess economic value(s), that is into entities that can circulate and be exchanged within the economy precisely because of that economic value(s).

With this research agenda in mind, the chapter will discuss the theoretical and methodological implications of investigating the processes of economizing innovation. Part 1 will discuss how the performativity programme in social studies of science and new institutionalism in organisational analysis illuminate different aspects of economization processes. Part 1 will suggest that performativity programme sheds light on the emergence of multiple ways of making innovation visible in economic terms, while new institutional theory helps to interpret the emergence and diffusion of standardized ways of measuring and managing innovation. In Part 2 the research design, strategy and methods are presented. The methodological tools for addressing the interplay between theory and evidence are then discussed. Finally, a section on the process of data analysis is presented.

# **PART 1: THEORETICAL FRAMEWORK: THE STUDY OF ECONOMIZATION ACROSS ACADEMIC LITERATURES**

## **2.1 Translating innovation into economic value through accounting**

The escalating political concern for economic growth and for closing the productivity gap between the UK economy and other so-called advanced economies (e.g. US and Japan), has provided the conditions for the creation of new spaces of economic calculability, such as the one of scientific discovery and innovation. Against this backdrop, the topic developed throughout the thesis centres on the question of how accounting has translated scientific research developed within universities and corporations, into economic entities and how this has implicitly involved multiple efforts to realize and appropriate the economic value of innovative scientific ideas. In other words, the thesis investigates how the domain of scientific discovery and academic research has been problematized in *economic terms*, what economic terms mean, and what actors and instruments are involved in such problematization. To be more specific, the thesis will investigate the extent to which economics has become increasingly entangled with innovation and scientific discovery, and how accounting has made this intertwining possible.

Following and expanding existing lines of enquiry in new institutional sociology, social studies of science and technology, and social studies of accounting, the thesis advances that it is through accounting that innovation has been translated into multiple forms of value, of which *economic* value is the dominant form. This section will discuss the academic traditions that have brought economization at the centre of the research agenda, i.e. the performativity programme in social studies of science and new institutionalism in organisational analysis. The reasons for exploring these two literatures are several. First, both literatures regard economization as a central process in the construction of modern actorhood and economic markets. Second, both literatures contribute to the understanding of what qualifies a specific

behaviour, object, or institution as economic. Third, despite the different assumptions on agency, they both regard accounting as central in the construction and formatting of agency. Fourth, they attend to the mechanisms of circulation of accounting practices. Finally, both literatures have been investigating, albeit to different extents, topics of innovation and academic research commercialisation.

#### *Why to examine economizing processes?*

In their 2013 paper aimed at bridging accounting to organizational theory, Miller and Power (2013) developed the claim initially made by Burchell et al. (1980) according to which multiple are the roles that accounting has come to play within society. Building on a broad definition of accounting which includes a range of calculative efforts which extend to disciplines of statistics and economics, Miller and Power argued that accounting metrics and representations can shape people, practices, and organisations. They also argued that “*accounting is a mechanism by which the economization of organizational life becomes elaborated and institutionalized*” (Ibid., p. 558). They offered a conceptualization of accounting as “*a frame of meaning for actors rather than being purely external to it*” (ibidem, 2013, p. 579). Such approach “*draws attention to the rationales, such as efficiency, sustainability, and accountability, which motivate the production of accounting numbers*” (ibidem, 2013, p. 579). In such guise accounting does not merely inform economic decision-making, but it constitutes the domain of economic activity itself, a process this one that the authors refer to as *economization*.

In this sense, studies of economization challenge the often taken-for-granted ideas of ‘neutrality’ and ‘objectivity’ that surround accounting representations of economic and social reality. Studying how accounting contributes to economizing innovation does not mean, therefore, to assess how effectively and efficiently accounting tools are in capturing the value of innovation. Rather, it means to attend to the contingent interplays between the social and technical aspects of accounting practices and the implications of such interplays for the domain under study (i.e. innovation). Without this type of analysis, we fail to appreciate not only the multiple forms of accounting involved in innovation, but also the effects of such multiplicity on innovation as a phenomenon.

A first step of such research programme consists in raising the question of what qualifies an object or behaviour as 'economic'. This question has been also addressed within more sociological lines of enquiry. This chapter will look not only at how economization has been discussed in some parts of sociological literature, but will also attend to the ways in which accounting has been conceptualized within the frameworks developed therein. If on the one hand scholars in social studies of accounting have argued that accounting has come to play multiple roles in the construction and linking of economy, science and society (Power 1996), on the other hand different nuances in the sociological conceptualization of accounting generate different interpretations of the roles of accounting in organisations and society. In other words, not only does accounting represent a frame of meanings for participants (Miller and Power 2013), but also the way in which we frame accounting through different literatures lends itself to different (albeit not necessarily conflicting) insights about economizing and accounting.

New institutional theory regards accounting as a cultural model, as an institution. As the chapter will show, this way of conceptualizing accounting leads to investigating economization in terms of how accounting become institutionalized, how different models or standards of accounting diffuse across different societies, and how accounting norms and scripts contribute to the formatting of modern rational actorhood. The worldwide expansion of accounting as a structure contributes, in new institutional view, to an ongoing process of rationalization of modern actors (Meyer and Jepperson 2000). In the context of scientific discovery/research commercialization, the insights we gain from new institutional literature have to do more with how accounting contributes to: the construction of universities as organizational rational actors (Krücken and Meier 2006; Ramirez 2006), the institutionalization of technology transfer models within universities (Colyvas and Powell 2006), and the construction of networks of university-industry collaboration (Powell 1990; Powell, Koput, and Smith-Doerr 1996a).

Studies of economization carried out in the context of the performativity programme, (Callon 1998c) within social studies of science, implies a conceptualization of accounting that emphasizes its material aspects. In this sense accounting is understood as know-how, set of practices and methods which contribute to equipping calculative agents and enable them to undertake certain types of actions, i.e. *economic* actions (Çalışkan and Callon 2010). Such conceptualisation

of accounting leads to investigating economization in terms of *differences* in the distribution of competencies, know-how, knowledge, material devices, and forms of organization across society. According to Çalışkan & Callon, by attending to such differences we can understand how economic markets are constituted. In this respect they stress the role of disciplines such as accounting and management science in providing the know-how, methods, and tools for agents to calculate, hence construct, tradable goods and values. In that context accounting is not understood as a mere instrument to achieve certain ends, but it also has the power of creating the very object it aims to represent (Hopwood and Miller 1994).

In turn, the chapter will argue that different approaches to the study of economization, and related conceptualizations of accounting, draw our attention to distinct aspects of innovation. For example, the performativity programme attends to the specificity of the markets' arrangements, to the differences that arise between markets, to agencies and their asymmetries (Callon 2005, p. 17). In the context of this thesis, the performativity programme helps to analyse how accounting configures the economic agencies of innovation. It also helps to identify and make sense of the differences arising in configuring incubation projects, new drugs, and new technologies as economic entities. Whereas in the new institutional framework differences seem to be flatten (Latour 2005), and the focus shifts toward those micro and macro level mechanisms (Nee 2005, p. 76) such as isomorphism and standardization that enable the emergence and diffusion of cultural institution (e.g. markets).

While the performativity programme is the main approach used in this thesis, the attention of new institutional theory to processes of normalization and isomorphism is also relevant to the study of innovation. For isomorphism can help to interpret the patterns of regularity in the modalities of formatting the economic agencies of innovation.

The remainder of the chapter is organised as follows. New institutional theory in sociology is discussed first, followed by a discussion of the performativity program in social studies of science. Both literatures will be analysed in relation to economization processes and in relation to three main themes: agency and action, circulation, and the conceptualization of accounting and economization. Finally, the conclusion will highlight arenas of synergy and collaboration between the two literatures and analyse the extent to which they address the issues of multiplicity and



similarities. In this respect the notions of *accounting complex* (Miller and Power 2013) and *socio-technical agencement* (Çalışkan and Callon 2010) will be discussed. Despite the differences, what one can gain from the analytical exercise of contrasting the two literatures is a better understanding of the multiple roles that accounting plays in economizing processes and in the construction of economic markets.

### **2.1.1 Economization and accounting in new institutionalism**

The organizational research carried out within new institutional scholarship since the late 1970s has examined organizations and how their behaviour is shaped by institutional environment, cultural beliefs, and networks (DiMaggio and Powell 1983; Powell and DiMaggio 1991), and how institutions interact with social networks and norms to shape and direct economic action (Nee 2005). New institutionalism in organizational analysis takes as starting point the increasing homogeneity of practices and arrangements found in the labour market, in schools, states, and corporations. New institutional scholarship holds that such homogenizing tendency, i.e. isomorphism, in organizational life cannot be explained in terms of individual utility maximizing actors, but in taken for granted quality of practices and their reproduction in self-sustaining cognitive structures. New institutional scholars argue that individuals do not choose freely among institutions, conventions, social norms or legal procedures but they rather seek guidance from the experience of others in comparable situations and by reference to standards of obligations (DiMaggio and Powell 1991).

Economization is understood here as a process which contributes to the cultural construction of modern actor as a rational actor (Drori et al. 2003). Indeed, new institutional and world society scholars have long argued for processes of rationalization at play within society (Meyer and Jepperson 2000). In other words, economization is part of a broader rationalization process and it is also engrained in the proliferation of organisations across different domains of social life, among which we find universities. In this context accounting is viewed as a set of features that contribute to the legitimation of organizations through “*the construction of an appearance as rational and efficient actors*” (Carruthers 1995, p. 313)

### *The conceptualization of agency and actors in new institutionalism*

New institutionalism in organizational analysis affirms that actors –whether individuals, organizations, or nation states- are culturally constructed and their agentic properties are constituted by institutional norms and scripts which have increasingly, and in an isomorphic fashion (DiMaggio and Powell 1983; Meyer and Jepperson 2000), diffused throughout societies. Modern organizations as much as individuals are becoming progressively equipped with authorized agentic capabilities, i.e. the capacity and responsibility to act as an “other” to themselves, to each other, and for the wider cultural frame (Meyer and Jepperson 2000, pp. 101-102) (e.g. corporations have ‘social responsibility’ and ‘reputation’). In other words, an increasing isomorphic tendency characterises the agentic structure of individuals, organizations, and states (Meyer and Jepperson 2000, p. 112). New institutionalism in sociology also regards human ontology and material (non-human) ontology as fundamentally asymmetric, which means that their agentic statuses are not treated equally. This will constitute, as discussed later on, a fundamental point of departure from the definition of agency proposed under the performativity programme within social studies of science.

### *Mechanisms of diffusion: from isomorphism to translation*

In their 1983 seminal work, DiMaggio and Powell (1983) advanced the concept of institutional isomorphism in order to illuminate on the ceremonial character and the politics of modern organizational life. They identified three analytical typologies of isomorphism, i.e. mimetic, normative, and coercive and shed light on the processes through which ideas and practices flow. They also stressed the importance of professions, higher education, and media in furthering ideas and model embedded in modern organizations.

More recent trends in new institutionalism in organizational analysis have attempted to go beyond isomorphism as central mechanism of diffusion, and looked at more micro-level mechanisms. A number of scholars have attended to the ways in which individuals place themselves in social relations and how they interpret and respond to their institutional context (Powell and Colyvas 2008). To address this line of enquiry, they set a research agenda that employed, among the others, tools borrowed from the sense-making literature (Weick 1995). According to Powell and

Colyvas (2008) sense-making works as a key micro-mechanism of institutionalization in that it regards the process by which institutional material is “pulled down” by individuals and translated within the organizations, as being multiple and highly contextual. Mechanisms such as retrospection mediate between identities and the enacted environment in so creating multiple modes of meaning-making.

Another trend in new institutional scholarship has questioned the traditional mechanisms of diffusion (i.e. isomorphism) and introduced the concepts of editing and translation, to go beyond the idea that models of how to better manage and measure knowledge, education, and science are simply ‘carried’ across different institutional settings. While travelling the world, institutional practices, their adoption, and reception are influenced, they argued, by local contingencies (Czarniawska-Joerges and Sevón 1996). Carriers of ideas and models are not simply passive mediators, but they are actively involved in activities that are crucial for the flow and development of ideas such as interpreting, advising, suggesting, pronouncing (Sahlin-Andersson and Engwall 2002).

In turn, the analysis of the mechanisms of diffusion of institutional practices and models has been addressed at both micro and macro level. The next section will discuss a number of micro and macro level studies of processes of economization and their relevance for accounting and innovation.

#### *Accounting, Economizing, and the Construction of Rational Organizational Actors*

This section will look at a selection of studies that have specifically addressed the issues of economization, marketization and the role of accounting. Studies which operate at a more macro level of analysis are presented first and then the section will move to those studies that attempt to investigate how macro trends institutionalize at a more micro level.

At a more macro level of analysis, attention has been devoted to the expansion of organisations across different societal domains (Drori, Meyer, and Hwang 2006). In this respect, scholarly work conducted under the new institutional tradition looked at the processes of economizing education across the world system and the role of the nation state in spreading standardized models of education through policy-making. For example, Krücken and Meier (2006) looked at how universities have become

progressively constructed as organisational rational actors. They identified four main features which characterise the transition of universities to organisational actors. Increased accountability, the definition of goals (e.g. mission of teaching and research), the creation of formal structures (e.g. technology transfer offices) and the rise of management profession within universities have transformed, they argued, the space of higher education into an organisational space. Accountability in particular, has contributed according to Krücken and Meier, to create an environment where more demand for “university auditability” is the norm. In other words universities have increasingly become the object of assessment, evaluation, and accreditation processes. This has entailed the (problematic) proliferation of indicators (e.g. bibliometric indicators) designed to formally measure knowledge and education.

If on the one hand Krücken and Meier’s study shows how increased structuration and managerialization have contributed to ‘organizing’ universities as rational actors, on the other hand their study sheds light on how accountability mechanisms have contributed to the economization of universities. Assessments and evaluations processes –and the related proliferation of accounting measures- have constituted universities as actors endowed with agentic properties, such as responsibility and auditability, and ultimately have rendered them increasingly similar to business corporations.

Other scholars (Djelic and Sahlin-Andersson 2006) looked at the institutional forces shaping the field of transnational regulation. Djelic (2006) analysed the processes of marketization that have characterised the space of transnational regulation. Referring to marketization both as market ideologies and market-oriented reforms, Djelic discussed the origins of contemporary marketization, its ideological sustainability, and the global diffusion of market-oriented reforms. She identified a number of carriers or transmission channels that enabled the global diffusion of marketization. These channels were represented by organizational carriers (e.g. International Monetary Fund and the World Trade Organization), routines and institutionalized practices (e.g. accreditation and rankings), relational or social networks, and normative and symbolic systems (e.g. ideas such as competition, transparency, maximizing shareholder value, etc). Djelic also identified mechanisms and logics for the diffusion of liberalism, alongside the classical typologies of isomorphism. She found structuration, socialization, and political logics to be at play in processes of diffusion of marketization as a cultural model. Djelic’s work is

relevant in that it shows how a specific form of economization –that is the creation economic markets- had its origins in liberal school of economic thought. It also showed how the diffusion of economic markets found an ally in disciplines/expertise such as auditing/accounting and management which in turn contributed to the privatization of state regulation and the managerialization of state bureaucracy.

Moving from macro-level studies of organizing and economizing to studies that looked at the micro-level instantiations of broader trends, Colyvas and Powell (2006) showed how an institutional transformation such as the joining of science and property –two formerly distinct spheres- contributed to redefine the boundaries between public and private science. In particular, the authors argued that the process of institutionalization is the outcome of “self-reinforcing feedback dynamics of heightened legitimacy and deeper taken-for-granted” (p. 306). The empirical settings were based on Stanford University model of technology transfer. Colyvas and Powell (2006) found that, at Stanford University technology transfer office, legitimacy entailed a question of appropriateness which in turn was translated into different questions according to the different stages of legitimacy. In the most recent stage the questions were related to the preferences about the industry partner. Colyvas and Powell also found that, in the case of technology transfer at Stanford University, what came to be taken for granted was the concept of confidentiality when disclosing university inventions to industry. The authors therefore elaborated on those shared activities and conventions which define the way things (technology transfer) are or should be done. They found that such activities and conventions involved interaction rituals between university and industry, social learning and the development of collective understanding, elaboration of roles and activities (e.g. university licensing ‘liaison’ or industry’s academic coordinator), definition of social and technical categories like inventor and invention.

In conclusion, Colyvas and Powell’s study enriches our understanding of the “cultural” content of the model of technology transfer developed at Stanford University and the micro-level mechanisms that enabled its institutionalization. However, it seems that the economic aspects of the linkages between university and industry, and the commercialization of academic research, are completely dissolved in the analysis of the ‘social’.

Colyvas (2007) extended the work on technology transfer at Stanford University, by analyzing the development of revenue disbursement models within the university,

the practices they entailed, the meanings attached to those practices and how in turn revenues and rewards practices were linked to distinctive ways of categorizing inventions, inventors and the relation between science and business. In this case economic practices such as revenue sharing agreements were investigated in relation to the sets of meanings attached to such practices.

Overall, the section has looked at studies that analysed the origins and diffusion of cultural models (e.g. liberalism in economics, Stanford 'model' of technology transfer) and how these contributed to shaping organizations as rational actors. Economization was understood there as part of a broader process of rationalization at work at societal and organizational level. Organizational forms however are not limited to markets and hierarchies but also include, according to Powell (1990), networks. The next section will look at processes of economization in the context of networks, the latter understood as a form of organizing economic interactions alternative to market and hierarchies. It will explore studies that analyse (or set the agenda for the analysis of) the factors that generate, sustain, reproduce networks. The next section will also review those studies that regard on the one hand institutional infrastructures (e.g. accounting) as enabling condition for networks, and on the other hand historical political, and cultural context as influencing the capacity for collaboration.

#### *Organizing, economizing, and network forms of organizations*

Powell (1990) maintained that “*relational or network forms of organization are clearly an identifiable and viable form of economic exchange under certain specifiable circumstances*” (p. 296). If on the one hand Williamson’s work on markets and hierarchies (Williamson 1975) contributed to accounting for the centrality of organizational forms in economic transactions, on the other hand the market-hierarchy dichotomy it proposed to explain economic exchanges is questionable, Powell argued. More specifically, Powell advanced that “*firms are blurring their established boundaries and engaging in forms of collaboration that resemble neither the familiar alternative of arms’ length market contracting nor the former ideal of vertical integration*” (Powell, 1990, p. 297).

Some scholars argued that economic exchanges can be represented as a continuum between markets and hierarchies, where the intermediate zone was

populated by hybrid organizational forms like quasi-firms, subcontracting arrangements, joint ventures, and matrix management (Powell 1987). However, a number of social scientists contended that there was not such a strong distinction between market and hierarchy. Particularly a group of critics stressed the embeddedness of economic action in social and cultural forces (Granovetter 1985).

With regard to this thesis, Chapter 7 will discuss how the forms of economic exchange observed in the field of innovation, i.e. exchange of value for money, occur in a distributed fashion while mobilising a variety of entities that range from individuals and organizations to accounting devices and principles.

Although sympathizing with the thesis whereby economic action is embedded in particular social structural context, Powell's aim was one of identifying the factors that make it meaningful to talk about networks and that generate, sustain, and reproduce them. Powell claimed to align with the Simmelian idea whereby "*similar patterns of exchange are likely to entail similar behavioral consequences, no matter what the substantive context*" (Powell, 1990, p. 306). After providing a number of illustrative cases of network forms (e.g. networks, industrial districts, regional economies, strategic alliances, partnerships, and vertical disaggregation) spanning different industrial sectors, Powell concluded that "*the absence of a clear developmental pattern and the recognition that network forms have multiple causes and varied historical trajectories suggest that no simple explanation ties all the cases together*" (Ibid., p. 323).

Powell's findings are relevant to this thesis in that they recognize the importance of attending to the contingent aspects of networks. The governance of innovation – whether through hierarchies, markets, or networks- is a highly contingent endeavor in that it depends, above all, on stakeholders' configurations, their objectives and resources (e.g. models of technology transfer, valuation techniques, and performance measures). The thesis aims to show how such configurations can be highly transient and variable and how accounting has a role in shaping and stabilizing such configurations.

Finally, Powell drafted a research agenda which revolved around two lines of enquiry. First, he suggested complementing a search for causation and factors that enable networks formation and durability with an investigation of the political and economic conditions supporting network forms. Secondly, Powell called for attending to the phenomenological dimension of network, i.e. how participants

experience issues like collaborative and competitive forces, and problems of control. Another avenue to be explored –according to Powell- was related to understanding how information is processed through networks and how learning is sustained.

Overall, the accounting that inhabits networks and markets, as forms of organizing economic interaction, is conceptualized as an institutional infrastructure that contributes to either enabling or hindering the emergence and growth of networks and markets. In other words, the type of accounting in networks is the one that Miller and Power (2013) so conceptualized:

“While accounting is profoundly technical, its role in patterns of economizing means that it is also and simultaneously profoundly institutional, in the sense of exhibiting styles and patterns of thinking about organizations and management that may be quite stable, and that are supported by habituated routines and work practices which realize and reinforce those styles” (Ibid., p. 7)

However, in Powell’s analysis (1990) of the determinants of networks (i.e. know-how, demand for speed, and trust), calculative attitudes emerge only in the absence of trust among network participants. According to Powell, when trust ceases, calculative attitudes and formal agreements replace cooperative behaviour and informal agreements.

In the context of this thesis, the emergence of calculative attitudes within innovation networks has less to do with a lack of trust and more to do with differences in participants’ goals and interests. The entities participating in the action of controlling innovation translate their goals and interests in numbers by mobilising different calculative frames (or styles, as emphasised in the quote above). However, the interplay between participants and calculative frames is highly contingent and result in multiple calculative practices. In the context of this thesis, calculative attitudes do not emerge from a lack of trust or a lack of cooperation, but rather emerge from equipping economic agencies with calculative tools. Paradoxically, if we use Callon’s notion of calculative action (i.e. calculating understood as listing, prioritising possible states of the world, and deciding what action to undertake to make them happen) (Callon 1998c), also trust and cooperative behaviour could be regarded as the outcome of calculative action.

Shifting the focus from the study of the “social”, where culture is deemed to be a constitutive element of societies, to the study of materialities (Law and Mol 1995; Callon and Muniesa 2005) and the interplay between humans and artifacts, we get a



quite different understanding of the role of accounting in processes of economization. The next section will discuss the performativity programme in social studies of science and its contribution to understanding how accounting is involved in economization processes. It is in fact by attending to the roles that accounting plays in economizing things that one can better understand the mutual shaping between accounting and innovation.

### **2.1.2 The *performativity program* in social studies of science**

*The study of accounting and economization within the performativity programme*

A group of scholars within social studies of science has long investigated economizing as a central process in shaping markets, the latter understood as multiple forms of economic organisation (Callon 1998c). The so called performativity programme, as formalized by Michel Callon (1998c), advanced the notion of performativity of economics to emphasize the idea of an interplay existing between the economy and the theories of economy. Callon's position maintains that "*economics, in the broad sense of the term, performs, shapes and formats the economy, rather than observing how it functions*" (Ibid., p. 2).

The object of Callon's programme centred on how behaviours, organisations, institutions and more in general objects are constituted as 'economic'. Core features of the research programme on economization were three key agents: the theories of the economy, the institutional and technical arrangements that extend human agents' capacity for action and cognition, and the things –comprising both their modes of valuation, their outcome and their materialities (which in turn influence the possible modes of valuation). Such emphasis on materialities<sup>2</sup> is central to the understanding of the role of accounting within the framework of analysis offered by the

---

<sup>2</sup> To clarify what is meant by *materiality* Callon and Muniesa's illustration comes handy: "Materiality and physicality must not be confused. A fish sold on the Marseilles market or a week's skiing holiday bought by an English person dreaming of snow and sun are both material, in the sense that they both are things that 'hold together' and that can be appropriated because they have objectified properties" (Callon & Muniesa, 2005, p. 1233). Yet, Law and Mol (1995) offer a conceptualisation of materialities and sociality as mutually co-produced. Following this view, materials can be considered as "relational effects".

performativity research programme. Accounting understood in its both programmatic and technological dimensions (Rose and Miller 1992) is involved in the performativity/economizing programme at different levels. First, accounting –as a science- is involved in the formatting of calculative agencies. Second, accounting understood as accounting numbers (Robson 1992) is involved in the process of inscribing, that is the translation of one’s interest in a material form.

### *The origins of the performativity programme*

While locating the roots of the performativity programme in the pragmatist tradition, Çalışkan and Callon (2009) distinguished between a structuralist and a pragmatic approach to the study of economic valuation. A structuralist approach pays attention to structures such as 'regimes of value', 'spheres of circulation', and 'systems of exchange' and keep them separated from individuals. A pragmatics of economic valuation instead considers the relations between things, people and their context. In this regard, economic anthropology that focuses on regimes of value, has been analysing the contradictions/tensions between capitalism and non-capitalism, and between commodity versus gift. This "analytic binarism" has the advantage of describing multiplicity in the systems and logics that underlie economization.

However, a pragmatics of economic valuation goes beyond the mere description of such multiplicity and investigates the processes that originate such multiplicities and differences. This line of enquiry is the one also pursued across this thesis, which aims not only to account for the different practices of making scientific discovery visible in economic terms, but also to investigate the origins and effects of calculative practices. In Chapter 6, the origins of different ways of ‘calculating’ incubation are interpreted in the light of the calculative frames. As noted by Beunza and Garud (2007), the calculative frames mobilized by actors in the process of attributing value to incubation, are made of both material and cognitive infrastructure. According to the authors, calculative frames are made of “*analogies, categorizations, and choices of metrics*” (Ibid., p. 33). In this regard, Chapter 6 will show how the origin of calculative practices such as measuring incubation programmes by means of economic development indicators is to be found in the interaction between managerial principles (management by objectives), non-

accounting devices (input-output analysis), and accounting devices (performance indicators).

Consistent with the idea of calculative frames, Çalışkan and Callon (2009) advanced the idea of “modalities of valuation”. The later differ from 'regimes of value' because "*that a modality of valuation is enacted over another, at a particular time and in a particular location, depends only on the immediate circumstances of exchange*" (Ibid., p. 386). Referring to Guyer (2004), Çalışkan and Callon emphasised the multiple character of valuations and the fact that they are "*locally shaped by creative, imaginative, and calculative people*" (p. 387). *In other words multiplicities, differences, asymmetries in valuations are empirically proved to exist, but the authors argue they are not embedded in pre-existing regimes or spheres. As a result valuation is not the result of structures which determine/influence value by means of passive intermediaries but "it is a consequence of how competent and active people engage with specific things*" (Ibid., p. 388). It is –they argued- this hybrid configuration of competent agents and circulating material entities that are of interest in the pragmatics of valuation program. Not the demarcation and contrast of regimes such as reciprocity, redistribution or market transactions.

According to Çalışkan and Callon (2009), it is by looking at formalist and substantivist influences in economics, economic sociology, and anthropology that a pragmatics of valuation can be positioned (and justified). Both intellectual positions have, according to Çalışkan and Callon, contributed to advance the definition/investigation of economization by shifting the focus of analysis from the economy (noun) to what is regarded as economic (adjective).

In the context of this thesis, shifting the focus from the economy to what is regarded as *economic* means to look at how accounting practices contribute to transforming technologies/scientific ideas into goods/services that can circulate, be exchanged, and acted upon. This thesis aims to show how accounting *economises* innovation, that is how accounting renders innovation's entities thinkable and actionable in *economic* terms. This begs the questions of what the entities of innovation are, what qualifies them as economic, and the consequences of such processes of economization. The thesis adopts a pragmatic approach to economization in a sense of identifying and characterising those entities of innovation that have been transformed into something economic. This is done by observing the interplays between the social and technical aspects of a phenomenon,

i.e. the interplays between people (e.g. managers, scientists, accountants) and things (e.g. accounting tools, scientific ideas). Analysing the interplays between people and things in the production of economic entities means that economization is situated neither at the level of society, nor at the level of individuals. Nor is economization observed as the effect of imposing structures or regimes of calculation over people and things. Conversely, in this thesis economization is analysed in the contingent interplays between accounting tools and people in organisations. The thesis shows how controlling innovation is a form of distributed action, in a sense that controlling innovation involves a variety of actions (e.g. monitoring, budgeting, assessing), which are performed by a vast array of people and things.

On the one hand the formalist position in economics, which in turn drew on neoclassical economics, holds that individuals make decisions based on the maximization of their utility. This principle of instrumental rationality leads to 'economic' behaviours and applies universally both to Western and non-Western. According to the proponents of the formalist school, there can be variation and diversity in the concrete actions observed and this can be accounted for by using the notion of culture. In other words, in the formalist view, economizing is synonymous with instrumental rationality (i.e. the maximization of an individual's utility function) and its modalities depend on the cultural model in use within a certain society.

On the other hand the substantivist school was rooted in another stream of economic thought, i.e. political economy, and regarded economizing as a sort of provisioning. To put it differently, according to the substantivist school the term 'economic' refers to anything (e.g. behaviours, activities and forms of organisation) that can be linked to those processes through which a society meets its material needs. Such processes -typically of production, distribution and consumption- involve a variety of institutional configurations which revolve around three modalities of circulation: reciprocity, trading and redistribution. Given the variety of institutional arrangements and modalities of circulation, it follows that instrumental rationality is only but one of all the possible economic rationalities (i.e. the one underlying trading mode of circulation).

How and to what extent have disciplines such economics, economic sociology and anthropology taken on board the debate between substantivism and formalism? The message that emerges from the debate is that to understand economization one has to

"identify and characterize entities that have been 'economized'" (Ibid., p. 391). In this respect the thesis aims to identify and characterize how the entities of innovation (e.g. scientific ideas, incubation programmes) have become economized. Economics, economic sociology and anthropology have, according to the authors, situated such economized entities between the individual and society. More specifically, economics has attributed to institutions the role of "socio-cognitive prostheses" designed -also by economists- to overcome agent's cognitive limits. From the perspective of economics, according to Çalışkan and Callon (2009), economic action and the construction of economic markets both require economics to design suitable institutions. The influences of formalist school are here most evident.

Economic sociology instead, as also discussed earlier in the chapter when presenting new institutionalism, regards both Western and non-Western economies as the outcome of institutional arrangements, networks, power and fields at plays in different times and societies. On this basis economic sociology tends to deconstruct economy in order to show how contingent historical processes are at play within the economy. Through the concept of embeddedness -which determined the shift to the so called 'new economic sociology'- it is claimed that the study of economy cannot be kept separated from the study of society. The emphasis of new economic sociology is on the idea that the economy is embedded in society and economics is embedded in sociology. Finally, anthropology has taken on board the task of investigating the role of materialities (e.g. standard, techniques, calculating instruments, etc.) in the processes of economization and in the processes of economic valuation. It is in this context that a pragmatics of economization/economic valuation is advanced.

However, the shift to a pragmatics of valuation implies not only distancing from structuralism, but also from the ontological asymmetry of humans and things. Such asymmetry is -according to Çalışkan and Callon- built into the infrastructure of economic thought, in "*the taken-for-granted relationship of production and consumption which presume the ontological divide between animate and inanimate entities, even though this is simply one mechanism for organizing the transformation of beings and their mutual attachments*" (Çalışkan and Callon 2009, p. 390).

The economization/performativity programme poses a distinctive set of assumptions about agency, its sources and distribution. These assumptions will be discussed in the next section.

### *Agency and the sources of calculativeness*

Understood as a capacity to act and to give meaning to action, agency in Callon's framework "*can neither be contained in a human being nor localized in the institutions, norms, values, and discursive or symbolic systems assumed to produce effects on individuals*" (Callon 1998b, p. 4). Action instead takes place in "*hybrid collectives comprising human beings as well as material and technical devices, texts, etc.*" (Ibid., p. 4). According to Callon, forms of agency are multiple and diverse, depending on how they are framed. Types of agencies can be pinned down to adaptive behaviours, reflexive agencies, calculative or non-calculative agencies, or disinterested or selfish ones, and they may be either collective or individual. I will focus here on one particular type of agency, that is the calculative agency. In fact, economization and market organisational forms are, according to Callon, accomplished through calculations and calculative agencies.

Calculative agencies are investigated in Callon's framework in relation to several dimensions. A first dimension has to do with the source of calculativeness, where by calculativeness Callon means the conditions under which economic action becomes calculable (Callon 1998a). A second dimension has to do with the modalities of calculating. Finally, a third dimension is related to how calculation and calculative agencies proliferate.

In relation to the sources of calculative action, the performativity programme locates them neither in cognitive psychology where calculative mental capabilities are presumed, nor in cultural sociology where cultural frames are deemed central to agents' calculative competences. Sources of calculativeness are instead to be found at the intersection between the materialities of things (e.g. accounting tools) and people's skills and competencies, where people are regarded as active and competent individuals (Çalışkan and Callon 2009). As discussed earlier in relation to new institutionalism, modern agency tends to assume over-socialized actors, that is actors who act as cultural dupes and passively adhere to social norms and scripts. In that framework, agents who operate in market contexts are simply better equipped with socio-cultural frames, or their institutions, than others. While maintaining that actors need indeed to be equipped, Callon argued that the sources of actors' calculative competencies are not to be found in institutions.

In responding to a critique of his work *The Laws of the Markets* (Miller 2002; 1998c), Callon further elucidated what constitutes agency in the context of the performativity programme:

"The actors that he (Miller 2002) brings into play are those usually studied by the social sciences. We find individual actors and collective actors (e.g. social classes) framed by institutions, values, worldviews, interests, etc. Nothing is said or even suggested about the place of materiality, about socio-technical agencements and consequently about the possible shaping of agencies who must be seen as susceptible to be (re)configured and built up" (Callon, 2005, p. 13).

According to Callon, an actor's calculative competencies lie in her ability to enter relations with other actors. The source of calculativeness is therefore a relational one because, it is argued, action within a network of relations can only be calculative. In order to explain this passage Callon draws on the example of two market participants –A and B- who are involved in a transaction, and a third actor –C- who acts as an intermediary for that transaction. Each of these actors will define their position in the negotiation/transaction by drawing a list of the entities involved, of possible world states, of possible actions and expected outcomes. The actor –say A- will include in her list of entities also B and C and their respective possible decisions. One can therefore understand A's identities and decisions only by taking into account B and C. Ultimately, according to Callon, this process of listing and ranking/prioritizing defines what constitutes calculation (Callon and Muniesa 2005).

There are two implications here. First is that calculation/calculating does not necessarily involve numbers in that ranking/listing/prioritising constitutes already a form of calculating. Second each actor will be able to draw that list/ calculate only if she enters a relation with other actors. By drawing lists of entities and possible world states what the actor A does is to frame the interactions in a way that includes both B and C in the analysis. In this sense the purpose of framing is to detach/disentangle/cleanse of ties the entities which are to be included in the frame. Although framing is supposed to disentangle the entities involved in the transaction from all the ties they have, what framing generates –according to Callon- is quite an opposite effect.

In other words, framing is likely to generate new entanglements because by including B and C in the frame a new set of ties are also brought in. Framing entails establishing rules of inclusion and exclusion. However, according to Callon, the very

act of setting up frames is conducive to (and potentially generates) overflows. The notions of framing and overflowing are rooted in the idea of action as a collective property that inevitably overflows. In order to be attributed to a particular agency, action has to be framed (Callon 2005, p. 4). In the context of this thesis, if one considers a research contract agreed and signed by university and industry, the contract binds not only the two institutions but also the pool of resources they bear (e.g. academic and non-academic staff, library resources, etc.). The idea of overflowing is that those resources that are included and regulated in the contract are conducive to other sets of relations, events, actions that were not originally foreseen in the initial contract. To illustrate the twin concepts of framing and overflowing, Callon brings the example of a transaction involving the purchase of a car. The two parts involved in the transaction, i.e. the buyer and the seller, would not be able to reach the end of the transaction if the car market –Callon argues- was not framed. For the transaction to take place one has to exclude from the frame a number of effects that the car transaction can potentially generate, such as effects on traffic jams, climate change, exploitation of workers in countries of the South working for car manufacturers, the victims of road accidents, etc. (Callon 2005).

The process of framing enables the transaction to take place, but it does not mean that that particular frame has crystallised, since the parties affected by the overflows will try to negotiate a new frame which internalize the overflows. Once the transaction takes place the good, i.e. the car, which was previously objectified/framed hence disentangled from the buyer's world, becomes attached to the buyer's world and her network of relations.

#### *Formatting calculative agents*

A second dimension investigated in Callon's analysis of markets and economization is related to how different styles of calculating/framing emerge and the extent to which they compete with each other. To put it differently, there are different sources of calculative action and these different sources depend, according to Callon, to different ways of formatting. In the context of this thesis, Chapter 7 will discuss how the sources of calculative action can be found in the interactions between accounting and managerial principles, and accounting and non-accounting devices. The interactions between these entities vary according to the arrangements under



observation. However, Chapter 7 will show that, other than differences, there can also be patterns of regularity in the sources of calculative action, that is different arrangements can feature similar sources of action (e.g. the management by objectives principle and the input-output framework constitute the source of action for several R&D funding programmes).

Formatting calculative agencies means to provide agencies with different frames of reference that in turn inform and shape their calculations. Many can be the sources of formatting. Among these, social sciences and economics are, according to Callon, notable examples of such formatting work. By creating frames of reference, i.e. economic models, economics provides different styles of formatting calculative agencies. The mutual relation between economy and economics is one where economy and economics perform each other. Performativity is the outcome of a process where the economy (as a thing) and economics (as the discipline which studies the thing) mutually influence –or better- perform each other. This mutual shaping, however, does not happen automatically. According to Callon, accounting (as much as law and marketing) tools are needed in order to mediate between the realm of economy and the realm of economics. In this respect, accounting acts as a mediator that links economics to the economy, while maintaining both as independent entities. Accounting provides the tools for framing interactions and enacting the calculative agencies and in so doing it mediates between theories of economy and economic practices. An illustrative example here is provided by the use of discounted cash flow formula for valuing new drugs across the stages of discovery and development (see Chapter 4 for more details). In this case accounting mediates between the estimates on R&D costs provided by health economics' studies and valuation practices used by companies.

To better understand the role of accounting in the mutual shaping between economics and the economy, scholars have investigated which qualities of accounting make such shaping possible. While referring to the Latourian notion of inscriptions (Latour 1987), Robson (1992) explored the qualities of accounting numbers that appeal to broader aspirations of control at a distance. Building on the notion of inscription as a material translation of any setting that is to be acted upon, Robson showed how qualities of inscriptions such as stability, mobility, and combinability resonate with those of accounting numbers.

First, the mobility of accounting numbers enables, alongside with their written quality, the visualization and movement of otherwise spatially and temporally dispersed corporate accounts (e.g. loans, cash flows, etc.).

Second, for accounting numbers to be acted upon at a distance they need to show stability. In other words they should be recognized by their users as accepted conventions/rules. The tendency towards normalization, standardization, and homogenization of forms of accounting codification contributes to create stable inscriptions. Accounting numbers can also be combinable –in the sense of being prone to processes of aggregation and accumulation- and this quality might be strongly related, according to Robson, to their numerical and conceptual character. The combinability of things that are different is achieved through accounting numbers. Combinability makes comparisons possible and, through processes of quantification, allows to perform calculations upon different things (e.g. averages, ratios, valuations etc.).

Callon's notion of calculation entails listing entities, states of the worlds, possible actions and outcomes, and ranking/prioritising them. In Callon's notion of calculation not all the framing efforts take the form of numerical representations. Framing efforts can also take the form of classification. As Espeland et al. (2008) noted in fact there are forms of quantification that name phenomena and forms of quantification that commensurate them. In this respect, accounting not only provides a numerical metaphor that contributes to formatting calculative agencies, but also constitutes a technique of classification.

However, economics alone cannot explain the changes in the styles of formatting calculative agencies. According to Callon, to understand such changes one has to look at the role of the State. By means of policies, rules, and legal frameworks the State plays a constitutive role in the economy. This thesis advances that changes in formatting of calculative agencies can be interpreted as the outcome of the interplay between economic theories and the rationales, programmes and technologies of government (Rose and Miller 1992). In this regard, Chapter 3 shows how changes in the discourses surrounding innovation can be traced historically in the economic and political conditions that led to the emergence of R&D productivity as a problematic of government. This thesis advances that changes in the formatting of innovation's calculative agencies were co-produced by changes in economic paradigms and in programmes of government might be, in other words, co-produced by historical and

political conditions. In the context of this thesis, the shift from neo-classical to neo-institutional/evolutionary approaches to innovation (Etzkowitz and Leydesdorff 1995; Nelson and Winter 1982), was reflected in the aspirations of the British government toward increasing economic growth and national productivity through research commercialisation (see historical reflections in Chapter 3). In the 1980s, the regime of direct control on research commercialisation was displaced by forms of governing innovation at a distance through mandated calculations, which aimed at realising the value of governmental programmes for technology transfer and incubation.

#### *Mechanisms of proliferation: disentangling/entangling and circulation*

The third aspect in Callon's theorization of markets centres on the mechanisms through which calculative agencies and calculations proliferate. Callon argues that framing –while temporarily disentangling objects from the network of relations in which they are embedded- also constitutes a source of new entanglements. This process of creating new attachments by cleansing previous/old ones, can be regarded as the mechanism through which calculative agencies proliferate.

To illustrate the concept of entangling and disentangling one can draw on the case of the invention disclosure submitted by an academic to a university technology transfer office (see Chapter 5 for more details on invention disclosure). By signing and submitting an invention disclosure, the academic agrees on a number of issues. He agrees to disclose to the technology transfer office all the relevant technical elements of the invention, and the details of any past and future papers, disclosures, presentation at conferences that the academic inventor has done or plans to do. He also agrees –in some cases- to a defined revenue sharing agreement which determines how revenues from the invention are going to be distributed among the inventor, the department, and the university. In other words, the invention disclosure frames the interaction between the academic and the university. In the moment that the academic inventor signs the disclosure, he agrees, for example, not to pursue commercialization opportunities without involving the university. The disclosure has disentangled the academic from his own network of relations with industry, with external collaborators, with colleagues at the pub, but has also created new entanglements with the department, the technology transfer office and the university.

A new entanglement because once an academic has opted in and disclosed the technology to the technology transfer office, he is bound to a series of arrangements (if the technology is then actually commercialised). He is entangled, for example, in the web of calculations included in the revenue sharing agreement (see for example Table 5.1 in Chapter 5). Interactions, however, happen all the time and if the academic goes down to the pub and shares his scientific ideas with colleagues from other neighbouring universities or companies then, unless the reality of the overflow is proved (i.e. sharing scientific ideas outside normal work, in the pub, with friends), it is not possible to frame that sort of interaction.

New entanglement means new associations and the latter, as Latour stressed, are a source of power. In this regard, Latour argued how the constant circulation of documents, stories, accounts, goods, and passions are those that construct a corporation as a ‘big’ and ‘powerful’ actor (Latour 2005, p. 179). It is through the constant circulation and aggregation of data from one centre of calculation (Latour 1987, p. 232) to the next that actors become powerful. When the UK government allocates innovation public funding on the basis of a *formula-funding* (see discussion in Chapter 5), the data that enters the formula is the result of sequences of aggregations which involved layers and layers of data to feed into Excel spreadsheets. Measures such as the number of spin-outs generated by a university in a year are devices that mobilize data that travel from the individual academic/start-up funder all the way through the technology transfer office, the finance department of the university until reaching the higher education statistics agency.

#### *The study of markets as a case of economization*

A place where to start the investigation of economization processes is –according to Çalışkan and Callon- the market and the processes that lead to establishing markets (i.e. marketization). The challenge in studying marketization is partly motivated by the fact that contemporary societies tend to conceive of market forms as all identical. Çalışkan and Callon advance that their approach attends to differences and diversity in market forms rather than taken market as a monolithic concept. Referring to markets and processes of marketization in the plural means to recognize and attend to the infinite ways of configuring calculating equipment and material devices. To put it

differently: "[T]he trajectories taken towards the achievement of markets are never of a singular course" (p. 4).

Popular conceptualization of markets regards them as "institutions that favour the creation of values by organising competition between autonomous and independent agents" (p. 3). Çalışkan and Callon propose a definition of market that –while still compatible with the popular conceptualization- insist on the materialities and technicalities, as well as knowledge and skills developed by market agents themselves. In other words, first markets organize the conception, production and circulation of goods, and property rights attached to them. Second markets are arrangements (or better *agencement*, as Çalışkan and Callon would say) of heterogeneous constituents (i.e. rules, conventions, technical devices, metrological systems, technical and scientific knowledge, competences and skills. Third markets "*delimit and construct a space of confrontation and power struggles*" (p. 3) where multiple definitions and valuations of goods and agents oppose one another.

Investigating the marketization processes means attending to the processes and the elements that determine the diversity of markets. Bearing this in mind, Çalışkan and Callon single out five types of framing markets:

1. pacifying goods (i.e. determining the value of goods),
2. marketizing agencies (i.e. calculative agencies),
3. market encounters,
4. price settings,
5. and market design and maintenance.

First, pacifying goods means to transform entities from entangled beings into passive things. This entails a process of reducing natural objects (from wild unknowns) to things with fixed qualities and incapable of expressing novelty or unexpected characteristics. In this respect, science and technology studies offer strategies for analysing the process through which entities are framed as passive and valuable. Such strategies include Callon's twin notions of framing/overflowing (Callon 1998a). Framing entails, as discussed earlier, establishing rules of inclusion and exclusion. However, according to Callon, the very act of setting up frames is conducive of (and potentially generates) overflows. With regard to this thesis, in the context of the due diligences carried out by technology transfer offices within universities, new technologies are assessed in terms of their commercial potential. The value of a technology is estimated by listing competitors, the size of the existing

market, the number of people affected by a particular disease that the technology aims to cure, etc. All these represent attempts to qualify and pacify the technology.

Second, marketization –compared to other forms of economization- is characterized by the multiplicity and diversity of actors competing to participate in defining goods and valuing them (p. 8). An inventory of such multiplicity of actors is an essential part of a study of marketization processes, Çalışkan and Callon argue. In this respect the notion of *agencement* is advanced by the authors as a methodological tool which is aimed at capturing multiplicity and diversity. Socio-technical agencements “are comprised of human beings (bodies) as well as material, technical and textual devices” (p. 9). And yet “agencements are arrangements endowed with the capacity to act in different ways, depending on their configuration” (p. 9). With regard to this thesis, considering arrangements from their capacity to act means, for example, to analyse a R&D funding programme in terms of the effects it generates on people (e.g. project managers) and things (e.g. the trajectory of a funded R&D project). In this respect, Chapter 7 will discuss what the effects of controlling innovation are and conceptualise these effects in terms of tensions between different versions of the value of innovation.

There are according to Çalışkan and Callon, at least three advantages from using the notion of agencement. First, it does not impose any *a priori* distinction between different types of agency, in so allowing for the continuous proliferation of differences to be accounted for/analysed. Second, agencements enable to study any actors, regardless their size/strength. In fact as similarly argued in Callon and Latour (1981), macro-actors are not bigger than micro actors and any *a priori* assumption about their size cannot be made. Their size is the same and in this sense they are *isomorphic*. What makes them different lies instead in that –compared to micro actor- macro actor is a force capable of associating so many other forces that it acts like a ‘single man’. In this sense an organisation, such as a corporation, is not different, in terms of complexity, from a single human being. Third, agencements do not distinguish between collective and individual action, but rather leaves the attribution of agency open. The reason for this, in Çalışkan and Callon words, is that: “All action is collective since it is distributed; what vary are the mechanisms for attributing the source of the action” (p. 10). The notion of socio-technical agencement helps address the issue of agency distribution. It casts the question of how differences in competencies, know-how, knowledge, material devices, and

forms of organization become distributed across actors and ultimately contribute to the constitution of markets. In this respect Çalışkan and Callon point at the role of disciplines such as accounting and management science in providing the know-how, methods, and tools for agents to calculate/construct tradable goods and values. This thesis contributes empirically to Çalışkan and Callon's notion of distributed action, first by showing that controlling innovation is a distributed type of action and second by showing that, while accounting devices (e.g. performance indicators, R&D budgets) are deployed across different arrangements (e.g. university incubators, corporate R&D unit), their enactment occurs according to modalities that are specific to each arrangement.

The asymmetrical distribution of competencies leads, according to Çalışkan and Callon, to inequalities and results into struggles for those who are under-equipped. For example, the liberal subject (both collective and individual) should be able to interact, define objectives, calculate interests and also enter complex negotiations (i.e. utility maximization). However, formatting this type of agency is particularly costly and might result in uneven distribution of competencies with the consequent inability to act and calculate. Asymmetrical distribution of agency results into relationship of domination where those under equipped are bound to succumb. In this respect, Chapter 6 will show how the emergence of quality and health-related frames for calculating the value of incubation programmes struggled to emerge. They both struggled compared to other calculative frames such as the commercial, economic development, and the finance frames. Struggles are partly due to the fact that the agents involved in incubation are not particularly equipped to calculate incubation in terms of quality and health outcomes, or when they are they still struggle in that their frames do not translate into economic terms.

The constitution of agents as autonomous constitutes as a pre-condition to the 'legitimate' distribution of asymmetries. Such ambivalent reality is highlighted by Çalışkan and Callon as follows: "*it is by affirming the autonomy of calculating agencies that markets are able to conceal and to legitimately impose the asymmetries that develop out of the achievement of calculative capacities*" (p. 13).

Third, market encounters between calculative agencies and goods do not happen haphazardly, Çalışkan and Callon hold. They are also framed and formatted through calculative devices. In this respect the role of non-humans in mediating such encounters is central. This is particularly evident if one considers the rise of

computerization and automation and its consequences in the shaping of markets (especially financial markets, but also firms). An interesting aspect here involves mapping the attribution and apportionment of agency between humans and non-humans established within encountering devices (p. 16). Such devices do not simply act as ‘intermediary’ but as ‘mediators’. Referring implicitly to a debate on the role of intermediaries versus mediators (Latour 2005), Çalışkan and Callon emphasizes how the concept of mediator is much more dynamic and hints to the fact that the mediator has an active role in producing a certain (desired) outcome. In this respect, Chapter 4 shows how a R&D budget does not merely express a future plan in quantitative terms, but it mediates between different positions within the organisation, and contributes to embedding the tensions between such positions (e.g. the tension between financial sustainability frame and innovation/quality frame).

Fourth, when it comes to define price-setting Çalışkan and Callon draw on (and extend) Weber’s notion of price. The latter is based on the idea that prices are estimated quantification (hence entailing calculative tools) and involve agents’ struggles to impose their definition of value –hence generating asymmetries. For an actor to successfully impose her calculations/valuation on the others –i.e. the valuation that is closer to her interests/goals- it takes to transform her position into an obligatory passage point (Callon 1986). The striking fact here is twofold –according to Çalışkan and Callon. First there is a multiplicity of prices available at a given time, and second prices are always based on other prices. The second aspect particularly emphasizes how interdependency are created between different transactions taking place at different times and in different locales. Prices are not only based on other prices but also on more physical variables taken into account in calculating (new) prices.

Finally, the issue of market design and maintenance is treated as central to the understanding of marketization processes. Here Çalışkan and Callon stress the linkages with what is called ‘performativity’ programme. The latter studies the role that economics has in making the diversity of forms of organization and modalities of functioning of markets possible/visible/debatable. The authors also extend the performative role of economics to other actors outside the academic field and such collaboration between the former and the latter (economists and other actors) become more frequent, systematic and reflexive.



However, marketization represents only one case of economization processes. Economic valuations and calculations can also take place in non-market type of settings. This seems to be the case for innovation, where not all the economizing processes result into the creation of a market as such. Innovation seems to be characterised more by attempts to *embed* market logics into existing or new arrangements. These attempts are marked by a variety of “valuation modalities” aimed at capturing the economic value of a drug/technology, an incubation programme, or an academic invention. Yet, ‘realizing’ and ‘visualising’ the value of such programmes is often a pre-conditions to the mobilization of financial (both public and private) resources around a specific technology, but not always these resources are mobilized in exchange of equity or ownership position.

The idea that economic valuations/calculations can also take place in non-market sort of settings is reinforced by some scholars in sociology. In an effort to trace and understand how we attribute economic value to intangible things, and therefore how we transform quality into quantity, Marion Fourcade (2011) investigated three prominent non-market valuation episodes. The context is the valuation of “nature” by ordinary people and their expert voices in the case of the non-commercial losses associated with large-scale maritime oil spills in France and the United States. Fourcade looked at how people framed the need for monetary compensation for a polluted landscape. Drawing on the work of Bruno Latour (1987), she argued that for how flat money/measures seem, the processes of quantification that lead to them are not flat at all. Indeed the production, selection, and application of valuation techniques involves “trials of strength”, processes of “translation” and “allies and enrolment”. In other words processes of quantification are highly contingent and political. In Fourcade’s words: “*Economic valuation [...] does not stand outside of society: it incorporates in its very making evaluative frames and judgments that can all be traced back to specific politico-institutional configurations and conflicts*”. (Fourcade 2011, p. 1769).

### **2.1.3 Contribution to social studies of accounting: the study of differences and the study of isomorphism**

Part I of this chapter discussed economization as a process that lies at the interface between social studies of science and new institutionalism. The choice of discussing

economization processes across academic literatures was motivated by a number of reasons.

First, the predominant theme emerging from the field is related to how economic market and economic theory have progressively configured the field of scientific discovery and innovation in economic terms. This has led to consider economization as the broader process to be considered in the analysis of the role of accounting in the field of innovation.

Second, the emphasis on economization (and economizing) and accounting devices has long been suggested (Burchell et al. 1980) and recently repeated in Miller and Power's paper (2013). Although reviewing different streams of sociological thought deployed in past and present accounting scholarship (e.g. governmentality and new institutionalism), Miller and Power do not explicitly include in their review the accounting scholarship that has drawn on social studies of science and more specifically on the performativity program advanced by Callon. Therefore, this section will seek to analyse economization and the role of accounting by means of a comparison between Callon's performativity framework and the new institutional framework. As argued earlier, different ways of framing accounting illuminate the different roles that accounting plays in the context of a specific phenomenon, such as innovation. These aspects will be presented later, after summarizing the main points of divergence and possible linkages between the performativity program and the organizational research program in new institutionalism.

Overall, there are differences between the two literatures and some of them cannot be easily reconciled at level of theory. As discussed below such differences can however be used to illuminate different pieces of evidence (Reed 2011).

First, they hold different assumptions in terms of agency and its distribution. The symmetry granted to human and non-human actors and the role of materialities (e.g. accounting techniques, standards, etc.) under the performativity program seem to diverge from new institutional conceptualization. The latter do not grant to non-humans the same type of agency as humans and it does give visibility to materialities. In the context of this thesis, the empirical evidence seems to benefit from an approach which attributes agency to 'things'. Performance indicators such as 'invention disclosures count' or 'spin-outs count' can have the effect of creating certain trajectories, certain courses of actions within a field. They have productive

effects. In this respect, Chapter 5 shows that research commercialization trajectories are shaped by accounting measures in a way that accounting measures create the reality they aim to represent. A university which aims to increase the number of invention disclosures can be constructed as an ‘inventive institutions’, hence increasing its standing and reputation. At the same time, across the innovation field, performance indicators have also become a *standard* way of evaluating organizational and individual performances. They have become a standard way of constructing/formatting universities as ‘rational’ economic actors.

Second, the ‘mechanisms’ through which ideas and practices ‘travel’ differ between the two approaches. One approach is more oriented to study diffusion by looking at isomorphic mechanisms, decoupling mechanisms, etc. The other approach looks at forms of entanglement and disentanglement, translation, framing and overflowing. In the context of innovation, processes of displacements and transformation have helped to understand how an invention disclosure submitted by a scientist to a local technology transfer office becomes embedded in a broader web of relations involving government actors and funding devices (see Chapter 5 for more details). At the same time, an increasing isomorphic tendency seems to characterize the way in which, for example, technology transfer office structure their activities. Models for attributing property rights on academic inventions, for sharing revenues arising from inventions are appropriated and embedded by different academic institutions.

Third, as Carruthers (1995) pointed out, new institutional tradition views accounting practices as a “*set of features that can legitimize organizations through construction of an appearance of rationality and efficiency*” (Ibid., p. 313). Not only has accounting a legitimizing role and not only does accounting contribute to the transformation of organizations into rational actors. It also has, according to Miller and Power (2013), an *adjudicating* role, which means that accounting practices exist “*to pronounce on and to evaluate the performance of individual and organisations*” (Ibid., p. 562). In the performativity program, accounting is instead viewed as central in forming/formatting the calculative abilities of agents, where agency has a distributed character. Accounting is not only an instrument used to achieve certain ends, but also contributes to shaping the realm where action takes place. With regard to this thesis, when consultants are called upon to set up performance audits for open innovation, the management and accounting expertise involved in such task does not

simply devise measures to ‘capture’ the reality of open innovation, rather it contributes through sets of measures to constructing what is meant by and done in the name of open innovation. By mobilizing these sets of measures accounting contributes to *performing* the economy through theories of economics of innovation. And also, by excluding or including certain possibilities in the setting up of measures, it contributes to *framing* economic action in certain ways rather than others. Therefore, the process of qualifying an object by setting its potential value or performance level is not trivial and should not be taken for granted. As Robson (1992) observed, the process of representation is linked to the problem of action at a distance. Thanks to their properties of mobility, stability, and combinability, accounting numbers make possible to influence contexts or situations remote from the actor. While inscribing (Latour 1987) distinctive sets of interests into numbers, accounting frames “the original substance” (Latour and Woolgar 1979) by listing a number of properties which qualify the substance.

Fourth, by granting visibility (and agency) to materialities the performativity program attends to the diversity and specificity of arrangements that lead to the construction of markets. It traces and problematizes differences instead of flattening them (Latour 2005). More in general the theme of differences and how these arise within *socio-technical agencement* is central to the definition of economization within the performativity program. Different market (and also non-market) configurations are contingent to the multiple devices (e.g. laws, calculations, reporting tools, decision-making procedures, etc.) that are mobilized within a certain network. Different market configurations also depend on how such devices become distributed. On the one hand, the study of differences is central to the performativity program, on the other hand isomorphism and standardization as social processes gain centre stage in new institutional analysis. As discussed earlier, new institutionalism (in organizational analysis) takes as a starting point the increasing homogeneity of practices and arrangements found in the labour market, in schools, in states, and in corporations (DiMaggio and Powell 1991).

Despite the differences between the two sociological approaches, there have been attempts to lay more explicit micro-foundations of institutional theory (Powell and Colyvas 2008). The building blocks of such micro-foundations could draw, according to Powell and Colyvas, on ethnomethodology and sense-making literature, but also on actor-network theory and the performativity program in social studies of

science. Miller and Power (2013) gather the variety of traditions in social studies of accounting (e.g. new institutionalism, governmentality) and show how they contributed to explain the different roles that accounting has in processes of economizing. From mediating, territorializing, adjudicating, to subjectivizing, accounting plays multiple roles in society. This multitude of roles in turn has to do with certain qualities of accounting, i.e. accounting as a fluid, historical contingent, and constantly shifting object. In order to address *theoretically* such multiplicity it might be useful to discuss two concepts advanced within social studies of science and social studies of accounting respectively, i.e. *socio-technical agencement* and *accounting complex*.

On the one hand, Callon advances the concept of socio-technical agencement to denote “*socio-technical arrangements when they are considered from the point of view of their capacity to act*” (Çalışkan and Callon 2010, p. 9). Agency and arrangements are not kept separated. When it comes to analyse markets using the notion of agencements, the heterogeneous nature of markets is emphasized:

“A market is an arrangement of heterogeneous constituent that deploys the following: rules and conventions; technical devices; metrological systems; logistical infrastructures; texts, discourses and narratives (e.g. on the pros and cons of competition); technical and scientific knowledge (including social scientific methods), as well as the competencies and skills embodied in living beings”(Çalışkan and Callon 2010, p. 3).

On the other hand, Miller and Power advance the notion of accounting complex to suggest that:

“[a]ccounting practice is an assembly of very different elements: ideas, laws, bureaucratic instruments, spreadsheets, reports, standards, and registers, not to mention accountants and other human agents” (Miller and Power 2013, pp. 588-589)

The notion, the authors argue, is similar to the one of network if not that the atomistic components are heterogeneous and are co-constructed rather than given. Both concepts clearly emphasize the role of materialities in the construction of ‘networks’. The fundamental difference seems to lie in the agentic properties attributed to agencements, while accounting complex does not explicitly mention the distributed character of agency. However, one can speculate that if elements in the complex are co-constructed rather than given, then some sort of agency is attributed to material devices too.

Although both notions are relevant to this thesis in that they provide a tool for identifying and analyzing the multiple accounting and non-accounting entities involved in economizing innovation, the thesis mainly draws on the notion of agencement. For the notion of *agencement* makes it possible to place the analysis of how innovation is controlled through accounting within the larger issue of how economic agencies of innovation are configured, organised, and distributed, and the role of accounting in these processes.

While applying the notion of *agencement* to the case of a hedge fund, Hardie and MacKenzie (2007) argues that it is important to single out the not too obvious features of the concept and focus “*on ways in which the composition and configuration of agencements affect economic action*” (Ibid., p. 74). According to Hardie and MacKenzie the notion of agencements emphasises the conditions of possibility for economic actors, and the infrastructure that enable them to be the actors they are, and how the distribution of cognition and action may shape the properties of actors (Ibid., p. 74). In this regard, Chapter 7 will discuss how innovation is assembled by means of a variety of human and non-human entities that interact with each other in the production of the multiple values of innovation. The discussion will focus, particularly, on the *effects* of the interactions between such entities in the context of the exchange of value for money (e.g. public and private financial resources).

In conclusion, although at theoretical level performativity programme and new institutional analysis bear different assumptions, at level of meanings the two literatures can be used to illuminate different aspects of the empirical material. As Part 2 will discuss, Reed (2011) advocates for a pluralistic use of theory where different theories can be used “*to illuminate aspects of a meaningful social context [...] and the coherence of the maximal interpretation derives from the coherence of background meanings interpreted to be surrounding the social action under study*” (p. 103).

Miller and Power’s notion of accounting complex constitutes perhaps an attempt to bridge the two literatures at the level of theory. On the one hand, the emphasis of the performativity program on materialities is congenial to accounting. In fact, both the programmatic and technological dimensions (Rose and Miller 1992) of accounting are involved in the idea of mutual shaping of economics and the economy put forward by the proponents of the performativity programme. First, accounting as

a science is involved in the formatting of calculative agencies. Second, accounting understood as accounting numbers (Robson, 1992) is related to the production of inscriptions (Latour 1987), that is the translation of actor's interests in a material form. On the other hand, how can we understand the homogenizing and normalising effects of accounting in the field of innovation, if not turning to new institutional theory? Different practices of valuing innovation and different meanings are attached to 'standard' accounting tools such as discounted cash flow and key performance indicators. Standard models of formatting universities, incubators, technology transfer offices as *rational* actors are also an important part of the innovation phenomenon. Overall, the pragmatic approach to valuation and the performativity programmes are those predominantly used throughout the thesis to make sense of innovation as a socio-technical phenomenon and the role of accounting in it. However, it seems helpful to combine the interest in materialities, offered by the pragmatic approach to valuation, to the analysis of the patterns of regularity in the processes of formatting of calculative agencies and of the homogenizing tendency within the field of innovation.

Both approaches shed lights on different aspects of the research question, which explores the role of accounting in shaping innovation, where shaping includes all those processes of translating scientific ideas into goods and services that have an economic value and that can therefore circulate in the economy. In this respect, 'controlling innovation' does not merely mean imposing calculative structures on the entities of innovation (e.g. new drugs, incubation programmes), but rather it means that calculative structures and the entities of innovation mutually shape each other. The empirical evidence presented in this thesis shows that in the process of *discovering, developing, transferring, and incubating* innovative scientific ideas, accounting contributes to realizing their economic value, in so translating them into *economic* entities. Once translated into economic entities (e.g. total project cost, value inflection point, etc.), innovative scientific ideas can be invested upon, and their value can be appropriated. Hence, they can circulate in the economy.

## PART 2: METHODOLOGICAL CONSIDERATIONS AND RESEARCH METHODS

### 2.2 Researching innovation as a socio-technical phenomenon

In order to investigate how accounting configures innovation, the thesis sets to trace the origins and distribution of the different forms of accounting involved in innovation (e.g. performance indicators, valuation techniques, etc.), the calculative frames they embed (e.g. public intervention, financial sustainability, etc.), and the intended and unintended effects that arise from the overlaps between different frames in the context of the exchange of value for money.

Such research agenda is pursued while maintaining a non-essentialist view of what constitutes accounting and “a constructivist symmetry” (Power 1996, p. 3) in the treatment of innovation and accounting. This philosophical positioning is consonant with the central process of this thesis which is the process of *economization*. Thus, to understand how accounting transforms the entities of innovation (e.g. new drugs, incubation projects) into *economic* entities we need to bracket out both accounting and innovation and observe them in their contingent interplays. Furthermore, because of the central role attributed in this thesis to accounting technologies (understood as the product of the interactions between social and technical aspects), the type of interpretivism here deployed is one that stresses the role of technology, rather than culture<sup>3</sup>, in society.

---

<sup>3</sup> Broadly speaking, the interpretivist paradigm locates the foundation of knowledge in the experience of human beings and focuses on “*cultural derived and historically situated interpretations of the social life-world*” (Crotty 2003, p. 67). However, when it comes to culture, there are several interpretive nuances (e.g. symbolic interactionism and phenomenology) which are rooted in *constructivism* and *social constructionism*, each of which attributes different roles to culture in the social world (Mead and Morris 1934; Merleau-Ponty 1967). Beyond all the nuances, the interpretivist paradigm aims to “*reconstruct the textures of human subjectivity*” and “*the meaningful worlds of social life in which subjects act in a certain place and a certain time*” (Ibid., p. 91).



While attending to the role of technology in society, and yet remaining within a constructivist/interpretivist paradigm, actor network theory (Latour 1987, 2005) offers a poignant view of how reality is ‘assembled’. By granting ontological symmetry to things and humans, actor network theory argues that, far from being passive, technologies create spaces of possibilities and shape human beings as much as human beings shape them. However technology does so in a particular way. As Latour suggests, technologies (as much as actors) make us do things, but they do so “*not by transporting a force that would remain the same throughout as some sort of faithful intermediary, but by generating transformations manifested in many unexpected events triggered in the other mediators that follow them along the line*” (Latour 2005, p. 107). In the context of this thesis, accounting technologies such as key performance indicators (e.g. invention disclosures count, spin-outs count, etc.) do not have the same effects across all the organisations that adopt them. They trigger effects such as the increase in number of spin-outs only when actors (e.g. university managers) use them as tools for performance evaluation. Furthermore, Latour seems to distance his work from the interpretivist epistemic mode in that the latter renders the world all ‘too human’ in contrast to a world of “inflexible objects” and “pure causal relations” (Ibid., p.144).

Although the origins of actor network theory are often rooted in constructivism (Brey 1997), the type of constructivism defended by Latour is not of the ‘social’ type. As Muniesa (2014, p. 11) clarified, in actor-network theory reality is constructed in an engineer’s sense, i.e. “*the scientific facts stand objectively in the laboratory as the bridge stands firmly over the water*”. Yet, reality does not simply ‘stand there’ without taking the trouble to happen, but rather it needs to be continuously assembled. In this sense the fascination of interpretive accounting research for actor-network theory (Roslender 2015) is partly motivated by the fact that accounting, as a science but also as a technique, endlessly provides the material and the tools for the assembling and construction of reality. Using an interpretive/constructivist paradigm *à la* Latour in the context of this thesis means to attend to the contingent interactions between people and accounting tools, and the constitutive effects that such interactions have on innovation. Embracing this line of inquiry means to combine the attention for accounting as the object of human experience to accounting as a practice that is co-produced by contingent historical, political, and economic forces (Hopwood 1983).

Although the research process is often widely characterised by *errors* (Swedberg 2012, p. 34), *false leads* and *dead ends* (Alasuutari 2000, p. 192) and therefore continuous changes, the process of gathering the traces of a phenomenon does require the prior design of methods and strategies. Both methods and strategies help govern all those practices which are carried out in order to conduct the observations. Methods and strategies provide “*the rules by which these observations can be modified and interpreted in order to assess their meaning as clues*” (Alasuutari 2000, p. 42). A method should therefore allow the production of data that surprise the researcher and should also provide a mechanism by which feedback on the hypothesis and the research design is ensured. The next section will introduce the research field by discussing the criteria for selecting the research sites and entering the field. Subsequently, the section will present the chosen methods of data collection, and the issues of access and familiarity with the subject of study.

### **2.2.1 Criteria for selecting the research sites**

Innovation as a phenomenon makes countless appearances in many arenas from technology transfer offices in universities to R&D units within private companies. For this reason, some boundaries needed to be established at empirical level. As Denzin and Lincoln (1998) suggested, the choice of the sites where to investigate a given phenomenon is informed by the processes that one intends to study. The underlying process that this thesis aimed to investigate is the changing nature of accounting –i.e. the “progress” of accounting agenda toward the construction of the “knowledge society” and “innovation economy”. With this research agenda in mind, three main criteria for identifying the research sites have been selected.

First, the research attended to those sites where claims “to produce innovation” or “to be innovative” were made, e.g. firms, research centres, public and private laboratories, etc. This criterion provided a starting point to unpack the ‘reality’ of innovation and investigate those materialities and human actors that populate it.

Second, the research attended to those sites where traditional accounting tools/systems (e.g. performance measures) could be potentially challenged. Forms of *problematization* and scrutiny of traditional modalities of producing numbers seemed to occur in contexts where *knowledge-based modes of production* (Gibbons et al. 1994) are fostered and implemented (e.g. R&D units of traditional manufacturing

companies, but also private research institutes, and yet university incubators). In these contexts the challenges posed to accounting were operating on two different grounds: a) the ground of quantification. Quantification processes were said to be problematic when resources and outcomes of “innovative projects” were not only intangible/immaterial but also of a long-term and risky nature; b) the ground of organisational forms. ‘New’ organisational forms, i.e. networks, were said to replace traditional ones, i.e. hierarchy and market (Powell 1990). Network forms of organisation were said to challenge accounting in the sense that they involve the simultaneous coordination of multiple objectives, goals, and interests which in turn emanate from multiple stakeholders.

Third, cases where both public (e.g. UK government, the European Union) and private (e.g. industry) resources were involved has been sought. This choice was motivated by an intellectual curiosity for the interplay between multiple logics (e.g. public and private) within and across organisational sites.

Overall, the empirical settings were based on sites where claims about innovation were associated with hybrids forms of organising (e.g. networks or collaborative arrangements) and knowledge-based mode of productions. In other words, the sought research sites were those where the world of research and that of business were brought together to collaborate on innovation/R&D projects. Those were also the sites where pre-competitive activities are in place (e.g. prototyping, testing, de-risking etc.), and where private and public resources were mobilised. And finally, the selected research sites were those where programmes of competitiveness and productivity devised by the UK government and industry were enacted through accounting. In such contexts, accounting and related forms of calculation were envisioned, constructed and promoted as mechanisms of government over innovators and innovation.

The criteria for selecting the research sites presented above were also exposed to two forms of contingency, which will be discussed in the next two sections. To anticipate, one contingency consisted in the opportunistic nature of access, i.e. the opportunities that emerged while the fieldwork was being conducted. The other type of contingency consisted in the influences exerted by the empirical and theoretical clues which were progressively emerging from the field.

## 2.2.2 Negotiating access

Prior to entering the field approval was obtained from Cardiff University Research Ethics Committee to carry out the research. Respondents would normally be contacted via e-mail, followed up sometimes with a phone call. The first interaction would include a cover-letter which provided a summary of the research project, a confidentiality statement, and the researcher and her main supervisor's contacts.

Prior to each interview the respondent would be also provided with an Informant Consent Form (also approved by the Research Ethics Committee) in which, once again, confidentiality would be guaranteed and data treatment process would be clarified to the participant.

All the interviews –except one- were recorded, and consent to record each interview was obtained before starting the interview. Specifically in relation to the second part of the fieldwork carried out at *Incubator#1*, the researcher was granted an in –depth access to the organisation. In this case a Confidentiality Agreement was also required by the organisation and signed by both parties.

## 2.2.3 Entering the field

This section will discuss how the researcher has had access to the organisations and research sites under study. Methodologically speaking, for the type of research approach adopted (Latour 2005), it is essential to follow the actors across the virtual and physical spaces where they regularly meet and talk about their concerns or where they act as spokesperson and representatives of somebody else's concerns. Conferences, scientific and social events are examples of such spaces. Important also the question of what participants' capacity and motivations to attend such events are because it provides an indication of their concerns and the strategies to address them.

Attendance at two events provided the arena to start the investigation and gain access to potential interviewees. The first event was a *Cardiff University Innovation Network Event*. It was organized by *Cardiff University Innovation Network* and sponsored by Cardiff City Council and South Wales Chamber of Commerce. The event was aimed at creating a space where entrepreneurs, venture capitalists, business consultants, university research centres, and public funding agencies could meet and 'network'. A one-day program involving workshops, one keynote speech,

pitching opportunities for start-up companies was set up in order to facilitate such “networking”.

The second event was held at the Royal Society in London on the occasion of the first public debate on *Wilson Review on Business-University Collaboration* (Wilson 2012). The Report was an independent review for the UK Department of Business, Innovation, and Skills, conducted by Dr Tim Wilson, and designed to give recommendation on how to form stronger links between universities and employers. The event was organized by the Research and Development Society and sponsored by the Institute of Physics and the University of Surrey jointly. Aim of the event was to gather people from industry and academia to debate around the Wilson Review on Business-University Collaboration (Wilson 2012). A hybrid panel of academics and entrepreneurs –in their respective capacities- discussed the areas of further development to be addressed such as the improvements in the information exchange between university and business, and in the funding for higher education innovation activities.

The *Innovation Network* event was more oriented toward networking purposes. In addition, workshops and seminars run by business consultants gave visibility to a range of models and tools for how best protecting ideas, for how being competitive, financially viable, socially networked, etc. The *Wilson Review* event was designed less for networking purposes and more for giving public visibility to possible solutions to the ‘problem’ of business-university collaboration. Such type of collaboration, as claimed in the review, has been an issue of central concern for British economy (Wilson 2012, p. 2), and the purpose of the event seemed to be discussing, negotiating, and framing the ways in which such issue could be substantiated in the future.

## **2.2.4 The research methods**

### *Interview methods in context*

As Alvesson (2010) noted, methods provide ideas on how to produce and make sense of empirical material. Interviews particularly as a method of data collection, Alvesson argued, need to be coupled with theoretical understanding in order to support our critical judgement. Without such understanding the material risks

*“naivety and leaves interpretations standing on a shaky ground”* (Ibid., p. 5). As discussed earlier the approach adopted in this study is constructivist. In the context of the constructivist paradigm, (open end) interviews are regarded as *“reality-constructing and interactional events during which the interviewer and the interviewee construct knowledge together”* and yet as a *“site of, and occasion for, producing knowledge itself”* (Holstein and Gubrium 2013, p. 430). While other authors in the interpretive tradition regarded interview as *“an inscription of narrative production”* (Barbara Czarniawska 1997; Czarniawska 2004). However, scholars also warned of the limited range of what can be captured through interviews, and argued that things also happen outside the frame of the interviews, i.e. outside of what is directly registered by individuals (Alvesson 2010). In the same vein Latour (2005) pointed out that when the researcher arrives to the interview site to conduct interviews, action is already taking place and:

“[E]ven when we are in the midst of things, with our eyes and ears on the lookout, we miss most of what has happened. We are told the day after the crucial events have taken place, just next door, just a minute before, just when we had left exhausted with our tape recorder mute because of some battery failure” (Ibid., p. 123)

In the context of this study, interviews constituted a space for immersing in the social but also technical world of participants. As discussed later in the chapter, the aim was to elicit conversations about participants’ everyday practices, their encounters with numbers, spreadsheets, and reports and to account for their interactions with such materialities.

### *Sampling strategy*

Interviews started with contacting people who attended the events discussed above. At the end of each interview, respondents were encouraged to suggest further contacts to the researcher. In most of the cases they would allow the researcher to mention their names to further contacts or they would themselves introduce the researcher via e-mail to other contacts. The various interviews were conducted over a period of two years. This gave time to the researcher to transcribe the interviews and reflect upon them as soon as the material was collected and before proceeding with other rounds of interviews. The sampling was partly ‘opportunistic’ and partly inspired by researcher’s exposure to theoretical material meaning that the sampling

was in part influenced by introductions and suggestions made by the respondents themselves, following what is called a snowball process. The first half approximately of the fieldwork was carried out across different research sites –involving a variety of organisations. During this period the researcher interviewed an Intellectual Property Director at a top tier university who keenly introduced her to an incubator manager who turned out to be a central figure for the second half of the field-work. The incubator manager was the one who granted the researcher an in-depth access to the incubator he was managing. Such access opportunity in turn influenced the design of the whole second part of the fieldwork. Had the incubator manager not given in-depth access, the fieldwork would have probably had a different configuration.

The choice over the type of respondents to be contacted has not been exclusively driven by opportunism. The choice has also been informed by the theoretical background of the researcher. In this sense the sampling pattern aimed at eliciting and addressing certain theoretical facets such as the dynamics between actors, resources, and interests within a given context (e.g. incubation). As Clarke (2003) illustrates:

“sampling” is driven not necessarily (or not only) by attempts to be “representative” of some social body or population (or heterogeneities) but especially and explicitly by *theoretical* concerns that have emerged in the provisional analysis. Such “theoretical sampling” focuses on finding *new data sources* (persons or things) that can best explicitly address specific theoretically interesting facets of the emergent analysis (p. 557).

In the context of this thesis, theoretical sampling means that pieces of theories have illuminated the research in the sense of identifying and mapping the entities in the field and have provided a preliminary interpretation of the relations among them. Callon’s concepts of translation and obligatory passages (Callon 1986) helped the researcher to map out the actors, interests, goals, and resources involved in incubation and technology transfer and their interrelations. However, this does not mean that theory has exclusively driven the process of data gathering.

The process of data collection generated forty-two hours of interviews distributed across several institutions, as summarised in Table 2.1 below. Interviews’ length ranged from half an hour to more than two hours. With regard to participants’ background and institutional roles, in most cases participants often had quite diverse

**Table 2.1: List of participants and interviews' length**

Organisation	Interviewee's Job Title	Interviewee's Background	Length (hh:mm:ss)
Technology Transfer Office	Business Development Manager	Degree in Economics, entrepreneur in marketing, SMEs-industry relations	01:16:52
Incubator	Director of Innovation	PhD in Pharmacy, University Technology Transfer executive, Venture Capital industry	01:37
Company	Head of Technology Strategy	Degree in Mechanical Engineering, Chief Design Engineer	01:45:36
Consultancy	Programme Manager	PhD in Biochemistry, Marketing and Sales Manager	01:07:00
Incubator	Commercial Director	Dean of Business School, Innovation Manager	01:20:37
Company	Chief of University Liaison Office	Degree in Mechanical Engineering	02:10:00
Incubator	Commercialization Manager	PhD in Molecular Biology and Biochemistry, Innovation Manager	01:00:16
Incubator	CEO	Degree in Chemistry, Master in Business Administration, Business collaborations	00:45:10
Start up	Chief Business Officer	Degree in Biochemistry, Master in Business Administration, Sales and Marketing Director	01:24:03
Venture Capital Company	Director of Healthcare ventures	Degrees in Economics, Leadership and Strategy, Pharma Business Development Manager	01:20:42
Incubator	Chief Executive Officer	PhD in Immunology, Chartered Accountant, Head of Business Development	00:56:15
Start up	Founder - Managing director	PhD in Chemistry, Scientist at multinational Pharma company	00:36:38
Incubator	Incubator manager	Master in Business Administration	01:30:33
University	Deputy President Deputy Vice Chancellor	PhD in Economics	00:59:03
Technology Transfer Office (TI)	Director of Operations	PhD in Molecular Biology, Business Development manager	01:13:08
Incubator	CFO	Accountancy qualification, Finance positions in retailing industry, Business Development	00:50:28
Contract Research Organisation	Managing director	PhD in Chemistry	00:30
Incubator	CEO	PhD in Biochemistry, Science director within pharmaceutical company	00:45:25
Incubator	Marketing, Sales & Events Manager	Commercial background in life sciences	00:59:54
Incubator	CFO	Accountancy qualification, Finance positions in retailing industry, Business development	00:27:34
Technology Transfer Office (TI)	Spinout portfolio manager	PhD in Molecular Biology, Accountancy qualification, Co-founder entrepreneur (biochemistry imaging software)	01:05:20
Technology Transfer Office (TI)	Licensing executive	PhD in Molecular Biology, Post doctoral positions in Molecular Genetics, Technology transfer	01:27:30
Incubator	CFO	Accountancy qualification, Finance positions in retailing industry, Business development	01:03:12
Innovation Consultancy	Founder/Principal	PhD in Neuroscience, Clinical Scientist, MBA, University-Business Partnerships	01:04:11
Incubator	Marketing, Sales & Events Manager	Commercial background in life sciences	00:58:49
Incubator	Accountant	Accountancy qualification	00:44:30
Start up	Chief Scientific Officer	PhD in Biochemistry, Academic scientist, scientist at Biotech company, science director at big pharma	01:33:16
Technology Transfer Office (TI)	TTO manager	PhD in Chemistry, Post doc position in Chemistry, Director biotechnology company	00:55:51
Technology Transfer Office (TI)	Industrial Partnerships Manager	PhD in Biophysics, Scientist at multinational technology company	00:51:01
Charity	Head of Legal & Operations / SBC observer	PhD in Molecular Biology, Intellectual property lawyer	00:59:14
Start up	Chief Operating Officer (co-founder)	PhD in Biochemical engineering, Master in Business Administration (MBA)	00:51:52
Incubator	CEO	PhD in Biochemistry, Science director within pharmaceutical company	00:35:11
Start up	Chief Operating Officer (and founder)	PhD in Biochemistry, Post doc positions, Scientist at multinational pharma company, MBA	00:54:03
Incubator	CFO	Accountancy qualification, Finance positions in retailing industry, Business development	00:57:53
Incubator	CEO	PhD in Biochemistry, Science director within pharmaceutical company	00:49:01
Big Pharma Company	Finance Director	Researcher scientist in biochemistry, Accounting qualification	00:58:12
Big Pharma Company	Academic Liaison Director	PhD in Biotechnology, post doc position in biotechnology, scientist in big pharma	00:54:01
Big Pharma Company	Finance Director	Chartered accountant, commercial finance director, Business administration manager in big pharma	00:52:19
Start up	CEO	PhD in Organic Chemistry, Post doc position, MBA, Scientist and programme leader at big pharma	01:20:59



background. It is very common to find in the sample former venture capitalists becoming incubator managers, or scientists with doctorates in molecular biology, rather than chemistry, obtaining Masters in Business Administration later on in their careers. Or yet, scientists becoming managers of their own start-up companies, and scientists becoming specialists in Intellectual Property protection. Interview materials most certainly benefited from such diversified career paths both in terms of the quality of insights and also in terms of the pool of contacts to whom to have access.

*Interview schedule: eliciting accounting materialities*

“In the relatively unstructured interviews typical in social studies of science, the investigator has in mind certain topics that seem to be important in the light of previous research, but which are too complex to be defined in advance”

(Potter and Mulkey 1985, , p. 248)

The interviews took the form of semi-structured interviews, which means that the questionnaire was treated flexibly and kept open to potentially interesting topics emerging from the conversation. The schedule used during the interviews took the form of maps rather than lists of topics. Only the researcher (and not the participants) would be able to consult the map. Mapping out the interview schedule had the advantage of keeping the focus on the main topics while connecting different parts of the interview more easily. Interview maps also facilitated time management. This was important considering that participants were often let talk freely and at length, in so making it possible for topics to occur as much naturally as possible. Sometimes topics in the map would not be covered either because of the time constraint, or because of other interesting topics emerging during the interview.

As exemplified in Table A-1 (see Appendix 1), interview topics would range from general topics such as participants' biographic information, background and role to more context-specific topics. Table A-1 provides the structure of an interview carried out with a technology transfer executive. In that case context-specific topics were related to university's approach to research commercialisation and the relations with other actors such as government and industry. Or yet, context-specific topics would delve into participant's experience of certain practices such as disclosing inventions, filing patents and other practices involved with the transfer of a technology. Talking

about participants' everyday practices was central in eliciting information on the material and technical aspects of their work (e.g. measurement practices, spreadsheets, records, graphs, etc.). The idea was that it is in the material and technical aspects of daily practices that accounting is more likely to emerge.

Since the researcher did not always have the opportunity to have access to internal documentation, *talking* about numbers, spreadsheets, measures etc. seemed the only way to access to accounting. In other words, the researcher constantly tried to make participants talk about their everyday practices, the meetings they had, their daily schedules, and how they experienced them. The idea, once again, was to elicit information on the calculative devices (e.g. financial models, budgets) existing within the organisation. Another topic addressed was related to participants' background and expertise and how this would be brought into current work practices. Another objective was to explore the frames of reference used by participants in their every day practices. The excerpt below is illustrative of how frames of references would emerge while talking about practices (e.g. the financial plan). The following conversation took place between the researcher and the Chief Financial Officer of a biotechnology incubator:

**[Researcher]** You were saying earlier that there are different versions of the financial plan and that you will commit to the one which has the most likely outcome...

**[Participant#23]** [he interrupts] yeah and I want to be conservative.

**[Researcher]** But what does that mean?

**[Participant#23]** if you take for instance funding and you have this [he reads out one of the key assumptions from the long term financial plan] *“It is assumed that [funder] agree an extension of the Grant Offer to April 2015 and that the grant allocation can facilitate the ground floor development of the Accelerator (tbc)”* you read to be confirmed [...] however I had already spoken with [funder] and they gave me a strong reassurance that this would be acceptable and then there is a [funder's] representative in the Board and he was able to confirm that yes, we have to sign the formal agreement, but in principle [the grant is confirmed].

The excerpt shows how “being conservative” is a frame that the participants normally deploys when ‘practicing’ the financial plan. This is an example of how calculative devices (such as the financial plan) in practice can embed a variety of meanings and calculative frames which translates into distinctive ways of *doing*

things (e.g. not taking the *grant* for granted is a way of practicing conservatism in financial planning).

Where documents such as internal strategy report, financial plan, and budgets were provided, the interview schedule would centre on them. The aim in that case was to elicit information on participants' experience and interpretation of such documents. Here below an excerpt from an interview with a Chief Financial Officer, where the researcher was provided in advance with a report, namely an open innovation report. The document equipped the researcher with more background information on the organizational and accounting practices. This helped to start the interview with already a common pool of information (i.e. the documents):

**[Researcher]** About the Open Innovation report and the proposed KPIs [key performance indicators]. Why do you need them?

**[Participant#34]** Well, they are ...I'm not convinced necessarily on KPIs. I think they were a term that consultants invented 20 years ago. But what is important is you need to measure the output of your effort. If you can't do that then you can't run anything. So you have to define what it is you should be delivering and producing and then you have to measure that, set the target each year and then you measure your performance against the target. That's what really KPIs are.

After discussing the qualitative methods and research strategies adopted to collect the empirical evidence, the chapter will discuss how the theory presented in Part 1 is used in the context of the empirical evidence. The next section will cast the questions of what role theory can have in the interpretation of data, what distinguishes a rough written account of data from a *maximal* or *thick* interpretation, and how this applies to the context of this research on innovation and accounting.

## **2.3 Discussing the relation between theory and evidence: *maximal* and *minimal* interpretation**

By questioning in abstract terms the relation between theory and evidence, this section aims to illuminate how the theory developed in Part 1 has shaped the process of data analysis. Nevertheless, a deep (*maximal*) interpretation will only be provided in the discussion chapter (Chapter 7). This section will evaluate the proposition offered by Reed (2011, p.103), according to whom it is the coherence of the background meanings surrounding a social action that gives coherence to the

interpretation, and not the abstract coherence within the set of different theories deployed to interpret a certain phenomenon.

The section is organised into two parts. The first –as just mentioned- discusses the role of theory and evidence particularly in the context of interpretive research. Against this background, the second part provides an outline/discussion of the main theoretical signifiers used to analyse and interpret the phenomenon under study, i.e. the interplays between innovation and accounting.

### 2.3.1 Innovation and accounting: from *minimal* to *maximal* interpretation

"[A]nthropological writings are themselves interpretations, and second and third order ones to boot. (By definition, only a "native" makes first order ones: it's his culture.) They are, thus, fictions; fictions, in the sense that they are "something made", "something fashioned" -the original meaning of fiction- not that they are false, unfactual, or merely "as if" thought experiments."

–Clifford Geertz (1973, p. 15)

Once gathered (or rather *while* gathering) the clues and traces of innovation as a socio-technical phenomenon, the interpretive researcher faces the uneasy task to provide interpretation(s). There can be several levels (or orders) of interpretation, as Geertz's quote in the opening of the section reminds us. From a scientific point of view reporting on a phenomenon is not sufficient and social researchers are asked to go *beyond* or *beneath* the mere description of facts and provide a deeper explanation/evaluation of them. This inevitably leads to the question of when and to what extent theories and theoretical concepts should ideally be brought into the research process. The literature is prolific of works that engage in the discussion of the relation between evidence and theory. Within these studies there are several authors who –somewhat in line with Geertz- emphasize the idea that there are different levels/degrees/orders of interpretation. The mechanisms proposed in order to progress through different depths of interpretation vary across the literature. For example, Reed (2008; 2011) advances that interpretive researcher should embark on a reconstruction of what he calls *landscapes of meaning* through a pluralistic use of

theory. In Reed's view (Reed 2011) establishing the phenomenon represents a first step toward explanation.

With regards to this thesis, establishing the phenomenon means to identify the entities of innovation that have been economised. In this regard, Chapter 4 will establish that technology transfer mobilises chains of calculations, such as key performance indicators, business plans, and market valuations. The question is: how can we render the fact of measuring a meaningful event? In this sense Reed argues that the researcher should then move from a *thin description* of the phenomenon to a thick, deeper understanding and comprehension of it. *Thick* description rests on the idea of human behaviour as productive of symbolic actions, and on providing accounts of what the "import" of such action is, i.e. what it is said (and done) in relation to that specific action (Geertz 1973).

The aim of interpretive research according to Reed is to reconstruct *landscapes of meanings* by bringing together theory and evidence according to a principle of *localized verificationism* – i.e. theory should "*adequately and reasonably comprehend the surface meanings indicated by a subgroup of evidential signs*" (ibid., p. 114). Localized verificationism represents a constraint which emanates "from below", i.e. from evidence. At the same time though the reconstruction of landscapes of meaning is to be subjected also to a constraint "from above" –i.e. all the theories deployed should together make sense.

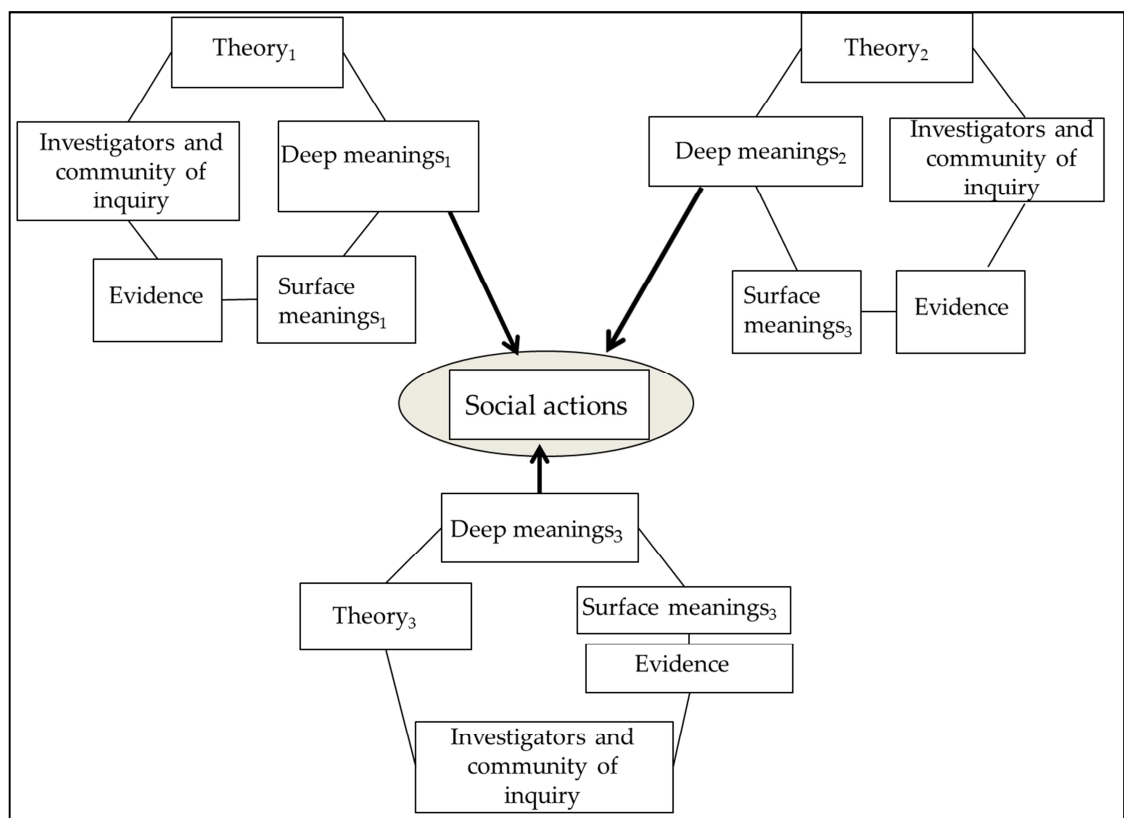
Overall, Reed's argument can be summarised in the idea that both the pluralistic use of theories and the unity in meanings should be satisfied all at the same time. And the way in which this is achieved is by means of a careful 'matching', at local level, of evidential and theoretical signifiers in order to build -what he calls- a good maximal interpretation. But what is a maximal interpretation? Reed (2011) speaks of a *spectrum* of interpretations that spans from *minimal* to *maximal* interpretation:

"At the minimal end of the spectrum, the frequency of theoretical terms is slight (or ... minimal), and the claims tend to be less controversial – though they can, on rare occasions, be startlingly new. The maximal end of the spectrum involves statements that mix, in a consistent and deep way, theoretical and evidential signification, in an effort to produce a powerful comprehension of the matter at hand." (ibid., p. 23)

With regard to this thesis, Chapter 4 will present in *minimal* terms the use of discounted cash flow (DCF) technique in valuing a drug throughout the different stages of drug discovery and development. Moving closer to the *maximum* end of

Reed’s interpretation spectrum, discounted cash flow can be said *to grant economic visibility* to a certain developmental drug. By drawing on social studies of accounting, which regards accounting tools as actively implicated in the construction of the object of their measurement rather than simply mirror it (Miller and O’Leary 1987; Hopwood 1987), one can interpret DCF as something more powerful than a mere neutral technique. The power of visualising the economic value of a drug lies in enabling certain notions of value rather than others. It also lies in mobilising certain financial resources rather than others. Therefore DCF creates possibilities of representation and possibilities of intervention.

Figure 2.1 shows the elements which characterize a maximal interpretation, i.e. different pieces of theories are used “*to illuminate aspects of a meaningful social context...and the coherence of the maximal interpretation derives from the coherence of background meanings interpreted to be surrounding the social action under study*” (ibid., p. 103).



**Figure 2.1: Maximal interpretation in the interpretive epistemic mode**

Source: (Reed 2011, p. 102)

In the same vein, Gioia and Chittipeddi (1991) argue for different “orders” of analysis in ethnographic accounts. What they call the “first order” is similar to a narrative story which is often told using participants’ words and their themes. There is then a “second order” analysis, they hold, which adds a more theoretical perspective to the first order story. In this sense, one can say that in interpretive research the theoretical dimension “emerges” from the evidence –i.e. the first order account- rather than the opposite.

The process through which descriptive accounts transform into interpretation has been extensively discussed by Wolcott (1994). He conceives of the research process as made of three inherent categories –i.e. description, analysis, and interpretation. All of them are deemed to be central to the process of “transforming data”. However, each individual researcher, in organising and presenting her data, will attribute a different emphasis to each of these three categories. According to Wolcott the shift from descriptive accounts to analytical and interpretive ones is highly subjective, meaning that the interpretive framework can be introduced earlier or later in the process depending on individual researcher’s decision. In other words, data is already theory laden (Pitman and Maxwell 1992, p. 761), meaning that some sort of implicit interpretation is already in progress during the very process of generating and reporting data.

Although Wolcott does not explicitly refer to “orders” or “levels” of interpretation, his idea of distinguishing between description, analysis, and interpretation in the process of transforming data can be useful. Finally, an interesting reflection that Wolcott offers is on the use of theory for both *analytical* and *interpretive* purposes. In the first guise, i.e. analytical, theory serves the purpose of providing structure; while in the second guise, i.e. interpretive, theory links the cases under study with larger issues. In the context of this thesis, theoretical tools from actor-network theory such as *inscriptions* have been used to provide a first level structure of the interview material (see section 2.3.2 below for a more detailed discussion). Subsequently, inscriptions have been used at level of interpretation to show how different modalities of framing incubation became translated into accounting numbers (see Chapter 6).

Figure 2.1 wraps up the reflections presented so far in a way that is meaningful to the present thesis. It maps out Reed’s idea of maximal interpretation as a journey where evidential signifiers (surface meanings), and theoretical signifiers (theory)

undergo a process of re-signification in order to produce “deep meanings”. The ways in which this re-signification of the evidence (in the light of the theory) takes place responds –according to Reed- to criteria of “adequacy” from below and “coherence” from above. Other authors we came across in this section also stressed how there is indeed a continuum that goes from the raw evidence to the *n*-order interpretation.

In conclusion, Reed’s (2011, p. 103) idea that the *coherence* of the maximal interpretation stands on a coherent re-construction of the case and not necessarily on the coherence of the social theories mobilised, is illuminating. It is insightful in that it shows that differences (and incoherence) at level of theory do not necessarily compromise the validity of the interpretation. In this respect Part 1 of this chapter discussed the theoretical tenets underlining this thesis, i.e. performativity programme in social studies of science and new institutional theory in organisational analysis. While there is a common thread cutting through Part 1, which is the study of processes of economization, the two theoretical programmes bear different ontological assumptions about agency and the mechanisms of circulation (e.g. translation versus diffusion, differences versus similarities/standards).

However, since both differences and similarities are found at empirical level (e.g. different calculative practices, different funding arrangements, but still similar calculative tools, similar frames etc.), both performativity and new institutionalism can contribute to provide a coherent interpretation of innovation. Again, this *trait d’union* does not imply an ‘abstract’ coherence between the two sets of literature that we just mentioned. It rather stems from a “*coherent re-construction of the case*”, and is motivated by a “*pluralistic use of theory [that] remain[s] empirically responsible to the case*” (Ibid., p. 116).

### **2.3.2 The process of data analysis**

The move from evidence to theory is by no means a linear trajectory. Rather it involves a sort of progressive enmeshment between evidence and theory. The process of data analysis has been informed to Reed’s (2011) idea that a pluralistic use of theory has to remain “empirically responsible to the case” and its coherence does not derive necessarily from the abstract coherence of the sets of theories. As discussed in the following, the analysis has been conducted in two stages, proceeding



from a first level broad thematization of the material to a second level theory-laden interpretation.

The first stage unveiled the substratum of meanings elicited and gathered during the interviews. Themes were created by using at first a (light touch) narrative analysis approach (Czarniawska 2004; B. Czarniawska 1997). This approach enabled the researcher to look at interviews' text as "inscriptions of social interactions" (Czarniawska 2004, p. 55) and helped to account for participants' narratives. This approach was combined with an intellectual interest for the material and social aspects of accounting and innovation. This means that the analysis of the interview material focused on those processes of listing, enumerating, prioritising that in turn lead to the creation of "*things that hold together and that [...] have objectified properties*" (i.e. materialities) (Callon & Muniesa, 2005, p. 1233).

With regard to this thesis, when a finance director talks about the "financial model" that he has contributed to create, he is talking of something that is 'material'. To clarify, financial models do not necessarily possess physicality (although strictly speaking they do inhabit some kind of physical space such as software, papers, etc.), but they are rendered 'material' when the financial director and the accountant define and list the properties of the models. They do so while discussing about the model in board meetings, and yet while compiling spreadsheets that show occupancy rates, income from rental, etc. In other words spreadsheets, graphs, numbers contribute to *inscribing* (Latour 1987) specific frames (e.g. conservatism) into the model and in so doing they create a "thing that holds together" and that can be transported across board meetings, used, drawn upon. Financial models are therefore an example of how devices can be both material and social, without necessarily having physicality. During the process of analysis the effort was to trace numbers and graphs not only directly in documents, but also indirectly in participants' oral accounts of materialities (e.g. numbers, practices, etc.), i.e. materialities as described and interpreted by them.

Practically, this process involved creating for each interview a document containing four columns like the excerpt provided in Figure 2.2 below. The first column presented the transcript from the interview. In this column, those parts with an interesting content were highlighted. As showed in Figure 2.2, expressions such as "targets", "75%", "right environment" were highlighted to draw the attention on possible sources of materiality and frames. The second column was devoted to

describe/follow the narrative moments of the interview such as: “listing”, “evaluating”, “classifying”, “creating solutions”, “introducing characters”, “referencing” to mention a few. The third column encapsulated/condensed (Rossman and Rallis 2003) in concise wording those interesting parts. The fourth column was devoted to coding, and this will be discussed below in explaining the second stage of my process of data analysis.

Transcripts	Narrative-Actions-devices	Emergent themes	Coding
<p><b>And that’s thanks to the loan that you can mobilize..</b> Well yes it is part of the philosophy that we are trying to help create a ...it’s not-for-profit company we are <u>not trying to maximize our profit</u>, we are trying to <u>create the right environment</u>.</p> <p><b>When you say that you try to be more selective, what does that mean?</b> Yes, we want companies that are in the life sciences and biotechnology sectors, we want people who generate their own intellectual property and rather than people that are just selling services. So <u>we have targets. We want at least 75% of occupancy to be IP-generating type of companies.</u></p> <p><b>Does such a target involve the funders?</b> It’s been agreed with the funders. It was a mechanism to help in order to have a clear target with the funders we agreed that we should limit the number of <u>certain type of companies to 20-25%</u>, <u>focus should be on the IP companies.</u></p>	<p><b>Repeating the board’s philosophy/story</b></p> <p><b>Inscription: 75%-25%</b></p>	<p>“it’s not-for-profit company we are not trying to maximize our profit, we are trying to create the right environment”</p> <p>“we have targets. We want at least 75% of occupancy to be IP-generating type of companies”</p> <p>“It was a mechanism to help in order to have a clear target with the funders”</p>	<p><b>Quality frame</b></p> <p><b>Accounting ontology</b></p>

**Figure 2.2: Excerpt from analysis spreadsheet (#20)**

The second stage linked each theme to broader theoretical concerns/concepts, which in turn were reflected in the theoretical framework that presented in part 1 of this chapter. At least three broad themes emerged from the second order analysis.

The first theme aimed to capture the ontological dimension of accounting. In other words the theme accounted for the multiple nature of the forms of quantification found in the field and for the variety of meanings that actors attached to them. For

example, in the context of a technology incubator, indicators such as the number of tenants/companies that have the potential to generate intellectual properties acts in some cases as a measure of quality and in other cases as a measure of innovation. The theme was meant to capture this sort of multiplicities.

The second theme aimed to go beyond the nature of quantifications themselves, and looked at the mechanisms by which they ‘travel’ across different organizational and institutional domains and organise financial (and non-financial) resources around them. For example, as also discussed in Chapter 5, by aggregating data about research commercialization (e.g. number of spinouts, number of invention disclosures, etc.) universities and the Higher Education Statistics Agency (HESA) in the UK are able to make decisions about the allocation of innovation public funding.

The third theme was related to the discursive and recurrent elements characterising the multiple forms of accounting found in the field. The theme, dubbed as ‘calculative frames’, aims to capture all those “*analogies, categorizations, and choices of metrics*” (Beunza and Garud 2007, p. 33) mobilised by actors in the act of calculating. As discussed in Chapter 6, incubators ontology seems to be shaped by multiple (and sometimes conflicting) programmes (e.g. public intervention frame, investment frame, quality frame, etc.) that are linked to distinctive ways of measuring performances within incubators.

Analytical memos were prepared for each interview to discuss the main narratives emerging from the analysis. Linking to the themes discussed above, each interview was supposed to contribute to our understanding of multiple forms of accounting (e.g. performance measures, valuations), of what they express about their ontologies (e.g. what frames they inscribe, what effects they have), of what programmes/discourses lay hidden behind them (e.g. marketization, economization, etc.).

## Conclusion

This thesis investigates the entanglements between innovation, as a phenomenon, and the economy by attending to the role that accounting plays in economizing innovation. In the context of this thesis, economizing means to translate the entities of innovation (e.g. new technologies, incubation projects, new scientific ideas, new drugs) into *economic* entities that possess economic value(s), that is into entities that

can circulate and be exchanged within the economy precisely because of that economic value(s).

Given the relevance of economizing processes in the context of this thesis, Chapter 2 discussed the theoretical and methodological issues, and research methods, involved in studying such processes. Building on Reed's idea (Reed 2011, p. 103) of a pluralistic use of theory where different pieces of theories can be used to illuminate different aspects of a phenomenon, the chapter discussed the relevance of two sociological frameworks to the study of economization, namely new institutional theory and the performativity programme in social studies of science and technology. Part 1 analysed the two literatures on issues such as agency, mechanisms of circulation, and conceptualization of accounting.

The chapter concluded that although the performativity programme constitutes the main approach adopted in the thesis, also new institutional theory can shed light on specific aspects of economizing innovation. In this regard, it was argued that while the process of configuring the economic entities of innovation gives rise to multiplicity and differences in practices of valuing and assessing innovation; at the same time patterns and similarities can arise too, such as the regularities in the mechanisms for attributing and organising economic action within the field of innovation.

Chapter 3 will discuss the historical and political context and the conditions of possibilities that gave rise to innovation as a problematic of government. The chapter will show how the space of interrelation between university and industry became a "laboratory" where the government has experimented with programmes for promoting and decentralising innovation, while maintaining at a distance control through mandated calculations and accounting devices.

# CHAPTER 3 LINKING SCIENCE, ECONOMY, AND THE STATE: THE EMERGENCE OF UNIVERSITY-INDUSTRY INTERRELATIONS

---

## Introduction

The programmes for *transferring* innovation from university to industry and for *incubating* innovation that will be analysed in the empirical chapters (i.e. Chapters 4, 5, and 6) and the forms of accounting mobilised to control innovation in those settings are not merely organisational phenomena. On the contrary, they are co-produced by a series of historical, economic, and political conditions that transcend the domain of the organisation. This chapter aims to show that the sources of changes in the instruments for controlling innovation can be better understood only by linking organisational practices to broader changes in governmental rationalities. Changes in the accounting tools are often influenced, as Callon (1998b) noted, by the role of the State in the economy. Legal frameworks, innovation policies, intellectual property regimes are examples of how the State can intervene in the space of innovation and shape how calculative agency is equipped and formatted.

The historical conditions for the emergence of discourses on the commercialisation of academic research and the rise of university-industry interrelations as a domain of governmental intervention are traced across the interconnected arenas of economic theory and innovation policy making in the UK. The chapter aims to contextualize the escalating political emphasis on innovation and R&D that has characterised the political discourses in the UK from the 1970s onwards.

First, the chapter will attend to different academic traditions within the arena of economics, and their influence on policy-making. The British economy of the past decades has been portrayed in economic analyses as only slowly closing the gap in productivity with North America and much of Western Europe (Broadberry and O'Mahony 2007). Besides cross-countries productivity and economic growth differences have been the object of extensive empirical and theoretical work within macro-economics for decades. Different schools of thought in economics have conceptualized the relation between technological progress and economic growth of nations in different ways. Where neoclassical model of economic growth (Solow 1956) treats technological progress as an exogenous variable, endogenous growth models (Romer 1994; Grossman and Helpman 1994) conceive of technological progress as endogenous variable. In simpler terms, in the neoclassical theory of growth technology is deemed to improve for reasons outside the economic system and it is independent from economic forces. Technology progress is considered –as vividly noted by Baruch Lev- like “manna from heaven” (Lev 2001). In endogenous growth models instead technology progress is generated through forces which are internal to the economic system (e.g. learning by doing, spill-overs, etc.).

The chapter will attend to such different conceptualisations not so much because they lead to different explanations of temporal and cross-countries differences in the rates of economic growth, but because they entail different ideas of State intervention on matters of innovation, technological progress, and economic growth. In fact, although both schools –neoclassical and endogenous growth- take into account R&D and innovation in their models of growth, only post-neoclassical endogenous growth theory stresses the role that State policies have in increasing economic growth rates, particularly through the creation of opportunities and incentives for innovation (Crafts 1996). This fundamental difference between the two models has had a strong impact on the ways in which science policies have been conceived from the 1950s until the first decade of 2000s. However, the design of innovation policies was not only influenced by highly formalized neoclassical and endogenous growth economics. Other traditions in economics, such as evolutionary and institutional economics (Fagerberg 1994; Nelson and Winter 2009; Lundvall 1992), which are classified as heterodox also for their use of historical and narrative accounts as opposed to highly formal/mathematical approaches (Nelson 1994), contributed to

influencing policy making toward the end of 1990s and throughout the first decade of 2000s.

Second, the chapter will look at the emergence of university and industry interrelations as a significant area where the set of concerns about productivity and economic growth has been addressed, and where programmatic solutions have continuously been created and tested. While holding that the emergence of discourses on the commercialisation of public-funded science entered the political agenda predominantly from the 1980s onward, the chapter will identify a number of conditions and events that facilitated this emergence. First, against a background of privatization and public sector reforms, the 1980s witnessed a progressive shift from a centralised model of governing technology transfer to a more competitive-oriented and decentralised style. This shift was evidenced by the end, in 1985, of the State's monopoly of intellectual property (IP) arising from universities and public research establishments. From a domain of direct intervention technology transfer progressively became a domain to be regulated 'at a distance'. At a distance control meant that British Governments from the 1980s onward attributed the ownership of IP, arising from public-funded research, to universities while letting industry free to negotiate licence terms to exploit IP and, where it was the case, to let industry free to negotiate ownership over IP (Lambert 2003). Second, a progressive shift in the principles for governing the allocation of public funding to science (e.g. the 1971 Rothschild contractor-customer principle) together with regimes of increased accountability created the conditions for linking via formulae the allocation of funding to science performances. Through mandated calculations, such as those implemented within the context of research assessment exercises, technology transfer became progressively visible and amenable to government control. Third, the late 1990s witnessed the establishment of the so-called "third mission" of universities to the aim of embedding "wealth creation" in universities' objectives, alongside the long-established missions of research and teaching. By linking the third mission to a "third leg" of funding, which was allocated on the basis of university innovation performances, the Government created intendedly (House of Commons Trade and Industry Committee 2003) the basis for increased competition "between people, academics and technology transfer offices."

The fact that innovation and public science commercialization have become the subject of political and economic concern was not something necessary or self-

evident. An extensive work of problematization –to which (macro) economics have actively contributed- has taken place by linking technological progress and innovation to economic growth. At the same time problematizing innovation in terms of productivity and economic growth meant also a shift in the role played by the State in the arena of research commercialization from 1950s onward. This chapter shows that a major shift was from direct intervention and control over scientific ideas –through the British Technology Group- toward exerting control at a distance. The latter role saw the State as an actor that contributed to the shaping of networks of people, ideas, and things (e.g. economists, accountants, scientists, research funding mechanisms, research assessment criteria, formula-based funding, patent law, etc.). Furthermore economics was also involved in designing the role of the State in the space of innovation. It did so by promoting models (e.g. “endogenous growth theory”, “triple helix”, “national systems of innovation”) in which the State, together with other institutions such as University and Industry, actively contributed toward the construction of the so called “knowledge economy”(Etzkowitz and Leydesdorff 1995; Lundvall 1992).

The next section will set science and innovation policies from 1950s onward in the context of the academic and political debate that has surrounded economic growth and productivity. The next section will also make the case that the emergence of science commercialization in political discourses is to be rooted into different – formal versus appreciative and orthodox versus heterodox- interpretations of the causes of economic growth and the role of technological progress. Subsequently, the chapter will show how different ways of framing science, technology and innovation in economic theory have been providing the rationales behind the programmes for governing innovation. From 1950s until 2000s the UK witnessed a shift from programmes labelled as “short-termist” and “ring-fenced” toward programmes aimed at incentivising innovation and technology transfer through regimes of increased competition and accountability. Finally, the chapter will show how this shift implied new forms of governance and new forms of State control over economic agencies and innovation.



### 3.1 The role of economic theory in the linking of technology progress, economic growth, and governmental concerns

“How the knowledge behaves as an economic resource we do not yet fully understand. [...] We need an economic theory that puts knowledge into the centre of the wealth-producing process. Such a theory alone can explain the present economy. It alone can explain economic growth. It alone can explain innovation.”

–Peter Drucker (1993, p. 67)

#### *Neoclassical versus endogenous theories of growth*

Differences in the explanation of countries' rates of growth depend on the economic theory under consideration. In neoclassical settings the rate of technological progress is treated exogenously, which means that technology –or knowledge- is assumed to proceed independently of forces within the economy (e.g. learning by doing, spillovers, etc.). The underlying assumption is that technology is driven by scientific processes whose direction and pace are largely independent of economic incentives (e.g. subsidies to R&D investments). Moreover, in neoclassical settings, technology is conceptualized as a public good accessible by all countries (Fagerberg 1994, p. 1149). On the basis of such assumptions neoclassical theory of growth explains the growth in output by attending to the growth in the state of technology. Nevertheless criticism was raised as to the rates of technology growth, which cannot alone explain the full contribution of technological change to the expansion of the output of a country (Grossman and Helpman 1994, p. 31). As the economist Christopher Freeman (1982) observed, in a typical pre-war (and many post-war) economics textbook the effects of innovation and R&D on the growth of national economies was a neglected area, while technological change was treated as a black box that “*needed not to be opened*” (Ibid., p. 195).

From the 1950s neoclassical theory of growth together with its set of assumptions about technology and innovation (i.e. technology as exogenous and as a ‘free’ good) translated into a style of policy making which scarcely considered technology transfer as a problem. According to Freeman (1982), science and innovation policy in the 1950s was characterized by an over-emphasis on ‘big science and technology’

(e.g. defence, space, and nuclear sectors). In this respect, Crafts (1996) noted that technology policy in the 1950s concentrated unduly on promoting radical innovations and too little on facilitating the diffusion of improvements and enhancing technology transfer.

In the decades from 1950s to 1970s, research commercialization, through technology transfer and incubation, was not part of the policy machinery mobilized by the UK government, yet. According to Crafts (Ibid.) two were the main features of British supply-side policy characterising the years of rapid relative economic decline between the 1950s and the 1970s:

“First, the poor targeting of subsidies to investment and, second, the failure effectively to tackle questions of institutional reform. These weaknesses did not go completely unrecognized but governments were generally too weak or too short-termist to address them” (Crafts 1996, p. 42)

Neoclassical theory of growth, as formulated by Solow, had according to some scholars (Grossman and Helpman 1994) dominated economists' thinking about long term economic growth rates for more than three decades from 1950s until 1980s.

It was in the early 1990s with the work of a number of economists (Romer 1994; Aghion and Howitt 1992; Grossman and Helpman 1994) on endogenous growth models that neoclassical growth theory started to be challenged. The endogenous growth models started to lay down the macroeconomic foundations of the so-called *knowledge economy* (Floud and Johnson 2004). In the summer of 1998, in Pebble Beach California, during a roundtable organised by Bank of America (“*The soft revolution: achieving growth by managing intangibles*”) the economist Paul Romer exemplified to an audience of practitioners/entrepreneurs the rationale behind endogenous growth theory:

“How can it be that we are wealthier today than people were 100 years ago? [...] There’s only one explanation for this increase in wealth. We took this raw material that was available to us and rearranged it in ways that made it **more valuable**. [...] What lies underneath this process of **rearrangement** are instructions, formulas, recipes, methods of doing things – the things accountants classify as **intangible assets** if they recognize them at all. They tell us how to take something that is not very valuable and rearrange it into a new configuration that is more valuable.” (Romer 1998, p. 9, emphasis added)

The idea emerging from Romer’s words is that increases in growth (and wealth) can only be explained by the value produced through the processes of rearranging things

into new configurations. Based on this idea, endogenous growth models challenged the neoclassical assumptions where technology is independent of economic forces and technological opportunities are the same across countries. While arguing that technological progress can take the form of new products, processes, and markets – many of which result from economic activities- endogenous growth proponents set to investigate the channels through which the rate of technological progress, can be influenced by economic factors (Howitt 2002). For example, technological progress, it was argued, can be influenced by economic policies (e.g. competition, trade, education, taxes, and intellectual properties) which in turn affect the private costs and benefits of doing and investing in R&D (Howitt 2002).

Given the recognition attributed by endogenous growth theory to State economic policies as a lever for influencing both country’s technological progress and rate of economic growth, the step toward linking governmental programmes to endogenous growth theory was closing. This link became visible in the autumn of 1994 when the then Shadow Chancellor Gordon Brown referred in his speech to “*post-neoclassical endogenous growth theory*” (Coyle 1999). Brown’s call for a new wave of thinking in Labour’s growth policy pointed to endogenous growth theory as the possible solution to the “relative” slowdown in UK macroeconomic trend (Snowdon 2002). The point was also reinforced by the then Prime Minister Tony Blair when in his speech in 1997 set out “*Education, education, education*” as one of the core priorities of the ‘New’ Labour’s education manifesto (Floud and Johnson 2004).

By mid-2000s the idea of a knowledge economy in which growth is generated and sustained through investments not just in physical assets, but in ‘intangible’ assets such as education, R&D, and knowledge, seemed to pervade national science policies. It was during a debate on innovation policy, held in winter 2007 at the House of Commons, that the linkage with endogenous growth theory was renewed:

“The [**post-neoclassical endogenous growth**] theory [...] saw subsidies for research and development and for education increasing the growth rate in an endogenous way by—this is the main point for our debate—increasing the incentive to innovate. That amazing idea, which linked those areas with the economy, **is now pervasive in the Treasury**” (House of Commons 24 January 2007, Col. 489WH, emphasis added)

The influence of endogenous growth theory on policy making has been evidenced by some scholars (Kitson and Wilkinson 2007) within economics. In their study Kitson and Wilkinson analyse how endogenous growth theory has informed the

economic policies of Labour Governments in late 1990s/early 2000s (HM Treasury 2000). According to the authors, endogenous growth models passed the idea that “*if you identify and target key areas of an economy then long-term growth can be improved – and the key areas are usually linked to knowledge, including educations, skills and research and development (R&D)*” (Ibid., p. 808). As it will be discussed later in the chapter, Labour’s 1998 White Paper (Department of Trade and Industry 1998) identified the key ‘drivers’/areas to economic growth to be skills and human capital, enterprise, innovation, competition, and investment. The choice of the skills and human capital driver was justified in a paper published by HM Treasury in 2000 as follows:

“[i]mproving skills and human capital is important in promoting growth, both as an input to production and by aiding technological progress. This has been recognised both in endogenous theory of growth and also in empirical studies comparing growth in different countries” (HM Treasury 2000, p. 32)

However, endogenous growth models were subjected to criticism for “retaining many of the restrictive assumptions associated with neoclassical economics” such as the assumptions of market efficiency and of rational utility maximization. More recently some economists wondered what happened to endogenous growth models after their surge in the 1990s and came to the conclusion that such models were only an “intellectual bubble” (Krugman 2013).

An assessment of whether endogenous growth theory survived in the political discourses and whether the “soft revolution” (Romer 1998) long argued by the economist Peter Romer effectively took place goes beyond the scope of the present chapter. Nevertheless, the history of accounting for intangible assets (Lev 2001) and the history of endogenous growth theory crossed their paths in the context of the 1994 Bank of America Roundtable. Since then, endogenous growth theory seemed to rely on developments in accounting for intellectual capital, given that intellectual capital is a key factor in endogenous growth theories. The success (or lack of success) of endogenous growth theory might have been therefore related to the ability of accounting to capture the value of intangibles. Moreover, the narrative turn in accounting for the intellectual resources of the firm, i.e. intellectual capital statements, is also paralleled by the narrative turn in economics and the rise of the

evolutionary and institutional approaches to growth theory, which will be discussed in the next section.

### *The emergence of the evolutionary and institutional approach in the study of economic growth*

In the 1980s, parallel to the development of formal approaches to economic growth such as neoclassical growth theory, other forms of theorizing the relation between innovation/technological progress and economic growth were put forward. Evolutionary theory of economic growth first emerged in the early 1980s (Nelson and Winter 1982) as part of the so-called “heterodox” economics, as opposed to neoclassical “orthodox” economics (Lawson 2006). In the evolutionary approach technical advance was treated as an evolutionary process in which ex-post selection, provided by market environments, determines winners and losers (Nelson 1994). They held that technology and know-how is embedded in organizational structures (e.g. firms, networks, institutions, etc.) and it is often difficult to transform from one setting to another (Fagerberg 1994).

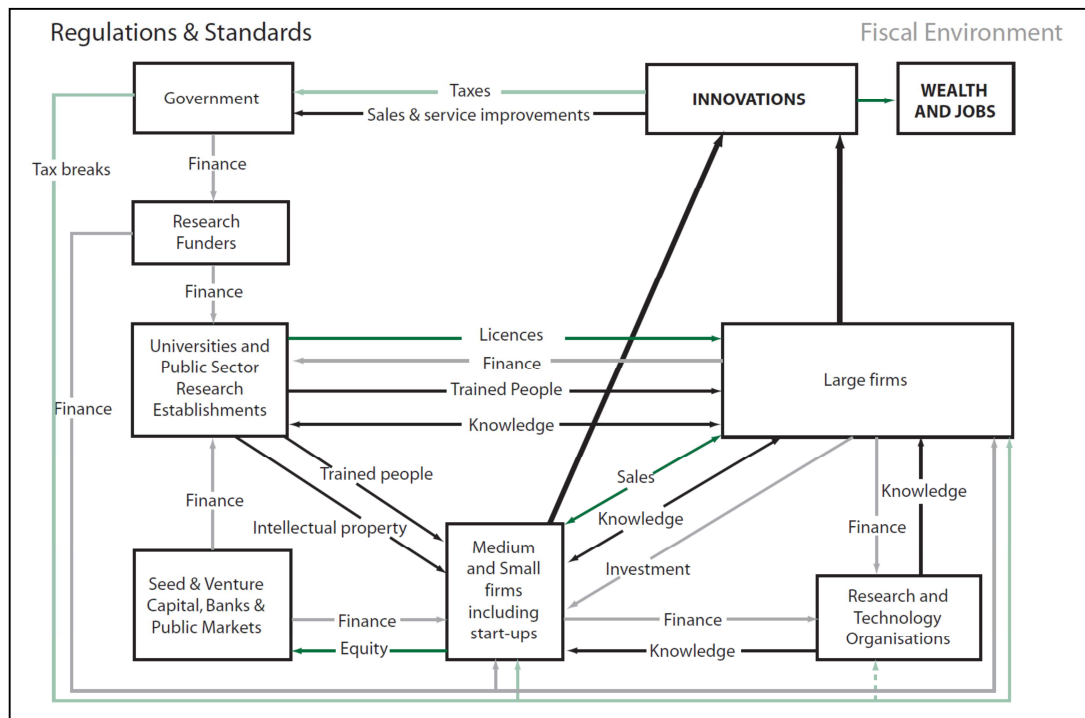
Evolutionary and institutional approaches in economics started to appear within the British political arena in the second half of 2000s, and challenged the influence that neoclassical and endogenous growth theories had on policy-making (PACEC 2009). If on the one hand the ideas furthered with endogenous growth theory entailed an active role of the State in modifying, through policies, private costs/benefits of R&D and incentivizing innovation; on the other hand national systems of innovation adopted an eco-system approach which included in the analysis of growth not only the State, but also Universities and other institutions. According to a study commissioned by the Higher Education Funding Council for England (PACEC 2009), evolutionary theory and national systems of innovation approaches have been informing UK innovation policy making in 2000s:

“Evolutionary and systems approaches to innovation policy have been increasingly emphasised in UK government thinking. This is most apparent in the Innovation Nation White Paper (DIUS 2008) and in the Sainsbury Report *The Race to the Top* (Sainsbury 2007). The Sainsbury Report explicitly adopted a systems approach and identified a national innovation eco-system as central to the elements determining the country’s innovation rate.” (Ibid., p. 24)

Overall, the emergence of institutional and evolutionary economics’ approaches to innovation policies in the late 1980s (Godin 2007) was at the heart of innovation policy-making across the 2000’s (DIUS and BERR 2008; Lord Sainsbury 2007). The relevance of this passage, in the context of this thesis, lies in the fact that adopting an eco-system approach meant a re-thinking of the role of universities. Universities started to be conceptualised as part of a system together with the government and the industry. As shown in Figure 3.1 below, the eco-system was defined to include:

“industrial research, publicly funded basic research, user-driven research, knowledge transfer, institutions governing intellectual property (IP) and standards, supply of venture capital, education and training of scientists and engineers, innovation policies of government departments, science and innovation policies of RDAs [Research Development Agencies], and international scientific and technological collaboration.” (PACEC 2009, p. 24)

Figure 3.1 highlights how knowledge and intellectual property emanating from universities, public sector research establishments, and private sector research organisations are treated as *input* resources to large, medium, and small size firms. Thus, following this representation, only firms can produce *innovations*.



**Figure 3.1: The innovation eco-system**

**Source: (House of Commons Science and Technology Committee 2013, p.11)**

Institutional and evolutionary economics informed the innovation policies of the last two decades, particularly those policies that led to the emergence of the university third mission and university third stream funding (PACEC 2009). Third mission was concerned with wealth creation (alongside with the traditional missions of research and teaching), while third stream funding was aimed at supporting initiatives which would lead to wealth creation (e.g. knowledge and technology transfer activities). Institutional and evolutionary economics approaches to innovation also challenged the view of neoclassical economics on the ground of State intervention. They argued that the motivation that was usually drawn upon by neoclassical scholars to justify State intervention on matters of innovation was the one of *market failure*. The standard neoclassical view is explained by the Deputy Vice-chancellor of a top-ranked British university as follows:

"It is pretty clear from an **analysis of the technological change** that there are lot of circumstances where pieces of useful technology get partially created in universities, but there is a serious **market failure** between that point and the opportunity for existing incumbent companies to commercialize that technology probably either because there is **asymmetric information** and they do not know that the technology exists or because the technology is immature so they might not be able to assess the commercial value properly or both." (#14 – emphases added)

Market failure, information asymmetry, and the difficulty to assess the value of a technology provide the frames for actors to *make sense* of the reason why a university should commercialise research. Besides, the University has a “moral” justification to intervene where the market fails, as the Deputy Vice-chancellor explains:

"If you take the view that one of the things that university can do is **contribute to society** [...] And what the university can do is to take some modest measures to move the technology forward a little further to the point where its commercial value becomes evident to somebody out there and then the market will operate and someone will pick up that piece of technology and do something with it. So it is about **bridging that gap**" (#14 -emphasis added)

From the words of the Deputy Vice-chancellor it is noticeable that moving from the policy arenas to the arena of universities the frame used to justify technology transfer and incubation activities conceptualizes markets as the main institutional set-up and universities as intervening only when the market ‘fails’. While criticising this view, institutional economic scholars argue that:

"Standard [neoclassical] economics will tend to see the market as the 'natural', if not optimal, framework of human interactions and economic transactions. This leads to biased conclusions when considering how to organize the economy (Nelson, 2006). The concept of 'market failure' reflects this bias since it indicates that the other institutional set-ups should be considered only when it is obvious that the market cannot do the job." (Lundvall 2010, p. 333)

Overall, the quotes above signal that institutional and evolutionary economics encountered obstacles in translating into the everyday practices of universities. The neoclassical ideas of market failures and State intervention as a last resort seem to be still embedded in the culture of universities. At the same time the 'battle of ideas' between neoclassical and innovation system approaches has recently come to the fore in the course of a public inquiry on "bridging the valley of death" in the commercialisation of public science (House of Commons Science and Technology Committee 2013). In that context, Research Councils UK (and others) stressed the idea of innovation as a system, while rejecting the idea of a single point of failure where State intervention is required:

"Research Councils UK consider that there is **no single point of failure**—or "Valley of Death"—that affects the whole **innovation system**, but sector by sector there are a number of different aspects where there can be insufficient progress towards impact. [...] In order to ensure that the innovation ecosystem is highly effective it is important to address the full range of factors including funding, regulation and cohesion of different sectors working across actual or perceived boundaries." (Ibid., ev. 174, emphasis added).

In conclusion, this section proposes that it was on the grounds of economic growth and productivity that political discourses and the commercialisation of public science became linked. Different ways of conceptualising the relation between economic growth and technological progress in macroeconomic theory have contributed to constructing the different roles that the State has come to play within the space of innovation. The dominance of neoclassical theory of growth in the past decades has somewhat been challenged since the early 1990s by the rise of endogenous theories of growth. While providing the macroeconomic foundations of the so-called *knowledge economy*, endogenous growth theories stressed the impact of knowledge and intellectual capital on economic growth and the role of the State in incentivizing innovation. In 2000s, the emergence of narrative approaches to innovation and economic growth have informed governmental programmes and contributed to re-define the role that institutions (e.g. the State and University) play



within the economy. Furthermore, the last decades developments in economics were also paralleled by new developments in accounting. An illustrative example here is the rise in the 1990s of accounting for intangible assets and the attempt to link the latter to endogenous growth theory (Lev 2001; Romer 1998). Yet, the emergence of appreciative or narrative approaches in economic theories of growth (e.g. national system of innovation, evolutionary theory, etc.) developed concomitantly with the emergence of narrative approaches in accounting for intellectual capital (e.g. intellectual capital statement).

The next section will discuss how the interplays between economics, science and governmental actors translated into policies and programmes for incentivizing the commercialisation of public science. The next section will also identify a set of economic and political conditions that facilitated the emergence of technology transfer and technology incubation programmes and practices in the UK.

### **3.2 Science policy and the emergence of technology transfer and incubation programmes in the UK**

Technology transfer and technology incubation – and more generally civil R&D- were not on the political agenda in the two decades spanning the 1950s to the 1970s (Crafts 1996). British science policies in the 1960s and the 1970s was mainly concerned with subsidizing physical investments while building the infrastructure for big science and technology projects (e.g. defence, nuclear etc.) in order to compete internationally (Ergas 1987). Conversely, the diffusion and transfer of technology to domestic companies within existing patterns of specialization was not pursued by British Governments at that time (Hall and Rosenberg 2010). The transfer of technology outside of defence-related projects together with investments –not only in physical capital- but also in human capital and education started to appear in the political agenda of 1980s and 1990s (Crafts 1996). This section will analyse how technology transfer and incubation activities progressively emerged as a result of the changing role of the State within the arena of science and technology. As it will be shown, such changes implied reconstructing universities as active actors in the economy, capable to contribute to economic growth by controlling at a distance the

commercial exploitation of public-funded science. Decentralising the commercialisation of research from the State to universities on the one hand meant a series of policies of intervention (Department of Trade and Industry 1998; Chancellor of the Duchy of Lancaster 1993; DIUS and BERR 2008; House of Commons Science and Technology Committee 2013; Lambert 2003) aimed at incentivizing universities and industry to collaborate (e.g. Teaching Company Scheme, LINK, Foresight, Higher Education Innovation Fund, etc.); on the other hand it meant exerting control at distance through devices such as Research Selectivity Exercise (1989, 1992), Research Assessment Exercise (1996, 2001, 2008) with the purpose of linking public funding to science performances.

From the 1980s until the 2000s the role of the State shifted from one of directly intervening in the commercialisation of academic research by means of agencies such as the British Technology Group, to a more ‘distant’ role with universities in charge of intellectual property (IP) management. This meant that the government, while still regulating the space of innovation through national policies, began to exert control over research commercialisation ‘at a distance’. This form of control was made possible also through practices such as the *formula-based funding* device which links financial resources, such as innovation, and business interactions funds, to mechanisms of accountability such as research assessment exercises and surveys (a more detailed account is provided in Chapter 5). Furthermore, the transition from a centralised to a more decentralised system for managing/commercialising IP rights (arising from academic research) was also paralleled by a shift in the underlying economic models of innovation and economic growth (e.g. neoclassical, endogenous, and evolutionary models). The rhetoric of *knowledge economy* which pervaded the 1990s was substantiated by macro-economic models that emphasized the role of State policies in incentivizing innovation and technological progress (Romer 1994; Crafts 1996). The same rhetoric continued to spread during the 2000s backed this time by more ‘appreciative’ (or narrative/historical) approaches, which regarded technology and know-how as embedded in organisational structures such as networks, firms and institutions (Lundvall 1992; Freeman 1991; Etzkowitz and Leydesdorff 1995; Nelson 1993). Within this group of studies not only was the dyad industry-government involved in commercialising public science, but also universities were conceptualised as central actors. All these events, i.e. the changes in intellectual property management and in macro-economic models, can be better

understood if set against an economic context –the one of the 1980s and 1990s- characterised by fluctuating economic growth, regimes of competition and increased accountability toward the use of public resources.

The key events, policies and programmes timelined in Figure 3.2 created the conditions for the emergence of technology transfer and incubation in the UK. The section will be organised as follows. First, the implications of the end of State monopoly on intellectual properties arising from universities and public sector research establishments will be discussed. Second, a discussion of the changes in the principles governing the funding of public science in the UK will be provided. Third, the rationales and programmes underlying two influential White Papers produced by the Conservative Government in 1993 and Labour Government in 1998 will be presented. Finally, the section will discuss the rise of the third mission of universities. The rise of technology transfer and incubation in the UK was therefore facilitated by a series of changes rooted in 1980s’ transition to neo-liberal rationales of government (e.g. end of monopoly, privatizations), and in late 1990s’ turn to post-neoclassical economic rationales. The latter contributed to re-configuring the role of the State as one of providing economic incentives through policies.

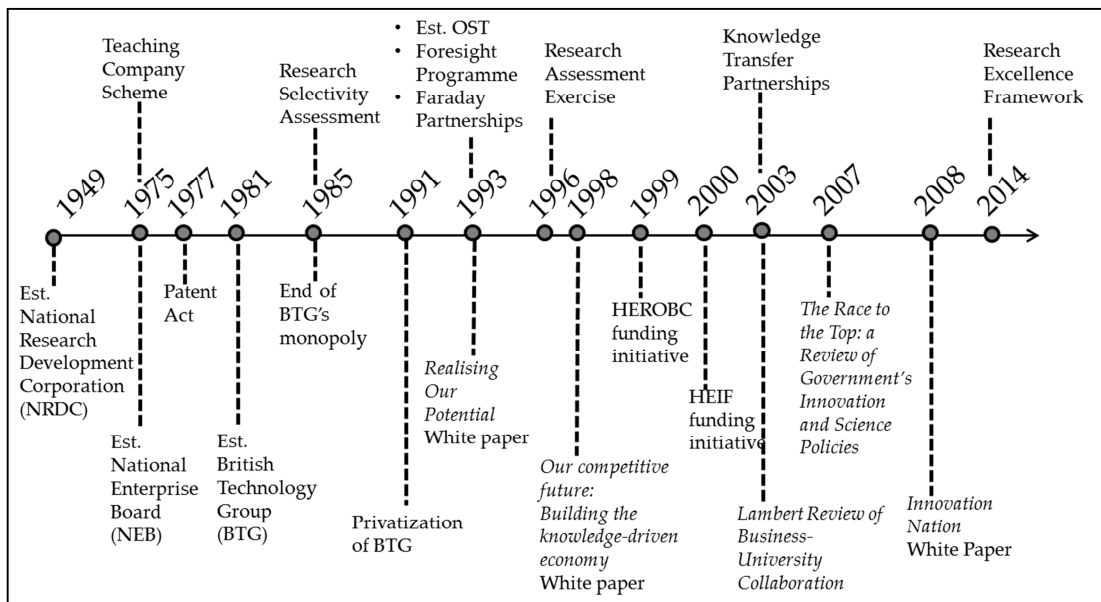


Figure 3.2: A timeline of key events, science policies and programmes

## *From centralisation to competition in research commercialisation programmes*

Programmes for transferring technologies arising from publicly funded research were first initiated in Britain after WWII –in 1949- with the establishment of the National Research Development Corporation (NRDC), whose aim was to protect with patents and then transfer the technology arising from British defence R&D to civil applications (Addison and Jones 2008). At that time, central planning, monopoly and direct State intervention were the rationales informing technology transfer in the UK. However, as Ergas (1987) pointed out, British style of technology policy was mainly “mission-oriented” and aimed at identifying and solving ‘big problems’ of defence, health and education to strive for international leadership. While technology policy was less oriented toward assisting domestic firms in competing internationally through the diffusion and transfer of technology, as it was instead the case in Germany.

In 1981 NRDC merged with the National Enterprise Board (established in 1975 as part of British industrial reconstruction programmes) to form the British Technology Group (BTG). BTG was a non-statutory body whose objectives consisted in obtaining ideas and inventions from universities, Government research establishments, private companies and individuals, in funding their development up to the stage where they become globally patented, and in licensing the resulting intellectual property to industry worldwide while gaining an income from such activity. In order to pursue these objectives BTG was given right of first refusal on intellectual property rights arising from publicly funded research. Such arrangement dates back to the 1940s –before BTG was established, when the National Research and Development Corporation was given the right of first refusal on the intellectual property arising from publicly funded research (Connor 1984).

In 1985 the monopoly of the commercialisation of publicly funded research held by BTG came to an end. This event constituted a first step toward decentralising the commercialisation of technology from the State to British universities. This passage –as it is often the case- did not happen automatically and if on the one hand a part of universities and other public sector organisations began to exploit their own scientific ideas through industrial companies, on the other hand the flow of inventions from universities to BTG increased (HC Deb 12 February 1991). In 1991,

amidst the wave of privatizations and public sector reforms put forward by the Conservative Governments, BTG became privatised. The decision was made –not without criticism (HC Deb 12 February 1991)- on the ground that, according to then Minister of Corporate Affairs, the transfer to the private sector:

“would rid [BGT] of restrictions on borrowing powers, obligations to submit investments for approval by the Department of Trade and Industry and remove the requirement that the salaries of its chairman and chief executive should be agreed with my Department and the Treasury” (HC Deb 12 February 1991, , col. 735)

In the late 1990s and early 2000s the Labour Governments’ policies on technology transfer progressively moved away from the centralised model of managing intellectual properties arising from public-funded research toward a model based on competition where university and industry could negotiate the terms of collaboration –and technology transfer- agreements. In 2003 the *Lambert Review on Business-University collaboration* was commissioned by the government in order to review existing practices in university-industry collaboration and make suggestions for future developments. The review paved the way toward a decentralised model of managing intellectual property (IP) generated during collaborations:

“The Review [...] suggests that where public funding is involved, this starting point should be for universities to own any resulting IP, subject to certain conditions. For its part, industry should be free to negotiate licence terms to exploit it. When industry has made a significant contribution to the research, then business should be able to negotiate ownership of the resulting IP itself. The Review does not believe that the UK should introduce legislation giving ownership of IP to universities along the lines of the Bayh-Dole Act in the US” (Lambert 2003, p. 5)

The new rationale underlying technology transfer was inspired to a principle of competition. The point was so illustrated in 2003 by the then Undersecretary of State at Department of Trade and Industry (i.e. Minister of Science):

“I think that past experience says that centralisation is absolutely not the way to go. The one disastrous bit of history here was the NRDC [National Research and Development Corporation] where it was all centralised and there was a monopoly. NRDC had all the rights to exploitation and that was a complete disaster. **I am actually more for competition** on this and that is why I would always support technology transfer offices in universities not having a monopoly over things even within a university. I think there should be clear policies about how the benefits are shared across the university, but I think the **more competition** between people, between the academics and the technology

transfer offices is a good thing probably.” (House of Commons Trade and Industry Committee 2003, , par. 632, emphasis added)

Organising technology transfer on the base of competition meant in the years ahead, –as the Minister of Science Lord Sainsbury of Turville himself explained (House of Commons Trade and Industry Committee 2003, par. 632), a shift in the allocation principles of public funding for technology transfer initiatives and the creation of a third leg of funding (besides funding for teaching and research) dedicated to innovation and technology transfer activities. The next section will discuss how the principles for allocating public funding to science have changed through time.

### *Shifting rationales in public funding allocation to research*

The end of monopoly of BTG in 1985 occurred in the context of the neo-liberal reforms which took place under the Conservative Governments in the 1980s. In a political and economic landscape characterised by the privatization of public research establishments and following a “ministerial demand for more accountability” (Jump 2013), the UK University Grants Committee (i.e. a predecessor of the Higher Education Funding Council of England) made the decision in 1985 to establish a national system for the evaluation of research in universities. Where teaching funding was allocated on the basis of the number of students taught, prior to 1983, the criteria to allocate public funding for research, according to some, was not “clearly defined” (Jump 2013). Prior to 1983 in fact the criteria for allocating public funding for research were informed to the so called Haldane Principle. The principle was first suggested in Lord Haldane’s 1918 report (Ministry of Reconstruction 1918) and introduced the notion that “*decisions about what to spend research funds on should be made by researchers rather than politicians*” (House of Commons 2009, par. 138). In 1971 Rothschild report (1971) questioned the relevance of Haldane Report and put forward the so-called customer-contractor principle.

The customer-contractor principle made the Government Department or Government Chief Scientist the ‘customer’ who commissioned ‘contractors’, the Research Councils and Universities, to do research (House of Commons 2009). It was based on the assumption that scientists “*cannot decide what the needs of the nation are, and their priorities, as those responsible for ensuring those needs are*

*met*” (Lord Rothschild 1971, par. 8). The principle did not go unnoticed and was subjected to criticism such as that voiced by the Agricultural Research Council:

“The Council also noted that according to the Rothschild Report the major part of the ‘Research and Development’ work, i.e. ‘applied’ research should be done on a customer-contractor principle, as R & D is in the manufacturing industries. Unlike industrial research where one can set out a definite objective and time-limit, do a cost-feasibility study, assess customer demand and profit, and then continue research to the pilot plant stage, little if any research in the biomedical field can be done in this way” (Council of the Nutrition Society, 1971, p. 73)

Despite the criticism, the customer-contractor principle informed Governments’ approach to the funding of public science from the 1970s onwards. The principle in fact guided Governments’ decision to establish clear objectives for expenditure, to develop criteria for assessing and managing research, and to ask “*research bodies to consider the national benefits of their work in terms of commercial exploitation and economic impact*” (House of Commons 2009, , par. 144).

Against a backdrop of increased accountability toward public science, the then newly appointed chair of University Grants Committee –mathematician Peter Swinnerton Dyer- put in place in 1985 the first of a series of systems of evaluation, i.e. the *Research Selectivity Assessment* (1986, 1989, and 1992). In the mid-1990s the system would be replaced by the *Research Assessment Framework* (in 1996, 2001, and 2008) first and then by the *Research Excellence Framework* (2014). Although the processes and criteria behind such exercises/assessment will be analysed in Chapter 5, some illustrative example of how assessment worked is provided here.

The Research Excellence Framework (REF) was carried out in 2014 to assess the research carried out in Higher Education Institutions between 2009 and 2013. REF was aimed at providing a *quality judgment* for each Higher Education Institution (i.e. university institution) and was eventually linked to the funding allocation process via *formula-based* funding.

The overall quality judgment for each institution revolved around three main elements, namely *outputs*, *impact*, and *environment*. The system of weights assigned to outputs under REF defines research *output* in terms of “originality, significance and rigour” with reference to international research quality standards (HEFCE 2012, p. 6). This element carried a weighting of 65% in the overall outcome awarded to the institution. Yet, *impact* was assessed in terms of the “reach and significance” of impacts on economy, society and culture. Impact was assigned a weight of 20%. A

third element, *environment*, was defined in terms of “vitality and sustainability” of the research base, and was given a 15% weight. Overall research output was the one carrying the highest weight, i.e. 65%. This means that the quality expressed and measured in terms of research output (i.e. publications) carried the highest weight. Different assessment exercises carried different systems of weight. Chapter 5 will discuss how weights have been changing throughout the years, but overall the staple of these systems of evaluation introduced in the 1980s, is the underlying logic of competition that they deliberately aim to instil. A logic that is particularly evident in the formula-based funding which will be also discussed thoroughly in Chapter 5.

### *Restructuring the public institutions of science*

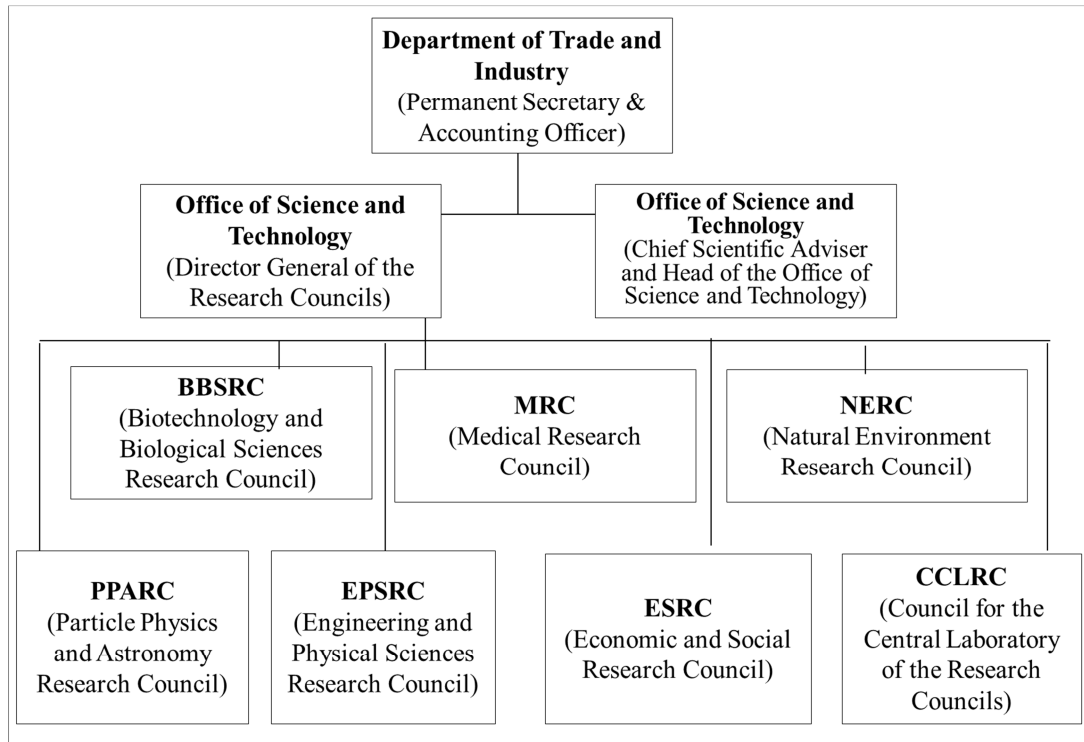
In 1993 the “*Realising our potential*” White Paper (Chancellor of the Duchy of Lancaster 1993) was published under John Major’s Conservative government. The paper recognised the importance of the UK science base and its central role in fostering the innovative and economic performances of the country. In terms of science institutional infrastructure, the paper reversed how science policies and science budget responsibilities were organised within the government. Until 1992 in fact the responsibility for science budget fell within the remit of the Department of Education and Science. Besides there was not a dedicated science minister, with the consequence that science matters fell under the Prime Minister’s general responsibility for trans-departmental issues. The 1993 White Paper introduced changes to this arrangements, by setting up the Office of Science and Technology (OST) and appointing the first Cabinet level Minister for Science (Georghiou 2001).

However, in 1995 OST was moved to the Department of Trade and Industry (DTI) (see Figure 3.3) with Science being part of the portfolio of the Cabinet Minister for DTI and the Minister of Science being a junior minister within DTI. As reported by Georghiou (Ibid., p. 259) the new set of institutional arrangements was then motivated by the aim of bringing science closer to industry, although such motivation was perceived at that time as “an ex-post rationalisation”.

In terms of programmes for science, the 1993 White Paper introduced the Foresight Technology Forecasting Panels whose aim was to advise on which fields the new and existing technology and knowledge transfer programmes (e.g. LINK and Teaching Company Schemes) should focus. Foresight programme was modelled



around the experiences of other countries, namely Japan, and was designed to bring together science and industry in networks, and inform priorities for public spending on science and technology. Implicit in the Foresight programme was the recognition by the government that science base in the UK could no longer support the full range of scientific opportunities but had to focus only on selected fields (Georghiou 2001).



**Figure 3.3: The relationships between the DTI and its Research Establishments**  
**Source: (National Audit Office 2002, p. 1)**

Another programme in the 1993 White Paper introduced the Faraday Partnership programme. Together with the existing Teaching Company Scheme (introduced in 1975), Faraday Partnerships were aimed to develop linkages between universities and industry. With Faraday Partnerships essentially the Government explored and tried to import the German Fraunhofer model<sup>4</sup>. However, concerns for the nature of the funding in support of such initiative emerged. In this respect, the President of the Association of Independent Research and Technology (AIRTO), Richard Brook,

<sup>4</sup> The Fraunhofer Gesellschaft is Europe's largest application oriented research organisation located in 59 specialist institutes around Germany. Its budget is €1.6B, of which €1.3B is for contract research where two-thirds of the revenue comes from industry and publically funded research projects and only one third from German Federal sources (House of Commons, 2011a).

argued that Faraday Partnerships “*started up in a very uneven way*” (House of Commons Science and Technology Committee 2011, Ev. 13) in a sense that they initially benefited from some ring-fenced funds provided by Engineering and Physical Sciences Research Council (EPSRC), but then in the following years, when the EPSRC funding was used up, the Department of Trade and Industry “*did not find the budget to provide what would be the core funding*” (Ibid.). Faraday Partnerships eventually shifted towards carrying out research that industry was more interested in paying for (House of Commons Science and Technology Committee 2011).

Following a major inquiry in 1996-1997 into the future of higher education, the Dearing Committee, and the Comprehensive Spending Review in 1998, the incumbent new Labour Government in 1997 identified science as a major priority (Georghiou 2001, p. 261). Based on this prioritisation, the Government increased the spending in science of £0.7 billion, to which Wellcome Trust (i.e. one of the major biomedical research charities in the UK) added further £400 million (Ibid.). According to Georghiou (Ibid.), “*an economic philosophy which distinguished between investment and consumption in public expenditure provided a suitable backdrop for a campaign which stressed the rewards available, and more pertinently the penalties of missing out on the wave of discoveries in genomics.*”

### *The rise of universities’ third mission and third stream funding*

The transition in late 1990s to the (New) Labour’s government was also marked by a series of reports and policies aimed at boosting economic growth by encouraging the links between universities and industry. An influential White Paper was released in 1998, devised by Peter Mandelson: “*Our competitive future: building the knowledge-driven economy*” (Department of Trade and Industry 1998). This second Competitiveness White Paper, which was realised five years after the first (Chancellor of the Duchy of Lancaster 1993), put at the centre of science and technology policy the investments on human capital and education. Influenced by economic theories of growth, such as the endogenous growth theory, the White Paper identified skills, innovation, investment, and competition as the key drivers to economic growth. Furthermore, the White Paper established what is today known as university’s “third mission” of wealth creation, alongside the other two well-established and longstanding missions of *research* and *teaching*. The White Paper

also set up the first stable stream of funding specifically dedicated to university's third mission by launching in 1999 the *Higher Education Reach Out to Business and the Community* (HEROBC) funding initiative. HEROBC was devised to encourage universities to develop better internal capacity for knowledge and technology transfer, to promote collaboration with industry and to develop effective technology transfer. According to Hatakenaka (2004) establishing third stream funding initiatives such as HEROBC (which would then become Higher Education Innovation Fund):

"was a decisive move from the perspective of universities, as it was the first time the mainstream funding body (HEFCE) had acknowledged the need for funding administrative infrastructure for university-industry relationships" (Ibid, p. 30)

Dedicated funds for setting up the administrative infrastructures to sustain research commercialisation had a central role in creating the conditions for the emergence of technology transfer offices and incubators. Moreover, as declared by the then Minister of Science Lord Sainsbury of Turville, the creation of the third stream funding in the late 1990s was aimed at instilling the logic of competition between "*people, academics, and technology transfer offices*" (House of Commons Trade and Industry Committee 2003, par. 632).

After the late 1990s, public funding for research and innovation in the UK continued to work under a dual system (House of Commons Science and Technology Committee 2002). On the one hand the Higher Education Funding Councils –under the aegis of the Department of Education and Skills- have been administering and allocating funding to Higher Education Institutions (HEIs) in the form of blocks grant distributed on the basis of research assessments. On the other hand the Office for Science and Technology (OST) –under the aegis of the Department for Trade and Industry (see Figure 3.3)– has been providing funding to the UK Research Councils, which would then allocate research grants on competitive basis.

Nevertheless –as discussed in the next section- the rise of universities' third mission also posed problems of potential conflicts between the charity status of universities and their trading activities. The charity status of public universities was seen by some as incompatible with the idea of profit-making activities arising from licensing intellectual properties. These activities were said to transcend the charity primary mission of university, i.e. research and teaching. To overcome this obstacle

universities' structures started to include commercial subsidiaries in charge of managing profit-making activities on behalf of universities.

### *Universities' charity status and the emergence of universities' commercial subsidiaries*

In the late 1990s wealth creation became crystallised in the so-called “third mission” of universities alongside teaching and research. Concerns emerged however as to whether universities – as charitable organisations- were allowed to make profits from activities which transcended their primary mission of research and teaching. Hatakenaka (2004) observed that in the 1990s taxation law in the UK was not very much clear about the fiscal treatment of profits arising from such activities; whereas in the US the Bayh-Dole Act was specifically regulating this aspect. The lack of regulation created the conditions for the diffusion of university commercial subsidiaries –or commercial arms- specifically devoted to the commercialisation of academic research. The same sort of concerns for the potential conflicts between charity primary purpose and commercial activities interested not only public universities but also research-based charity foundations. As illustrated by the Head of Legal and Operations of a biomedical charity foundation:

“In charity commission mind- the fact that we were dealing with intellectual property they considered that an asset, a trade and therefore that should be done through a subsidiary. I spent a number of years then to persuade the charity commission that what we were actually doing was consistent with what the charity mission was and because of the trading part was not primary purpose and trading was actually accelerating what we were trying to do, we could do it without being a separate subsidiary”  
[#30]

There was in fact a number of implications involved in setting up a separate trading subsidiary to carry out technology transfer activities and these were related to the fact that a trading subsidiary had to be self-sustainable:

“[W]e had a business plan and a structure that allowed us to succeed, but it meant we were doing only things that we thought that would give us enough return so that we could be self-sustainable. [...] we didn't fund early stage projects that had too much risk, because they had a low chance of success, [...] or there were no markets or the market commercial return was very thin and that sort of things” [#30]

The risk was one of selecting only projects that would increase the chances of success and therefore the profitability of trading subsidiaries.

Since the rise of the third mission in the 1990s, an increasing number of universities in the UK have begun to incorporate a commercial vehicle to carry out technology transfer activities. According to HEFCE (House of Commons: Science and Technology Committee 2013) the vast majority have staff employed in technology transfer offices not only for intellectual property exploitation, but also for a range of “knowledge exchange” activities. This trend is relevant in order to understand how commercial considerations have progressively entered the arena of universities in the UK. Commercial frames have been shaping the way in which science is regarded, that is science as *instrumental* to the achievement of broader societal goals such as economic progress. This in turn helps to contextualise the relevance of this thesis, which aims to investigate the processes of making scientific discovery visible in economic terms through accounting.

## Conclusion

*Accounting, economics, and the shifting role of the State in the emergence of research commercialisation programmes*

This chapter argued that a number of events and conditions have enabled the emergence of technology transfer and incubation in political discourses. First, macroeconomic theories contributed to the problematization of economic growth in terms of technological progress. Neoclassical, endogenous, and evolutionary growth theories have informed science policies in the last six decades and contributed to constructing the role of the State in the arena of innovation. Second, from 1985 the end of British Technology Group’s rights of first refusal on intellectual properties arising from publicly funded research led to a decentralisation of the responsibilities to commercialise research from the State to universities. Third, the late 1990s witnessed the institutionalisation of wealth creation (and research commercialisation objectives) as part of universities’ mission and the creation of the so called “third mission” alongside the long-established missions of teaching and research. The third mission was then linked to the so called “third stream” of funding through which the

Government, still today, allocates financial resources for innovation and research commercialisation on competitive basis (i.e. on the base of performances).

Overall, the decades from the 1950s to the 2000s have been characterised by two stages of State intervention in innovation. The first stage, which characterised the post WWII period (i.e. the years of the industrial reconstruction), saw the establishment of the National Research and Development Corporation. At this stage the governance of innovation was characterised by a centralised regime in which the State intervened less with policies and incentives, and more with direct initiatives (e.g. monopoly of intellectual property). The second stage, initiated with the liberalisations and the public sector reforms of the 1980s, was characterised by a regime of increased accountability toward public spending, by more decentralisation in the management of the IP generated through public resources, and by increased competition. In this second stage State control was (and still is) exerted at a distance through devices such as research assessment exercises and surveys, whose functioning and effects will be discussed in Chapter 5 and 6. To anticipate the discussion, it was also by devising and implementing the concept of *formula-based funding* that Governments have been able to control research, and its commercialisation, at a distance. At a distance control was made possible by making research commercialisation visible through assessment exercises and surveys, and by linking the outcome of such surveys/assessments to funding allocation via specific *formulae*.

In conclusion, the chapter expands past scholarship in accounting (Robson 1993b) that has shown how in the 1980s, when the neoliberal logic of privatization started to permeate the UK economy, the linkages between science, technology and the industry gained prominence within the arena of economic and industrial policy-making. It was in the 1980s that R&D discourses became intertwined with ideals of a managerial society. According to Robson (1993b), it was in the 1980s that the issue of how to make R&D activities manageable without government agencies intervening directly in the realm of private enterprises became a government priority. R&D was constructed as a space where the ‘problem’ of UK productivity could be tackled by leveraging private investments through mandated calculations and R&D disclosures. In line with this past scholarship, the chapter has shown how macroeconomic theories have contributed to shaping the role of the State within the space of innovation. The chapter has also suggested that the success/failure of certain

economic theories of growth (e.g. endogenous growth theories) might be somewhat linked to the ability of accounting to capture the value produced, at firm level, by the ‘drivers’ of the knowledge-economy (e.g. intellectual capital). Accounting for intangibles is an area that has progressively emerged from the late 1990s in both the accounting and economics arena (Lev 2001; Romer 1998). In other words the problem of “realising the value” of firms (Edvinsson and Malone 1997) and entire economies seemed to be a problem co-fabricated by both accounting and economics. While setting the agenda for the creation of the so called knowledge economy, endogenous growth theorists whether intendedly or not, opened up a controversy on how best “capturing the value” produced through knowledge/technology at both country and firm level. Moreover, there seems to be a parallel which runs between the emergence of more “appreciative” and narrative approaches in economics (e.g. national systems of innovation, evolutionary and institutional theory) (Nelson 1993; Lundvall 1992), and the shift to more narrative approaches in accounting for the immaterial resources of the firm (e.g. intellectual capital statements).

This chapter was motivated by the knowledge that attending to the historical and political conditions for the emergence of research commercialisation discourses can help to interpret certain accounting and organisational practices within universities, incubators, and corporate R&D units. The chapter discussed the historical and political conditions that facilitated the transition from State direct intervention on research commercialization toward forms of intervention at a distance. The following chapters (i.e. 4, 5, and 6) will move to the realm of organisational practices and explore how control at a distance has been performed while *discovering*, *developing*, *transferring*, and *incubating* innovation. Particularly, the next chapter (i.e. Chapter 4) will focus on the problem of productivity in *discovering* and *developing* innovative drugs (i.e. pharmaceutical R&D) at BigPharma1, a big pharmaceutical company headquartered in the UK. The chapter will show how accounting practices, such as valuation and budgeting practices, did not only translate neo-liberal ideas of flexibility, autonomy, and freedom across the organisation, but also translated innovative scientific ideas into *economic entities*. By establishing the multiple values and costs of scientific discoveries, accounting has translated the latter into economic entities (such as *total R&D project costs* or *economic value of a drug*) that can circulate within and beyond the corporation.

# CHAPTER 4 THE MULTIPLE ROLES OF ACCOUNTING IN THE RE-ORGANISATION OF DRUG DISCOVERY AND DEVELOPMENT ACTIVITIES AT BIGPHARMA1

---

## Introduction

Amidst contested scenarios of declining R&D productivity and rising R&D costs, the space of pharmaceutical R&D has witnessed in the past two decades endless processes of organisational reforms. While discovering and developing innovative drugs remains central to the advancement of human health, relatively little is known in terms of how the economic relevance of scientific ideas is constructed through accounting and how the translation of scientific ideas into categories of value and cost influence their circulation. To better understand such processes, this chapter will examine the interplay between accounting and innovation as enacted in corporate R&D practices, and more specifically in corporate drug discovery and development practices.

The empirical focus of this chapter is on the role of accounting in the context of the re-organisation of drug discovery, i.e. R&D activities, at BigPharma1, a globally renowned pharmaceutical company headquartered in the UK operating in the consumer healthcare, vaccines, and pharmaceutical markets across Europe, USA, and Asia Pacific. Since early 2000s the economic imperatives of productivity and competitiveness have provided the ground for a series of organisational reforms within BigPharma1. The reforms were conceived and implemented in order to provide a



solution to the ‘exacerbating’ problem of drug discovery pipeline productivity. Over a span of nearly two decades BigPharma1 has designed and implemented at least two rounds of organisational reforms which in turn have involved the mobilisation of a variety of resources and models such as “incubation” models, “biotechnology company” model, and “open innovation” models.

The chapter will show that a central role in the translation of these models and the underlying neo-liberal ideals of “flexibility”, “freedom”, and “autonomy” across the organisation was played by accounting. In this respect accounting devices have not only provided the calculative infrastructure for such translation to take place, but also shaped those ideas they were meant to operationalize, contributing to economizing scientific discovery, i.e. innovation. How this happened is investigated by paying close attention to the socio-material content of accounting practices, their origins, the inscriptions they produced, and ultimately the effects that they have generated in the context of Drug Discovery Centres, Therapeutic Areas, and Incubator#1. More specifically, Drug Discovery Centres and Therapeutic Areas were conceived as units within the R&D organisation, while Incubator#1 was conceived as a partnership between BigPharma1 and other public and private stakeholders.

The remainder is organised as follows. First, while introducing the context of organisational reforms at BigPharma1, the chapter will show that a fundamental condition for reforming the organisation was the construction of the productivity of the drug discovery pipeline as a problem. Subsequently, the chapter will discuss what and how accounting devices have been mobilised in the re-organisation of BigPharma1’s R&D efforts into Drug Discovery Centres and Performance Units. While remaining within BigPharma1’s R&D space, the chapter will then shift from the domain of corporate R&D to a domain, i.e. Incubator#1, where BigPharma1 is one among a mix of private and public sector actors. The chapter will discuss the mediating role played by the financial model, the innovation budget, and the open innovation report within Incubator#1, i.e. a partnership between BigPharma1, the UK government, and a UK biomedical research charity. Finally, the chapter will present the findings and argue that the *fluid* and *combinable* characters of accounting devices have ultimately contributed to making drug discovery visible in economic terms and amenable to economic intervention. By mobilising accounting tools such as discounted cash flow, financial model, and innovation budget accounting has not only contributed to translating innovative scientific ideas into categories of costs and

value, but also enabled managers to shape the trajectories of such ideas on the basis of economic rationales (e.g. financial attrition, financial sustainability, etc.).

## **4.1 Re-configuring the problem of drug discovery pipeline productivity into an organisational problem**

In the last two decades the decline in R&D productivity has become the object of growing concern within big pharmaceutical industry (Paul et al. 2010; Scannell et al. 2012). As discussed by Pammolli et al. (2011), the decline in productivity has been attributed by some (Evenson 1993; Segerstrom 1998) to a saturation of easy targets. While others (Helpman 1998) have pointed out that the decline might be only a temporary phenomenon to be attributed to the time lag between investments and the outcomes that usually follow the introduction of radical technological changes (e.g. the genomic revolution). Distinctive discovery paradigms have developed through time (Drews 2000) and contributed to shaping the drug discovery process (see Figures 4.1 and 4.2). It was in the 1970s –with the human genome sequencing– that we started to witness the rise of biotechnology and more targeted approaches to drug discovery. Yet, the rise of synthetic organic chemistry and the shift to non-natural drugs, the rise and fall in the 1980s of computer-aided design for drugs, a return in the 1990s to empirical methods such as small molecule library synthesis and high-throughput screening are all paradigms that have had an impact on how drug discovery is represented and practiced today (Pisano 2006; Pritchard et al. 2003).

In late 1990s and early 2000s, the problem of the productivity of the drug discovery pipeline started to emerge as a result of several works at the boundaries of health economics, biotechnology, and business. Analysts, scientists, and the like contributed in their analyses to making the problem visible and tangible by observing the trends for a number of healthcare/medical R&D indicators such as: the increased cost of developing a new drug, the increase in total R&D expenditures, the almost constant rate of introduction of new molecular entities (NMEs), the rise of the

attrition rate<sup>5</sup> (Pammolli, Magazzini, and Riccaboni 2011; DiMasi, Hansen, and Grabowski 2003; Kola and Landis 2004), the decline in the number of new drugs launched in the market per million of dollars spent by biotechnology and pharmaceutical companies (Scannell et al. 2012).

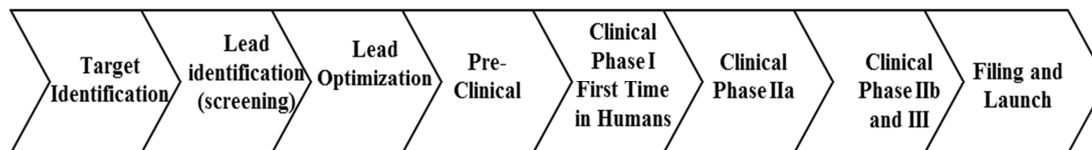
The decline was said to be of such a magnitude that some authors (Scannell et al. 2012) have been advancing the hypothesis of an “Eroom’s law”, that is the backwards spelling of Moore’s Law (i.e. a law formulated in the 1970s that stated that the processing power for computers will double every two years):

“Eroom’s Law indicates that powerful forces have outweighed scientific, technical and managerial improvements over the past 60 years, and/or that some of the improvements have been less ‘improving’ than commonly thought” (Ibid., p. 191)

Against this backdrop a more flexible, “entrepreneurial” approach to drug discovery was advocated (Douglas et al. 2010) to address what was constructed as the drug discovery pipeline productivity problem. This was the context to a series of reforms aimed at the re-organisation of R&D and innovation activities which took place at BigPharma1 from early 2000s onward. The problem of productivity of the drug discovery pipeline as constructed through R&D indicators translated –in the case of BigPharma1- into an organizational problem, i.e. the problem of how to re-organise BigPharma1’s R&D activities. The model of Drug Discovery Centres was first developed by BigPharma1 in early 2000s and it was aimed at re-organising the

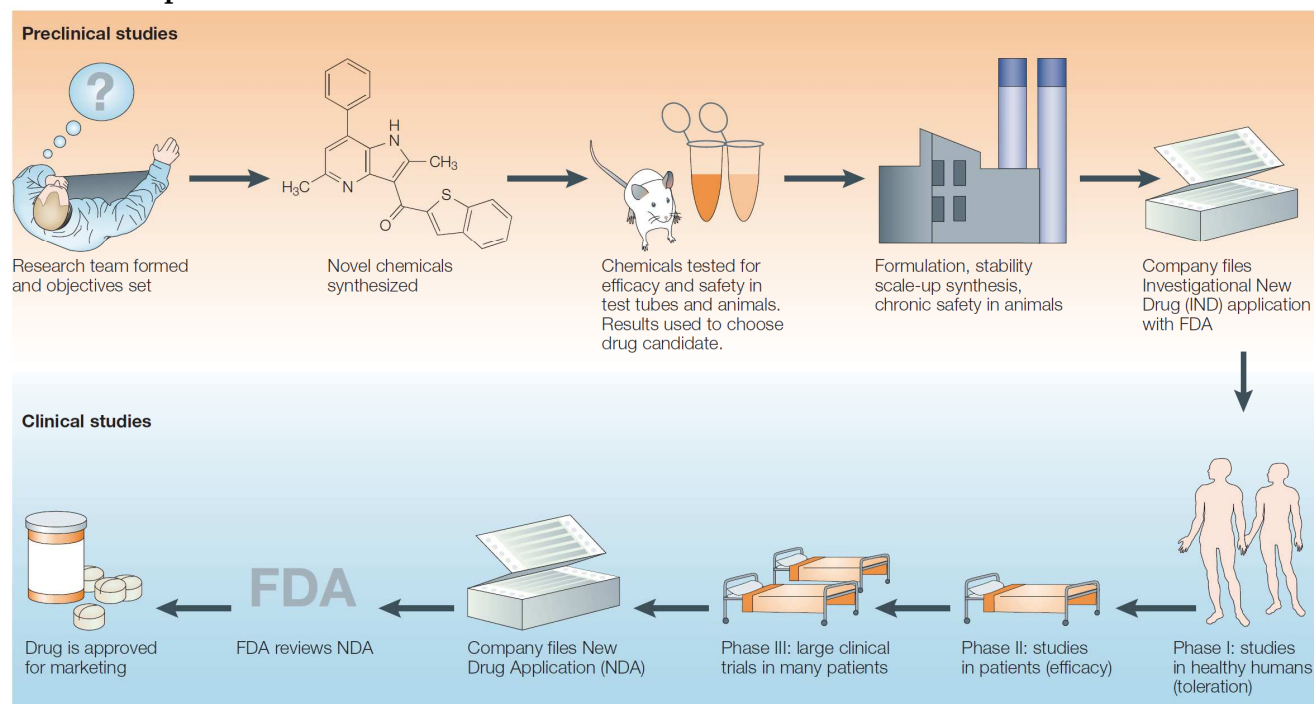
---

<sup>5</sup> Drug discovery attrition rate is usually defined as the rate of failures in developing new drugs, i.e. the failure of New Molecular Entities (NMEs) to reach the “first time in humans” stage. According to a number of authors (Herter-Sprie, Kung, and Wong 2013), several are the factors that can lead to drugs failure, and these include usually a mix of technological and technical obstacles across the development stages.



**Figure 4.1: A visual representation of the stages of drug discovery and development**

Source: adapted from Huckman & Strick (2005)



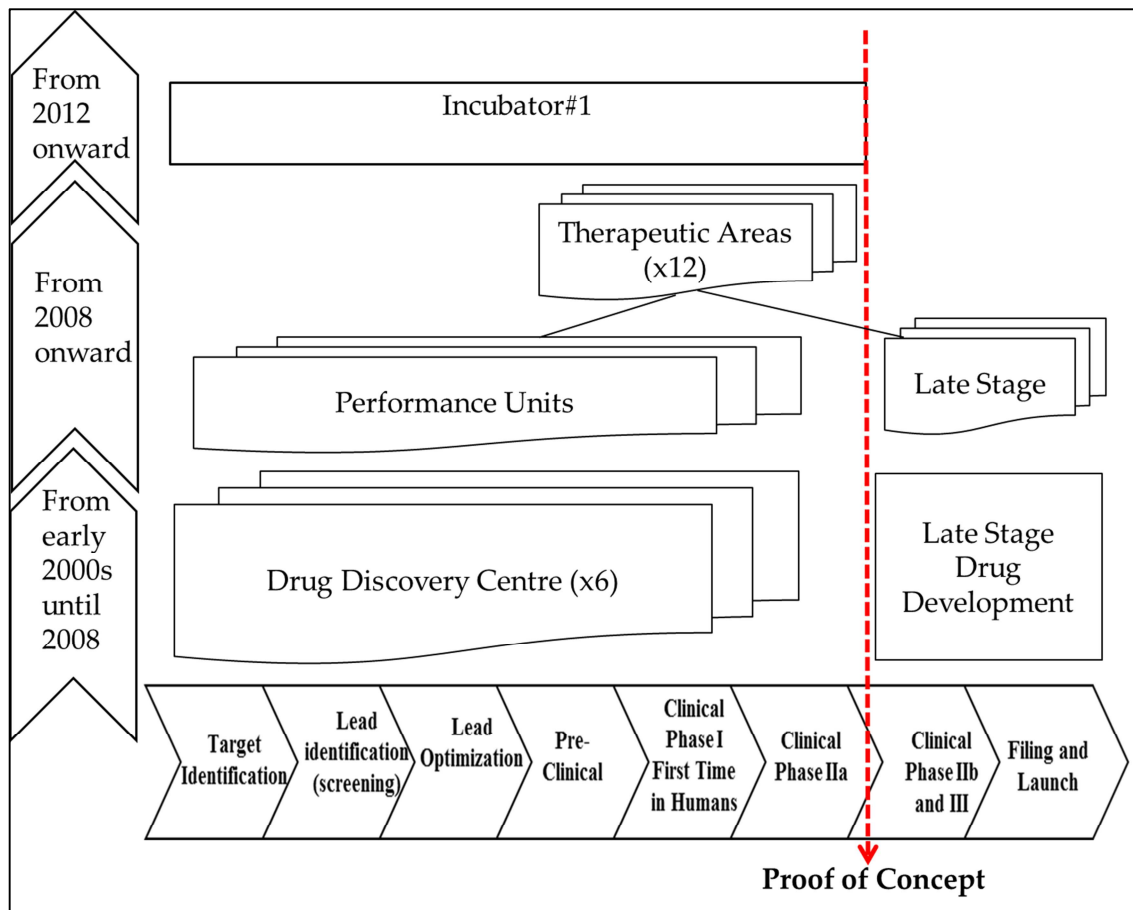
**Figure 4.2: A visual representation of the drug discovery process**

Source: (Lombardino and Lowe 2004)

drug discovery pipeline from early stage Research and Development (R&D) up to clinical trial. The model consisted in breaking down part of the R&D unit into the so called *Drug Discovery Centres*, which would carry out drug discovery and development activities until the proof of concept stage (see Figure 4.3)

However, almost a decade later such centres would be merged and re-organised into *Therapeutic Areas*, which would carry out all drug discovery and development activities including also the late stage development activities. Contextually, each Therapeutic Area would be broken down into small *Performance Units* (see Figure 4.3). The rationale for this organisational reconfiguring was to replicate the perceived advantages of the biotechnology company model (e.g. “flexibility” and “freedom”) within the context of BigPharma1. The latter had already adopted in the past the strategy of acquiring biotech companies and integrating them into BigPharma1’s existing organisational structure. Beyond the biotech companies acquisition strategy, the re-organisation first into *Centres* and then into *Performance Units* meant translating the entire model of biotech companies into the R&D organisation of BigPharma1, with the ultimate aim of creating an internal competition between performance units for innovation.

Parallel to such organisational restructuring, in 2012 *BigPharma1*, in partnership with *CharityFoundation1*, the UK government, a former regional development agency, and the UK’s innovation agency, opened *Incubator#1* at BigPharma1’s R&D campus. The bio-incubator is a jointly-owned not-for-profit organisation which provides office-space, facilities and services to start-up companies and to various academic projects in the area of life sciences and biotechnology. Whereas the transition to Drug Discovery Centres and Therapeutic Areas/Performance Units meant embedding the biotech model within BigPharma1, the *Incubator#1* initiative was imbued with the rhetoric of “open innovation” and “collaboration”. Incubation and open innovation were conceived as part of the solution to the problem of drug discovery pipeline productivity. Compared to Centres and Therapeutic Areas, one of the peculiarities of *Incubator#1* initiative lies in the fact that it constituted a solution that brought the State and other private actors both into the R&D space of BigPharma1 and into the campus of BigPharma1.



**Figure 4.3: A timeline of the re-organisation of drug discovery at BigPharma1**

All in all, the reforms that took place in the last fifteen years at BigPharma1 can be seen as the continuous and restless attempt to construct solutions to address the problems of the productivity in the drug discovery pipeline. Central to such solutions was the so called *biotech model*. The main features of such model were usually summarised as follows:

“[The biotech] model is based on external investment – typically, venture capital – in an innovative idea arising from an entrepreneurial source, often a group of academics [...] It assumes that investors can realise value through one of two routes: flotation on the public markets or, more frequently, a trade sale to an established pharma company” (PricewaterhouseCoopers 2010, p. 6)

The next section will investigate what made possible to translate the ideals behind innovation biotech model into organisational practices at BigPharma1. The section will argue that accounting instruments such as discounted cash flow had a role in translating the ideas of flexibility, freedom and responsibility embedded in the biotech model into BigPharma1’s practices. By inscribing innovation and economic value into *value*

*inflection points*, accounting made the drug discovery process visible in economic terms and amenable to economic intervention.

## 4.2 Accounting devices in the transition to Drug Discovery Centres and Therapeutic Areas

As part of an interview to a scientific journal back to 2012, the former head of R&D at BigPharma<sup>1</sup> explained the rationale for conceiving and implementing Drug Discovery Centres. The motivation for dividing up the big R&D operation into smaller units was to remove “bureaucracy”, while giving more “authority” and “accountability” to the smaller units. Based on these ideas, Drug discovery Centres were created and implemented in the early 2000s in order to re-organise BigPharma<sup>1</sup>’s approach to drug discovery. There were about six Centres located within and beyond the UK and each of them employed between 200 and 300 people. Each Centre would focus on one or more therapeutic areas (e.g. respiratory, immuno-inflammation, etc.) and would cover all the discovery and development stages from target identification until the proof of concept (see Fig. 4.3). According to the former finance director of one of these Centres, what characterised them was the fact that they were run as many biotech businesses. This entailed according to the finance director a number of features. First, each Centre had a certain freedom and autonomy over the budget. Second, they had a commercial focus, which often meant that a clinician was appointed to the head of research in each Centre. Third, the performances of each Centre were assessed against a set of simple targets, such as the number of proof of concepts<sup>6</sup> produced by each Centre in a year.

The next section will explore the interplays between accounting, understood here as valuation practices, and drug discovery in the process of translating the model of innovative and flexible biotech business into Centres. Valuation tools such as *discounted cash flow* and inscriptions such as *value inflection points* contributed to linking science, time, and economic value throughout the drug discovery process. While

---

<sup>6</sup> In drug discovery Proof of Concept usually refers to clinical phases I and IIa. In Phase I clinical studies, the safety and dosage of the drug is tested on a group of 20 to 100 healthy volunteers or people with the disease/condition.

In Phase II the drug is tested for efficacy and side effects on up to several hundred people with the disease/condition (“The Drug Development Process”. FDA. Accessed 16 November 2015 [http://www.fda.gov/ForPatients/Approvals/Drugs/ucm405622.htm#Clinical\\_Research\\_Phase\\_Studies](http://www.fda.gov/ForPatients/Approvals/Drugs/ucm405622.htm#Clinical_Research_Phase_Studies)). At the end of Phase IIa a decision is made as to whether progress to the later stages of drug development.

linking drug discovery to economic value, accounting translated the drug discovery chain into a ‘value chain’. By transforming the drug discovery process into a value chain, accounting made it possible to mobilise and switch financial and non-financial resources across different areas and stages of drug discovery.

*Linking science, time, and value: discounted cash flow and the drug discovery process*

When it comes to innovation in the context of drug discovery and development, there are a number of accounting practices that contribute to shaping the drug discovery process (see Figure 4.1). Drugs portfolio valuation was a practice in place at BigPharma1, as the former head of finance of one of the Drug Discovery Centres stated:

“One of the things that we used to look at in drug discovery was the value of the portfolio” (#16)

Drugs valuation within BigPharma1 consisted in linking the scientific and technical stages of the drug discovery process to the economic value of drugs. The changes in the economic value of a drug throughout its development stages were inscribed in the so called “value inflection point”<sup>7</sup>, as a former BigPharma1 scientist pointed out:

“[T]here is a good reason why this [drug discovery process] is segmented into sections; it is because each one of these points [corresponding to the end of each stage] represents a value inflection point” (#39)

What values inflection point did was to both inscribe and combine time –expressed in stages of drug discovery- and value. The implication of this linkage can be explained as follows:

“[M]oney goes up, the closer you get to the market ... you launch here and you count to be making 10 hundreds of million or billion and this point the risk has gone down to 90% and you probably get approval and you probably going to get billions and billions” (#39)

The probability of success was, therefore, one of the elements that determine the rise and fall in the economic value of the drug according to the different stages of the drug

---

<sup>7</sup>In differential calculus, an inflection point is a point on a curve at which the curve changes from being concave to convex, or vice versa. In drug discovery financing it refers to “the attainment of a goal or completion of body of work, for example the completion of a toxicology study, which if completed successfully serves to reduce some of the inherent risk in the project” and makes the project “relatively more attractive investment proposition than previously and should facilitate an increase in interest from potential investors” (O’Neill and Hopkins 2012)



discovery process. While looking at Figure 4.1 we can follow the description provided by the former BigPharma1 scientist:

“Here [end of phase 2] the risk is probably 50 and 50, you prove it is safe and efficacious and the risk is 50% and the risk is discharged at the end of phase 2 is proof of concept is where you show safety and efficacious application in man population. [While] preclinical you are down to 5%-25% so you are still in a super risky area” (#39)

The origins of the risk estimates the scientist refers to can be traced in a number of studies:

“They are having a couple of reports on this, a couple of publications around the risk. It is all based on the risk adjusted Net Present Value, so you can do the net present value discounted cash flows to get to the value” (#39)

The literature on biotechnology and pharma valuation widely refers to discounted cash flow techniques (e.g. risk-adjusted Net Present Value) for valuing biotechnologies and drugs (Keegan 2009; Svennebring and Wikberg 2013; Stewart, Allison, and Johnson 2001). These studies refer to the work of DiMasi et al. (1991, 2003) as industry standards which provide the estimates for pharmaceutical R&D costs. According to the head of finance of BigPharma1:

“You are going to take industry standards...so typically in the industry how much does it cost to take this type of asset to this type of development activity, how long and what the chances of being successful” (#36)

Prompted by the researcher to provide an example of source of industry standards, the head of finance cites *DiMasi's data*.

In 1991, DiMasi et al. (1991) published a work that aimed to provide a project-level estimation of R&D costs in pharmaceutical industry. The study was based on data collected through surveys across a sample of 93 New Chemical Entities (NCEs) discovered and developed by 12 U.S. pharmaceutical firms that first tested in humans between 1970 and 1982. The authors reported that preclinical expenses averaged 66 percent of total self-originated NCE research, which spread over 42.6 months prior to the initiation of the clinical period. The estimated cash outflows were converted to their present value in the year of market approval using a real (inflation-adjusted) cost of capital of 9 percent. The authors estimated the total cash outlays per successful new NCE to be US\$127.2 million. In 2003, DiMasi et al. (2003) updated their 1991 study and analysed a sample of 68 NCEs, which were discovered and developed by 10 pharmaceutical companies and had been first tested in humans between 1983 and 1994.

The new estimated R&D costs per new drug amounted to US\$ 403 million, amount which was then capitalized to the point of marketing approval at a real discount rate of 11 percent, obtaining a total pre-approval cost estimate of US\$ 802 million. The studies hence demonstrated how total capitalized R&D costs have increased at an annual rate of 7.4% above general price inflation. In so providing evidence and support to industry-wide claims about the rising costs of pharmaceutical R&D (clinical trial costs particularly) (Collier 2009).

Since their release, DiMasi et al.'s studies (1991, 2003) on R&D cost estimates have gained wide currency. As the authors themselves stated, the proposed estimates "*have been used by the [U.S.] Office of Technology assessment (OTA), the Congressional Budget Office (CBO), and various researchers to analyze policy questions such as the effects on R&D activities of health care financing reform or changes in intellectual property legislation related to the pharmaceutical industry.*" (DiMasi, Hansen, and Grabowski 2003, p. 152). Furthermore, the estimates have been often referred to by industry associations in their reports on the state of pharmaceutical R&D (EFPIA 2015; PhRMA 2008).

Perhaps a contributing factor to the diffusion of the estimates provided in DiMasi et al. (1991) was the endorsement they received by the U.S. Congress Office of Technology Assessment (OTA) (Office of Technology Assessment 1993). In 1993, the OTA reviewed DiMasi et al. (1991) study and highlighted sources of weakness. However, gaining access to proprietary company management cost accounts, the OTA noted, can be a very costly, lengthy and difficult process, mostly given pharmaceutical companies' resistance to provide access to proprietary data (Ibid., p. 66). Nevertheless, OTA concluded that the DiMasi et al. (1991) produced reasonably accurate estimates.

While becoming progressively institutionalised within pharmaceutical industry and policy making, the estimates of R&D costs provided in the study of DiMasi et al. (1991, 2003) have attracted strong criticism from a number of scholars. Light and Warburton (2005a, 2005b; 2011) advanced a critique of the \$802 million R&D cost estimate proposed in the study of DiMasi et al. (2003) and observed that:

“The estimate of R&D cost in this article [DiMasi et al 2003] is widely cited and accepted as an authoritative “fact” in the press and in the highest national and global policy circles. Given the prominent use of these cost estimates by the pharmaceutical industry and its advocates to influence national and international policies, it is critical that they be scientifically valid and relevant to the policy uses made of them.” (Light & Warburton, 2005a, p. 1032)

While warning on the “*constructed nature of R&D cost estimates*”, Light and Warburton (2011, p. 14) deconstruct the methodology and assumptions that have led to the \$802 million figure:

“Shortly after [DiMasi et al 2003] appeared, the Tufts Center for the Study of Drug Development announced that the average cost of developing a self-originated new chemical entity, including post-approval studies, was \$897 million (TCSDD, 2003; Kaitin, 2003). This figure, like the ones that preceded it, is based on confidential, unsystematic data, and has dubious scientific validity. In addition, adding post-approval studies to the costs of R&D is inherently questionable, because these “seeding trials” are designed primarily to familiarize physicians with the new drug and encourage its use; they are rarely randomized or blinded, but instead feature open-label case series, and are often sponsored by company marketing departments (Kessler et al., 2004)” (Light and Warburton 2005a, p. 1032)

Furthermore, Light and Warburton argued how the high R&D costs in pharmaceutical industry, the latter supported by the estimates of DiMasi et al. (2003), are a “myth” which is merely constructed and overlooks at best a number of facts. In this respect, Light and Warburton claimed for example that half of the costs are profits foregone, that trials costs are inflated, and that the time for R&D (i.e. 52 months for preclinical research, 72 months for trials, 18 months for regulatory review, a total of 142 months or 11.8 years) is inflated, and that corporate R&D risk is much lower (Light and Warburton 2011).

The controversy over the high estimates of R&D costs built up with a reply and a rejoinder of DiMasi et al. (2005a, 2005b), where the authors substantially rejected Light and Warburton’s critique. Beyond the technicalities of the arguments (see Collier (2009) for a summary), the controversy shows how the risk and R&D costs estimates provided by a number of academics within the arena of health economics gained the status of ‘established facts’. That is, facts which are hardly contested and widely recognized within the industry and policy making arena, but still hotly debated within the arena of health economics.

Once extrapolated from studies conducted within health economics, the probability of success and R&D costs estimates are usually incorporated in what is known as the discounted cash flow formula. A former BigPharma1’s scientist explained this passage as follows:

“The discount rate would be a relatively standard 10 or 14%. And then depending on what phase in the discovery process you are adding an additional discount factor which is then taking into account that if you are in the preclinical it is much more risky, and if you are here therefore you have

to multiply for another 10% which takes the value down. So each stage in this chain, the risk gets less as you move up here” (#39)

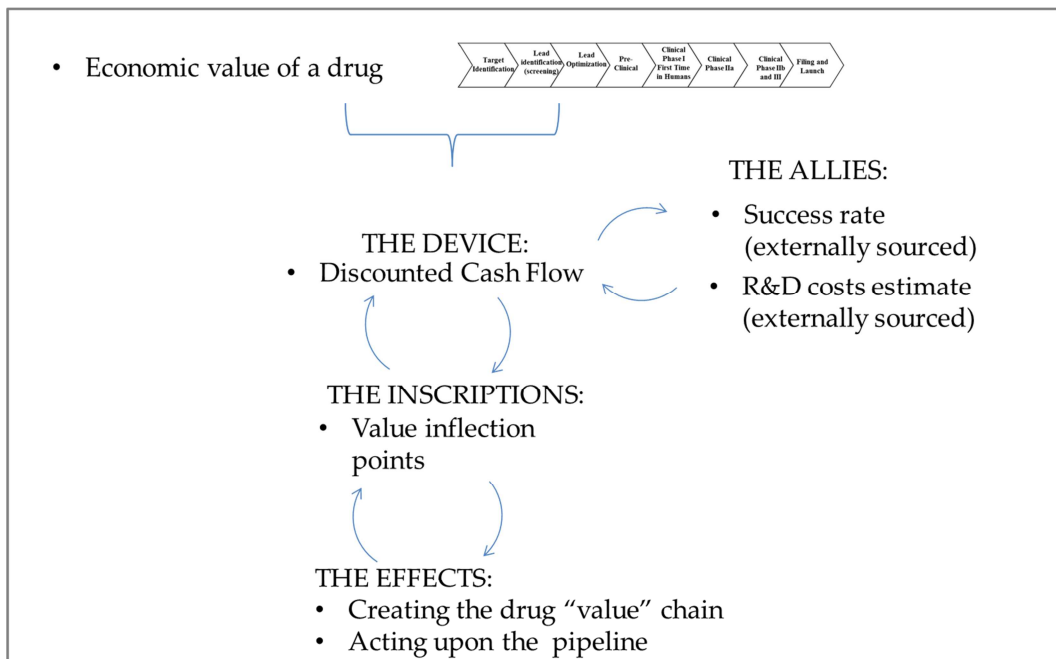
According to one of BigPharma1’s heads of finance, discounted cash flow formula is:

“[A] pretty boxed standard way of valuing in the industry for research pipeline assets because you don’t really have anything else as reliable” (#36)

Drug valuation at BigPharma1 implied linking time, expressed in terms of stages of drug discovery, to monetary value in order to produce what were called “value inflection points”. The latter correspond to the drop and rise in the value of a drug/asset at each stage of the drug discovery process. Inscribing economic value and drugs development phases into “value inflection points” has generated two effects. The first effect consisted in transforming the drugs R&D pipeline into a “drug value chain”. The second effect consisted in creating the conditions for acting upon the pipeline. In fact once the value was calculated then financial resources/investments –internal as much external venture capital funds- could be mobilised more easily, or current investment could be switched more “flexibly” between therapeutic areas.

As shown in Figure 4.4 below, linking drug development stages to economic value was made possible through a specific accounting device, which is the *discounted cash flow formula*. In this case, accounting has made itself relevant to the realm of pharmaceutical R&D activities/drug discovery by providing a “boxed standard” (#36) technique for quantifying/estimating the value of assets/drugs in each stage of drug development.

Without the discounted cash flow formula such quantification would be problematic for the actors in the field. In fact, the drugs/assets in the pipeline usually are not commercialised in the market yet, and in this sense one can say that both their market and their commercial value are only potential ones. To be sure, the value of a drug from preclinical stages all the way down to the launch in the market is only projected and its value cannot be determined by means of market prices mechanism. The power of discounted cash flow, in this case, consisted in making the drug discovery process commensurable by assigning economic value to the assets in the pipeline at each stage of their development. Discounted cash flow contributed to translating innovative scientific ideas into economic entities amenable to be acted upon by switching investments and resources across therapeutic areas/projects.



**Figure 4.4: Transforming the drug pipeline into a “value chain”**

Overall, discounted cash flow became a standard technique of valuation in drug discovery and development ultimately because of its *fluid* character. Discounted cash flow was fluid in that its components, i.e. cash flows, risk, and discount rate adapted to the environment of drug discovery and transformed into drugs’ success rates and drugs’ R&D costs. While the estimates of such components were debated across the arenas of health economics and pharma industry, the formula itself never became contested.

*Embedding the uncertainties of drug discovery through financial attrition, wish lists, and R&D budget*

This section will continue the analysis of the role of accounting in translating the ideas behind innovation biotech model (e.g. flexibility, freedom, autonomy) into organisational practices at BigPharma. The interplays between innovation and accounting are investigated in the context of the budgeting practices in place within Drug Discovery Centres. The section will show how accounting instruments such as *wish lists* and *financial attrition*, contributed not only to visualizing and prioritizing drug discovery activities, but also to embedding and normalising the ‘unknowns’ of the drug discovery process, i.e. the sources of project failure and delay. By inscribing the uncertainties of drug discovery into a number, i.e. the financial attrition rate, accounting attempted to control innovation not by acting on the sources of delays and failures, but by creating a ‘fictional’ form of control.

As highlighted earlier, running Drug Discovery Centres as a biotech business meant also that each Centre had a budget and could exert a certain degree of autonomy over it. According to a former BigPharma1 finance director, having autonomy over the budget meant creating the budget, understanding it, having it approved, managing it, and readjusting it according to the changed circumstances. First of all, “creating a budget” in the Centres entailed looking at costs. According to the former finance director of one of the Centres, the budgeting and forecasting process was made of a “spectrum” ranging from “predictable and controllable costs” to “difficult costs”. The predictable costs were exemplified as follows:

“You can predict the number of people you have, you can calculate how much they are going to cost and you can build a fairly accurate estimate for that and then there are costs that people incur such as travelling, training etc. the costs they incur in the lab in the day to day....so those costs are reasonable to forecast and control” (#16)

The “difficult costs” instead were related to the temporal dimension of projects:

“The difficult costs in drug discovery are obviously the project costs, because you don’t know how quickly the project will progress and indeed most projects will be slower than you forecast” (#16)

Not knowing when the costs were going to happen –which is to say not knowing how fast/slow the projects would go- constituted a problem and was making the budget “interesting” and “unusual” to the eyes of the former finance director. In order to solve the obstacle posed by “difficult” costs and manage the “unusual” budget, at the beginning of the year all the teams were meeting together with the aim of determining the total projects budget figure:

“To manage that we would get all the project teams together, we would agree all their project plans, let’s say 25 projects, each one had a plan for the next one-two years of activity, we would have a pretty good idea of how much each activity would cost. So a particular type of animal study for 7 days for 14 days we have relatively standard costs for those. A clinical study 15 people 3 months you can estimate for that. So you can build up a picture of all the activities that people plan and then add all of those together and that’s your total projects budget” (#16)

The total project budget, however, was a figure that apparently was not going to happen and this was mainly because of “unexpected problems” –according to the former finance director. This was something that has been learnt and internalised by the management team throughout the years:

“[Y]ou know you are not going to spend all of that because projects fail they hit unexpected problems. So what we discovered over several years was that let’s say you [say you’ll] spend fifty million, you add up all of the plans you interrogated...in reality you only spend twenty/twenty-five because you didn’t know why but you would get what we call the financial attrition”(#16)

In other words, all the uncertain and unknown aspects involved in the running of drug discovery activities in the Centres was embedded by the finance team in the concept of “financial attrition”. The latter was exemplified by the former finance director as follow:

“Through the year if you have the project plan from January to December and you plan to spend this amount -say 50- and then you track the actual spend and then the attrition is the difference. Percentage of attrition. So what I would do and let’s say that is 25. (#16)

“So the difference between the planned spend and the actual spend. We called it [financial] attrition. It is due to various factors, mainly delays but also some failures or cancellation. So it’s only in financial terms, in terms of budgeting that’s all we have to do is to say the plan is up to that, how much do we think we are actually going to spend” (#16)

To be sure, financial attrition constitutes an underspend on a budget in a period that is attributable to delays in projects or to project failures. Financial attrition aims to encapsulate a certain type of underspend into a category, without actually acting on the causes that led to underspending. In this sense financial attrition creates a fictional control of the unknowns characterising innovation, i.e. drug discovery.

In terms of managing the budget, there was a practice in the Centres such that the budget was managed as a total set where each individual project would carry on with the activities and the finance director would review the pool of activities and track the spending three-four times throughout the year. This practice was aimed at revealing both overspends and underspends, and making a decision accordingly:

“[W]e would decide if the level of attrition was what we thought it was going to be. If it’s likely we are going to overspend we have to agree changes to plan to reduce the plan spend and equally if we were going to underspend we were saying to people “you can accelerate what you are doing” (#16)

Here a new device, i.e. the level of financial attrition, is brought into the scene in order to address the issue of control over the unpredictable aspects of the drug discovery process. As the former finance director put it:

“It was a quite interesting area because you couldn’t tell where the underspends would be, where the attrition would be, but it almost always

happened. It just took experience to manage. We learnt, when I started we didn't quite know, we learnt" (#16)

However, the difficult part was for people –particularly new members of the team- to accept the level of attrition, i.e. to accept the fact that the approved budget would be lower than the total cost of the activities necessary for a specific project:

“Initially it was a bit scary because it looked like you are going to spend all this money and you only have budget for this month and eventually after two or three years we realised ...and for people new they always have difficulties in accepting this but I say “don't worry I think we are going to spend this”. So that was an interesting aspect of running the Drug Discovery Centres' budget” (#16)

The origins of financial attrition as a practice were not easy to trace. Although the concept might resemble the one of *variance*, they are not the same. On this point the finance director clarified as follows:

“Variance is the total difference between the budget and the actuals; in drug development, a major contributor to the variance is “attrition” – the combination of time slippage and other changes to project plans that will delay spend. Other elements of variance are – costs e.g. clinical studies, toxicological studies etc.” (#40)

At first glance, it seemed that financial attrition was a category that originated from within the organisation. On the contrary, the finance director explained:

“[Financial attrition] is a peculiarity of drug development – particularly early stage development. However, the same also happens often with capital projects which tend to suffer delays rather than being ahead of time. I have used [in the past] a general allowance for slippage of capital projects when planning” (#40)

The origins of financial attrition seem to be tracked down to the practices related to capital projects planning and a parallel can be drawn with the notion of *allowance for slippage*.

Financial attrition was linked with another budgeting practice, i.e. *wish list or activities lists*. This practice was such that every year each Drug Discovery Centres' Finance Director had to submit a list of activities for the projects which were planned to be carried out throughout the year. Let us assume that the total of that list was £300m. However, the “approved budget” for that year was given only for a lesser amount –say £200m. The difference between the two numbers was due to the rate of financial attrition. As a finance director at BigPharma1 observed:

“[Wish list] mostly comes from the fact that what you think is going to happen isn't what happens. So you might want to recruit 50 patients in 2015



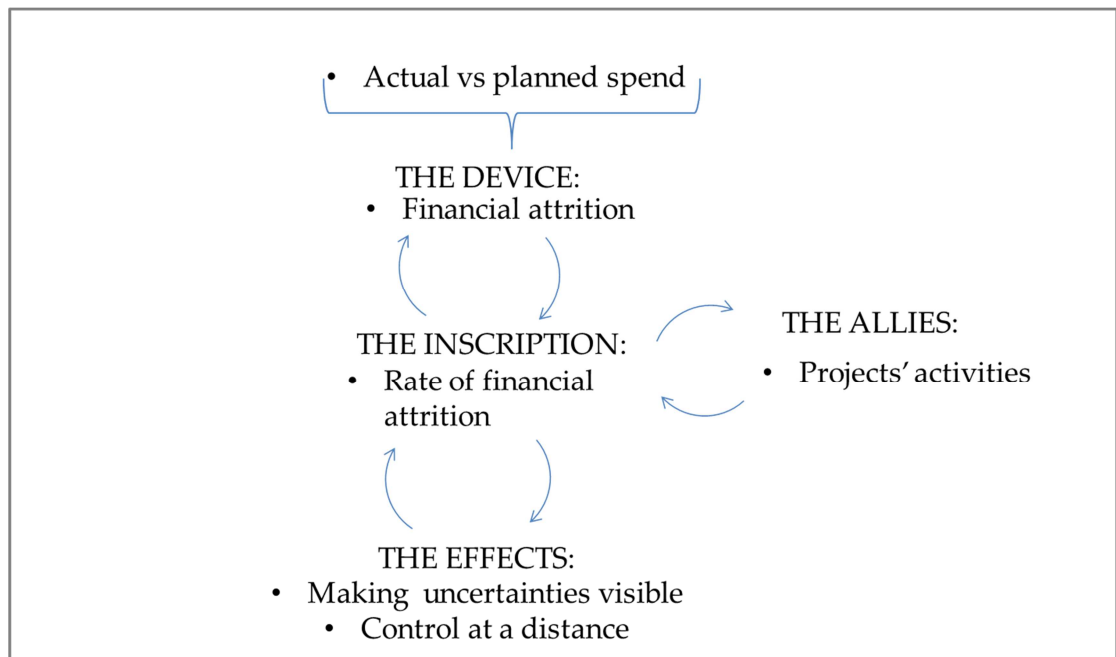
and that is going to cost you 10 million pounds to run that study, you are going to recruit 10 and you are going to spend 2 million pounds. So say you haven't spent 8 of the wish list. So we have a wish list versus an actual [approved] budget" (#36)

Yet, making sense of the gap between approved budget -£200m- and the total of the wish list -£300m- the finance director stated:

"I was counting on that [activity] not working because it helps to bridge that 100 [£300m less £200m] million pounds gap that I have" (#36)

In order to understand why the finance director was counting on the activity not working one has to look at the role and the effects of budgeting practices in the context of drug discovery at BigPharma1. Budgeting practices such as "financial attrition" and "wish lists versus approved budget" represent an attempt to make the uncertainty and the unknown visible through accounting. Accounting, through the financial attrition rate, enabled top management to grant autonomy/freedom to Drug Discovery Centres, while exerting control at a distance over the R&D activities in the pipeline.

Overall, the problematic of measurement and control faced by BigPharma1 (and Drug Discovery Centres) lies in the difficulty to trace the origin of underspends within the organisation. BigPharma1 learnt through experience that underspends were often related to "a combination of time slippage and other changes to project plans" (#16). What was unknown was *where* in the organisation such changes were going to happen, or in other words in which projects they were going to happen. Through processes of accumulation of information about actual and planned spends, the organisation developed a practice of monitoring the systematic underspends and inscribed them in what was called the *historical rate of attrition*. As shown in Fig. 4.5, the attrition rate acted as an *inscription*, travelling from the periphery, where science was mundanely carried out, to the core of the R&D organisation, where funding decisions were made. Every time an activity was cancelled or delayed in the periphery, at the decisional core where wish lists and budgets were drawn, a new activity would be prioritised and the gap between the total of the wish list and the approved budget would become closer. Being able to bridge the gap between the total of the activities and the approved budget meant to ensure the stability of the inscription. This helps to explain why the head of finance would "count on that activity [in the list] not working" (#36), for activities that do not work, act as *allies* toward bridging the gap and ensuring the stability of the attrition rate.



**Figure 4.5: Constructing the “autonomy” of Drug Discovery Centres as biotech businesses**

The rate of financial attrition was *combinable* in a sense that it was often attached to other devices such as wish/activities lists. Because of this property not only has financial attrition made uncertainties visible within the organisation, but also it has created a form of control at a distance that was essentially fictional. It was fictional because it did not act directly on the causes of uncertainties (e.g. delays, slippages, failures), but rather it tried to make those uncertainties accepted and normalised. In this sense financial attrition was more the product of uncertainty, rather than controlling it. By granting “autonomy over the budget” and “sufficient resources” (#20) to Drug Discovery Centres and by setting up financial attrition as a device, the top management of the R&D unit at BigPharma1 was able to control at a distance the R&D activities while granting the freedom and autonomy typical of biotech businesses.

The chapter so far showed how accounting, understood as budgeting and valuation practices, contributed to shaping innovation in drug discovery. In the case of Drug Discovery Centres and Therapeutic Areas, accounting as discounted cash flow tool shaped innovation by translating the drug discovery process into a value chain where each development stage corresponds to a change in the economic value of the drug. By making drug discovery visible in economic terms, accounting made it possible to switch investments across therapeutic areas and to mobilise resources around the drug discovery process. Furthermore, accounting understood as budgeting practices, shaped innovation in a sense of making it possible to visualise and prioritise, hence to calculate,

the costs of R&D activities. While inventing the financial attrition category, accounting not only contributed to embedding and normalising the unknowns (e.g. failures and delays) of drug discovery within the R&D organisation, but also created a fictional form of control over them, that is a form of control that did not involve acting directly on the causes of uncertainty.

The analysis has so far centred on the interplays between accounting and innovation in a context where *discovering* innovation is managed by a private corporation. How does accounting configure innovation when discovering innovation takes place in a context characterised by a mix of corporate (i.e. BigPharma1), charity, and public sector actors? To address this question, the next section will analyse the interplays between accounting and innovation in the context of BigPharma1's incubation programme, which is a programme for nurturing early stage drug discovery projects arising from both BigPharma1 and other organisations (e.g. universities). While remaining within the space of BigPharma1 R&D activities, the analysis will shift to a context where BigPharma1 is *one* among a variety of public and private stakeholders. This begs the question of whether and how the calculative frames and devices deployed within the corporation are translated into incubation, and whether such frames come into conflict with those of other stakeholders. The next section will address such question by examining the role of accounting practices, such as budgeting and financial planning, in translating different visions of incubation into numbers that can prove the value (and the cost) of *incubating* innovation.

### **4.3 From *discovering* to *incubating* innovation: accounting devices within Incubator#1**

In 2012 BigPharma1, in partnership with *CharityFoundation1*, the UK government, a former regional development agency, and the UK's innovation agency opened Incubator#1 within BigPharma1's research and development campus. The bio-incubator was a not-for-profit organisation which provided office-space, facilities and services to start-ups and various academic projects in the area of life sciences and biotechnology.

Whereas the transition to Drug Discovery Centres and Performance Units meant embedding the small biotech cultural model within BigPharma1, the Incubator#1 initiative was imbued with the rhetoric of open and disruptive innovation. The narrative surrounding Incubator#1 in the press releases, in the institutional website, in the reports,

and in the banners and posters displayed inside the incubator building made three evident and interconnected claims. The first claim was the one of being an incubator which was “different” from anything else already existing, in the sense of offering an innovative approach to incubation. The second claim stressed the idea of being the first and only incubator in the UK to deliver “open innovation” programmes. The third claim revolved around the commitment to creating an “ecosystem” that *connects* “academia, big pharma, and biotech”.

In the attempt to show how controlling innovation has been performed in the context of Incubator#1, the remainder of the section will analyse how the above claims came to be linked to accounting practices, such as financial modelling, budgeting, and internal reporting. Attention will be given to the interplay between the social and technical aspects of accounting practices, that is the cognitive models, categorizations, and metrics mobilised by actors in the enactment of innovation within the incubator. Ultimately, accounting devices such as the incubator’s financial model, the innovation budget, and the open innovation report constitute spaces where stakeholders experiment with accounting tools (e.g. budget categories, ratios) in order to translate their objectives and interests into numbers. Only by translating innovation objectives and financial objectives into numbers, the tension between the two sets of objectives become visible, hence actionable.

#### *The financial model as a socio-technical device*

The practices of both incubation and open innovation within the incubator were shaped by what was called the “financial model”, hence the importance of understanding its key characteristics. The actors involved in the process of producing (and updating) the model were the chief financial officer, the chief executive officer, the chairman, the accountant, and three other top managers. The model was shown to the board of directors in the form of power point slides, which contained graphs and excerpts extrapolated from the spreadsheets of the model. Descriptively, the constitutive elements of the model consisted of a set of key assumptions about occupancy and rental levels, funding requirements, business development and innovation objectives, and a number of financial projections (e.g. Profit and Loss, cash position, etc.).

The process, culminating with the final version of the model, started with a first draft of the key assumptions. The CFO would produce the first draft based on past board meetings and his own experience. The key assumptions covered areas such as rental (i.e.

rent and service charge per square foot) and occupancy levels (i.e. percentage of space occupied by tenants/companies), and funding requirements (i.e. funding agencies, duration and amount of funding programmes). The assumptions were then run by the CEO and the chairman, to whom only the excerpts from the model were shown. The key assumptions were then discussed with each individual manager (i.e. marketing and event manager, and operations manager) according to the specific areas that they were responsible for. Once they were “comfortable” with such assumptions then the following stage consisted in updating and running the model on the basis of those assumptions. This last step was carried out by the CFO in conjunction with the accountant and it was aimed at creating what was called a “*base-case*”. To create a base-case meant to run the model starting from the key assumptions. Once drafted the base-case the CFO and the accountant run at least six versions of the model by modifying the assumptions, with the aim of providing different projections. The chosen version was the one that “*fairly reflected*” (#23) the most likely outcome and that everybody “*felt highly confident in achieving*” (#23).

The financial model embedded the frames of simplicity, financial conservatism, and quality/innovation.

First, the frame of simplicity implied that too many details portrayed and communicated at board level can only generate complications and further questioning coming from the board of directors since “*they start to become suspicious*” (#23). All these complications needed to be avoided, in the CFO’s view and replaced with simple and clear information about the running of the business. As a result of employing this ‘simplicity’ frame, graphs and tables were constantly drawn upon by the CFO in his communication with the chairman, the CEO, and the Board. This choice was motivated by the fact that “*this board likes graphs, they are scientists, they find it quite helpful*” (#23) and also “*if they [top people] just see a big table of figures then it’s hard for them to really understand*” (#23). So, the CFO –and the accountant, who “*is really good at Excel*” (#23) -were the only ones who had access to the details of the model contained in the Excel spreadsheets.

Second, financial conservatism and financial sustainability frames were also embedded in the financial model. In many instances the CFO seemed to act as the spoke person for financial conservatism. He had been applying it since he was working at BigPharma1 as finance director of one of the Drug Discovery Centres. Financial conservatism meant, for example, to be highly confident that certain funding opportunities would actually take place by the time specified in the model, or that a

certain tenant would come to occupy the space by a certain date. Financial sustainability meant to be a self-sustaining incubator, that is to breakeven without drawing on loans and grants made available from the stakeholders.

Third, another frame embedded in the financial model revolved around quality and innovation. According to the CEO, quality and innovation consisted in promoting activities that showed how “different” and “unique” the incubator was and in “*evangelizing around innovation and open innovation*” (#32) by means of such activities (e.g. business development support, access to drug discovery expertise, etc.).

However, financial conservatism, financial sustainability and quality were often in tension and such tension was noticeable in many instances. During the conversations with the CFO he was often drawing a parallel between sales/marketing people that he met in the past, and the figure of the CEO at Incubator#1. In his view finance people tended to be conservative while sales or marketing people:

“would try to over inflate their sales because that means they can have a big cost budget or a big advertisement budget or a bigger promotion budget, because they are marketing people and they want as big advertisement budget as possible”

This tension between financial sustainability and the quality frame was traceable also in two documents. One was a strategy report, and the other one was the 2014/2015 budget. Back to spring 2013, all Incubator#1’s stakeholders convened in a one-day meeting with the aim of discussing Incubator#1’s vision, mission, and strategy. As a result of the workshop, an internal report was compiled containing the strategic priorities, objectives and the actions to be taken in the years to come. Under the objective “*Success and key metrics*” there was an item which crystallized what was described as a tension, i.e. “*innovation vs [financial] sustainability*”. The item was then explained in the same document as follows: “*financial success can be achieved more quickly without focusing on [Incubator#1’s] other goals of driving innovation*”. The point scrutinised and contested the centrality of innovation objectives as opposed to those related to the financial sustainability of the incubator. It reinforced and visualised that tension between financial conservatism and innovation that we encountered earlier on. According to the strategy report an agreement needed to be reached between these two ways of framing Incubator#1’s strategy. The next section will argue that the ways in which the tension between innovation and sustainability have been inscribed into accounting numbers were two, i.e. the IP/CRO ratio and the innovation budget figure.

### *Producing inscriptions: the IP/CRO ratio and the innovation budget figure*

In line with the assumptions included in the financial model, the budget 2014/2015 presented the projections related to Profit and Loss, funding requirements, capital spend, operational spend, cash flow, building running costs, management overhead, and finally the projection for *business innovation and development projects*. The projection of business innovation and development objectives for the year 2014/2015 appeared as a list of prioritised “strategic” items (e.g. new business creation projects, Phase 2 Accelerator project). For each item two numbers were projected: one was the “potential” amount for 2014/2015 and the other was the “approved budgeted” amount. Below the line featuring the total approved budget figure (e.g. £200k), a list of additional strategic projects was also provided. Such “additional” items were not included in the approved budgeted amount. The CFO explained the reason for having the “additional” funding/projects below the budget line as follows:

“I introduced this concept of “additional funding” to enable us- during the growth phase- to carry out these brand-building type of activities [...] He [the CEO] is always pushing here [business innovation activities], he likes these things and I was pushing back [...] We came to an agreement [...] we could re-prioritize to get the total back down to 200” (#34)

The quote highlights how business development and innovation activities are considered as “brand-building” type of activities, that is activities which are associated to the frame of ‘marketing’. Put it differently, innovation activities are seen by the CFO as activities that contribute to constructing the image and reputation of the incubator as innovative, rather than developing the internal innovation capabilities of the incubator. The CEO made sense of the distinction between approved versus additional items as follows:

“Anything below the line you must not do. That means you cannot budget for it, you cannot put resources into it until you deliver one of the top five and then the next priority moves up. So that’s portfolio management for me. The budget line sets where you have to draw the line and you have to be...it’s very very difficult. Because that project is one that you need to do, you want to do but you have to show discipline of not to do it until you deliver” (#35)

The effect of having an approved budget as opposed to the potential budget for business innovation objectives, consisted in exerting “discipline” over innovation and over the innovation spokesman, i.e. the CEO. The rationale behind the *approved versus potential budget* seemed to be very similar to the one characterising *wish lists versus approved budget* in place in the Drug Discovery Centres. Perhaps this similarity has to do with the

fact that the incubator CFO was a former finance director of one of the Drug Discovery Centres. This suggests that a translation of accounting devices from the Centres to the Incubator#1 took place thanks to the CFO, who effectively acted as a spokesman for both financial sustainability and financial conservatism.

Whereas the budget for business innovation objectives constituted one way to inscribe the tension between financial sustainability and quality/innovation, another way of inscribing such tension was by means of the *Intellectual Property/Contract Research Organisations ratio* (hereafter “IP/CROs” ratio). The ratio was presented by the incubator managers as the key performance indicator of Incubator#1. Descriptively, the ratio represents the percentage of tenants that could potentially develop intellectual properties (IPs), as opposed to the percentage of tenants that provide research services on a contract base to pharmaceutical and biotechnological companies (so-called Contract Research Organisations, CROs). On the one hand, by IP-related companies it is meant those companies that carry out intellectual activities in a scientific (or industrial) field that can give rise to protection rights such as patents or copyrights (WIPO 2014). Often operating at very early stages of drug discovery, IP-related companies are said to contribute to constructing the incubator as an innovative environment. Given the early stage of drug discovery at which they operate, such companies often do not produce revenue streams and have to rely on external investments in order to pay the rent to the incubator. For this reason they are said to pose a risk to the financial sustainability of the incubator. On the other hand, CROs are regarded as a more stable source of income for the incubator in that their main activity consists in providing services on a contract base (i.e. fee-for-services). However, since service providers tend not to generate IPs, they are not counted as high quality/innovative tenants.

Overall, the IP/CROs ratio inscribed the tension between financial sustainability (i.e. making profits) and quality and innovation objectives, by creating a space where the objectives of the incubator could be discussed and negotiated through numbers. In agreement with the board of the incubator, the management team has set the ratio at the level of 75%/25% - 80%/20%. This means that the targeted percentage of tenants that have already developed or will potentially develop intellectual property is set at 75-80%. While the targeted percentage of tenants that provide services is set to be at 25-20%.

Compared to the budget for business innovation objectives, the IP/CROs ratio seems to align the members of the management team and the board of directors, such that



IP/CRO is regarded as the key performance target for the incubator. Consistent with his frame of simplicity, the CFO regarded the ratio as a *simple* and *clear* target which could prove the progress toward the construction of the “high quality scientific environment” at Incubator#1:

“My view is that you must have clear targets about what you are going to deliver, and how you are going to measure against that. If the target is going to help you to achieve those objectives then it’s worthwhile, but you shouldn’t be distracted by having too many things, because that will reduce the focus that you have. I mean, our KPIs to be quite honest, at the beginning was quite simple: attract high quality tenants –something like Proof of Concept in [Drug Discovery Centres]. High quality tenants defined as 80/20 percent –IP versus the rest- that’s our KPI” (#34)

The IP/CRO ratio also embedded both the quality/innovation objectives and the financial sustainability objectives of the incubator. As a consequence, the ratio shaped incubation in a sense of putting less emphasis on filling the building with income generating/fee for service sort of businesses. Talking from his office in the Incubator#1 building –located within BigPharma1 campus- the CEO observed:

“If you build one of these [Incubator#1 building] next to one of those [BigPharma1 buildings] then people will come and the quality will be good and you wouldn’t have to fill [the incubator] like other incubators in the UK and other incubators in the world with CROs and service providers. CROs are contract research organisations – fee for service” (#35)

The IP/CROs ratio provided a space where the financial sustainability and quality frames could be experimented, calculated, discussed, and negotiated by actors. The (intended) effect of the ratio was to perform the incubator’s environment according to the frames embedded in the ratio itself. Hence, innovative environment is an environment where 80% of the companies are IPs generating companies. However, this might exclude from the picture those CROs that are still regarded innovative, although not producing intellectual properties. In this sense the ratio contributed to enact a vision of innovation which clashes with intellectual property.

### *The open innovation audit report*

In 2013, the management team of the incubator commissioned an innovation consultant to write up an open innovation audit report. The reason for this decision was explained by the CEO as follows:

“I need to show that in addition to the incubator success, there is a measurable success caused through open innovation” (#35)

The first part of the report was based on a series of interviews conducted by the consultant with the incubator's tenants and other stakeholders, to the aim of building a picture of the open innovation activities in place within the incubator. In other words it was intended to show to stakeholders in general the progress toward the achievement of the open innovation objectives, by means of case studies and narrative type of accounts. The second part of the report focused instead on the design of a set of key performance indicators for open innovation and collaboration, with a view to develop in the future a more systematic approach to the assessment/audit of open innovation.

One can look at the *open innovation audit report* from different perspectives. First, the open innovation report acted as an ally for the innovation programme in that it translated the innovation objectives of the incubator into numbers and performance measures. In this way, measures of innovation could compete with those of financial sustainability (e.g. profitability measures). Its role was to show the board of the incubator that the activities funded under the innovation budget produced quantifiable successful results, potentially aligning the quality frame to the financial sustainability frame. Second, the report embedded a distinctive set of metrics, categorization, and models of innovation.

With regards to the models embedded in the report, the latter explicitly drew on work such as: "The innovator's DNA: mastering the five skills of disruptive innovators" (Dyer, Gregersen, and Christensen 2013) and "Open Innovation: The New Imperative for Creating and Profiting from Technology" (Chesbrough 2003). The following will briefly summarise the main message advanced in these works and the main points of criticism. The concept of disruptive innovation is based on the idea that a lower margin product, which is positioned at the bottom of the market and which initially reaches less profitable customers, can take over the entire industry. An illustrative example here is the mainframe computing industry, which was "disrupted" and taken over by the incumbent production of more affordable personal computers.

However, critics held (Lepore 2014) that the theory of disruptive innovation has failed as a tool for predicting disruptive innovation, while being evangelised as a "gospel", in Jill Lepore's words, within and beyond corporate arenas. Open innovation is defined as "*the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively*" (Chesbrough, Vanhaverbeke, and West 2006). Often presented as a shift away from the closed system innovation paradigm, the concept of open innovation attracted criticism from various scholars. Some authors stressed the lack of precision in

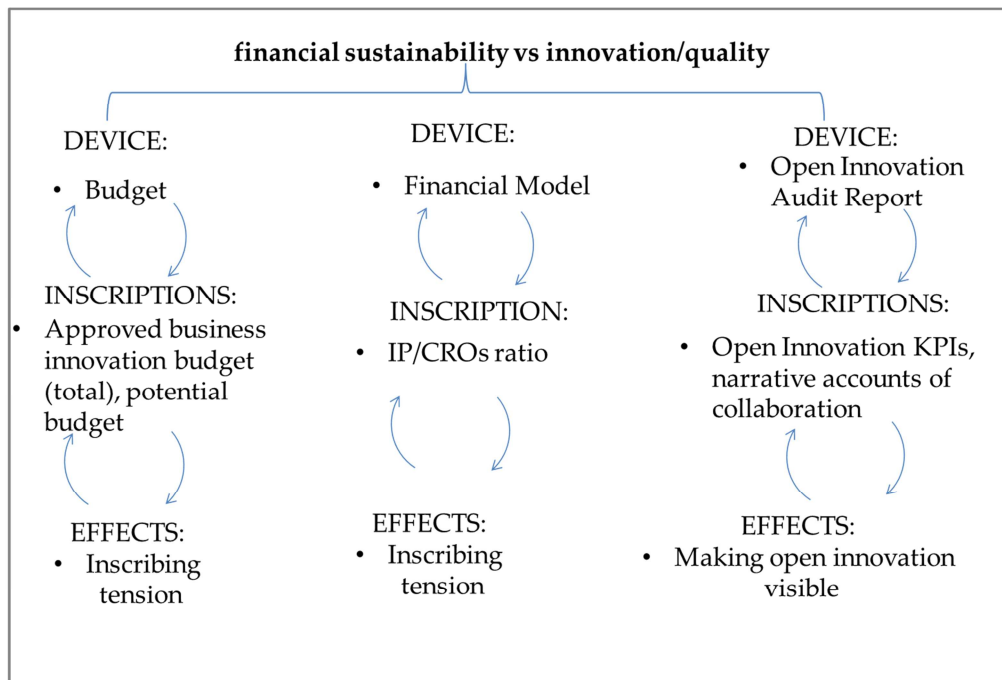
Chesbrough's definition (Trott and Hartmann 2009; Dahlander and Gann 2010), while others (Trott and Hartmann 2009) criticised the fact of presenting open innovation as a new paradigm, and argued that it rather constitutes a re-packaging of existing concepts and models in innovation and R&D management literature.

With regards to the metrics included in the open innovation report, a number of performance measures of open innovation were created such as the *number of new collaborations*, and the *number of conversations started with new co-tenants*. In this case, not only has accounting adapted traditional tools, i.e. performance indicators, to new environments, i.e. open innovation; but also it has contributed to realising the value of open innovation.

In conclusion, the accounts from Incubator#1 reveal the emergence of a tension between different ways of framing the incubation programme, i.e. incubation as a financially sustainable business and incubation as an innovation and quality driven environment. Such frames were mobilised by different actors within the organisation, and both were embedded into a number of accounting devices such as the *financial model*, the *budget*, and the *open innovation audit report*. Figure 4.6 shows how each of these devices contributed to creating spaces of experimentation, tension, and negotiation. The budget for business innovation and development translated the innovation and quality objectives into a list of all the innovation activities that the management team wished to carry out and the related costs. However, the total budget figure for innovation was approved to cover only a part of such activities. The approved budget figure contributed to inscribing the tension between financial sustainability and innovation objectives. Furthermore, the financial model addressed the same tension by constructing a 'balanced' proportion between service providers and IP-generating tenants, i.e. the IP/CROs ratio. The proportion seemed to constrain the number of tenants which provide services and generate income, in favour of "high quality innovative" companies, which generate IPs but not income. Finally, by providing narrative accounts of "open innovation" activities, the open innovation audit report has contributed to enacting open innovation and how this should be audited and acted upon.

Overall, different forms of accounting contributed to negotiate the tension between different calculative frames. In this respect, the *approved* versus *potential* budget for business innovation will still be negotiated in the future. The tension will be solved perhaps only when the outcomes of open innovation projects will be made fully 'auditable' and 'transparent', or perhaps this will but exacerbate the tension. Conversely the IP/CROs ratio seemed to be a much more stable inscription, i.e. an inscription that

all the parties agreed on, such that it was transformed in the main performance target of the incubator.



**Figure 4.6: Inscribing the tension between the financial sustainability frame and the innovation/quality frame**

## Conclusion

### *Economizing science through multiple accounting devices*

The chapter began with a problematic of productivity in the drug discovery and development pipeline. It developed further by narrating situations which showed how the problem of productivity was reconstructed as a problem of the corporation, which in turn became a problem of how to re-organise R&D activities in such a way that productivity could rise again. It presented several accounts from finance directors, scientists, incubator managers, and consultants and suggested a number of things, which are summarised in Table 4.1.

First, the material showed how accounting as discounted cash flow formula, was linked to innovation in the drug discovery process. Linking accounting and innovation through discounted cash flow formula had the effect of transforming the drug discovery process into a ‘value chain’ characterised by *value inflection points*. Furthermore, attributing value to the assets/drugs across the different discovery and development

stages has enabled managers and investors to act upon the pipeline and to mobilise financial and non-financial resources across the different stages of drug discovery.

Second, the empirical material showed how accounting, in the form of a ‘new’ category, i.e. financial attrition, made it possible for the organisation to visualize the uncertainties inherent to innovation, i.e. to the drug discovery processes. By translating the financial attrition category into a percentage (i.e. 50%), which represented the slippages and failures occurring during the R&D process, and combining it with other accounting tools, such as “wish lists”, accounting made it possible to shape innovation. In this case, shaping innovation meant not only that financial attrition and wish lists made it possible to prioritise, rank, and select which R&D activities to include in the approved budget and which activities to exclude or defer. But also that activities were ‘expected’ to fail or to get delayed in order to avoid underspends and carry out all the wished activities. By normalising failures, delays, and slippages, accounting created a sense of discipline and control in the management of R&D activities without having to intervene on the causes of such failures, delays, and slippages.

Third, in the case of Incubator#1, the empirical material showed how accounting simultaneously inscribed multiple and sometimes conflicting calculative frames (e.g. innovation versus financial sustainability) by means of the IP/CRO ratio, the incubator financial model, and the business innovation and development budget. In this case, accounting shaped the innovation activities of the incubation programme by providing certain actors (e.g. managers, board members) with the tools for translating their goals, objectives, and interests into different versions of value, i.e. value as ability to make profits, or value as ability to produce intellectual property. Accounting also provided the space where these different versions of value could be experimented and negotiated.

Overall, what the chapter suggested is that it was not only a problem of productivity the one that actors in the field were concerned about and busy to fix. There was a wider discursive element coming to the fore, which is related to science, and how it is possible to govern science in a way that it can ally with the market, the State, and the corporations toward the objective of fostering innovation and hence economic growth. The pipeline productivity was a part of a wider discourse on how science can be linked to the economy in such a way that science becomes “economized”. How accounting is implicated in making such connection possible was the focus of the chapter. The questions that seemed to cut through all the accounts presented were: how do actors frame science in such a way that it can be brought from remote places in academic

departments, private and public research laboratories to the market place? How can science be enrolled to take part to the so called “race to the top” (Lord Sainsbury 2007)?

All the indicators, formulas, and budgets presented in the chapter were mobilised by actors in order to frame science and try to control such an unpredictable and unreliable ally. Financial attrition, wish lists, performance indicators are mobilised to control innovation, that is to control for the fact that technical tests do not work out as planned, for the fact that activities take longer than expected, for the fact that scientists from private corporations are not always interested in collaborating with their colleagues in universities and incubators, and when they want to they have to confront with all the red tapes of the big organisations. Without the different forms of accounting discussed throughout the chapter, Drug Discovery Centres, Therapeutic Areas, and Incubator#1 would probably become a dis-organised, value-less, un-prioritised, flat ensemble of drug discovery and development activities. After costing, framing, prioritising, valuing innovation– the decision making process becomes instead hard to contest precisely because of the ‘objectivity’ granted to the accounting devices that are mobilised throughout. So, to answer the initial questions, accounting has done and performed a lot, in all those different ways that have been discussed earlier on. And importantly all of them count as accounting for innovation.

Accounting devices made it possible to translate innovative scientific discovery into *economic* entities such as project R&D costs, drugs’ value, etc. As a result of such translation, scientific ideas can be acted upon, financial resources can be mobilised, and investments can be switched in so shaping the trajectory of scientific ideas. We have seen throughout the chapter that the ways in which each accounting device has contributed to such translation are multiple, and the effects each device has generated are multiple too. And it is such ability of accounting to adapt to contexts and enrol into *programmes* that makes it powerful. Probably the power of accounting for innovation does not lie in creating “new” tools, but in adapting to new problematics of control by mobilising and combining (Latour 1987, p. 227) traditional, yet *fluid*, devices and new rationales.

This chapter showed how *discovering* and *incubating* innovation involve translating scientific ideas into *economic* entities and how accounting made such translation possible in the context of the private corporation. The next chapter will investigate the practices of *transferring* of innovation in the context of universities and technology transfer offices within universities. In shifting the perspective from private to public contexts, one would expect to find different sets of concerns, calculative frames,

tensions, and accounting devices. The chapter will show how university's concerns for commercialising research have been translated into performance indicators. The chapter will also discuss the effects of such translation and the tensions that have emerged, such as the one between publishing and commercialising research.

**Table 4.1: A characterisation of accounting devices in Drug Discovery Centres, Therapeutic Areas, and Incubator#1**

	Drug Discovery Centres and Therapeutic Areas			Incubator#1		
Accounting device / Characterisation	Financial attrition	Wish/activities list	(Risk adjusted) Discounted cash flows	Financial model	Innovation budget	Open innovation audit report
<b>Descriptive elements</b>	Underspends, attrition rate	List of R&D projects and activities' costs	Drug development cost estimates, probability of success, sales potential	Key assumptions about: rental level, occupancy level, funding requirements, innovation objectives	Business innovation and development objectives, list of activities' costs (prioritised)	Open innovation KPIs framework; review of open innovation initiatives already in place
<b>Embedded frames</b>	Being "realistic", "objective", and "clear"	Being "realistic"	Science-time-value relation	Financial conservatism and sustainability, simplicity, quality of incubation	Innovation, quality, and financial sustainability	Auditability, open innovation model
<b>Calculative action</b>	Estimating and reviewing attrition rate	Costing, creating and prioritising list of activities	Valuing the market, using industry standards	Assessing prospective tenants, creating a base-case, assessing IP potential	Prioritising activities	Measuring/narrating open innovation/collaborations
<b>Origins of practices</b>	Capital projects planning	Portfolio management	Health economics, investment appraisal	Financial analysis	Portfolio management	Auditing, KPIs
<b>Inscriptions</b>	Historical attrition rate	Projects/activities total, approved budget	Value inflection points	IP/CROs ratio (%)	Business innovation and development projects total (£) (potential and approved)	(future) Open innovation KPIs, (current) IP/CROs ratio



# CHAPTER 5 EMBODYING TENSIONS THROUGH ACCOUNTING: THE CASE OF TECHNOLOGY TRANSFER IN THE UK

---

## Introduction

“Many young scientists are now spending 50% of their time writing research proposals where they are expected **to hypothesize about ‘impact’**. They can have no real idea of impact at this point, so if they are honest on this issue they will be denied **funding** because it’s perceived that they’re doing research that is not particularly **useful**. Thus an intrinsically corrupt approach is being fostered which slowly but surely is destroying our discipline which is based on doubt, questioning and more importantly a deep respect for evidence-based truth” (emphasis added)

–Sir Harold Kroto, 1996 Nobel Prize in Chemistry

The quote above is taken from a public interview to Sir Harold Kroto -1996 Nobel Prize in Chemistry and effectively exemplifies the core theme of the thesis, which is the role of accounting in realising the economic value of science, where science is increasingly regarded as *instrumental* to the achievement of economic progress. More specifically the quote points to the underlying theme of this chapter, which is the paradoxical character and the unintended effects of measuring and valuing academic science on the basis of criteria such as usefulness and commercial relevance.

The chapter will explore how accounting is implicated in *transferring* innovative scientific ideas from university to industry, in the context of university technology transfer offices. Attention will be given to the accounting and law devices that have been mobilised to align academic researchers with research commercialisation programmes within universities. Instances of such devices include invention

disclosures, key performance indicators, performance targets, and the so called *formula-based funding*. In the process of making research amenable to commercial exploitation, different sets of aspirations (e.g. the “inventive” university, the growth of regional economies) are translated into accounting numbers and result (either intendedly or unintendedly) into tensions and contradictions. At least two types of tension emerge from the analysis. One is the tension between *publishing and commercialising* academic research and the other is the tension between *licensing and spinning-out* research ideas. The section will show how accounting not only was deployed to inscribe different aspirations, but also has contributed to either creating or mediating tensions within the field. The Research Excellence Framework (REF) and the Higher Education Innovation Fund (HEIF) will be drawn upon to show how the *formula-based funding* device has produced inscriptions (e.g. the weights) which have both generated and dissolved a number of tensions (e.g. publishing versus commercialising).

## 5.1 Framing science through technology transfer

“Anything is a disclosure. Also a conference, because anybody can take a picture of your slides or poster or talk. Technically even talk to your friends down the pub is a disclosure [...] So we need to know if they [academics] are going to publish, because that helps to know whether we’ve got to rush to file the patent or whether we’ve got time”.

–Licensing executive (#22)

The opening quote is suggestive of the role that technology transfer plays within universities: ‘capturing’ (#22) ideas developed by academics before they reach the public domain. As Michel Callon (1998c, p. 253) suggested, academic research ideas can be conceived as *overflows* that take place everywhere (e.g. in the laboratory, at the university cafeteria etc.) and all the time, whether this is during the conduct of ‘normal work’ or not.

The section examines how technology transfer is itself an assemblage of costly law and accounting devices established to ‘capture’ scientific ideas. Such devices are deployed to the ultimate aim of making scientific ideas visible in economic terms, and in so contributing to the construction of markets of scientific ideas. This section will consider the construction of two spaces within universities where framing efforts occur: one is the space of research commercialisation and the other one is the space of research

publication. The section will show what framing devices are mobilised within these two spaces and the effects they produce. Particular attention will be given to research commercialisation since this is where attempts to economize science is most concentrated. Research commercialisation is enacted across different centres of calculations within and beyond university institutions involving university's finance offices, technology transfer offices, the Higher Education Statistics Agency (HESA), and offices within city councils and (former) regional development agencies.

The remainder of the section will first provide an overview of what is meant by technology transfer practices. Then the discussion will turn to the law and accounting devices that are deployed by technology transfer offices in order to capture scientific ideas and their value. In this respect, the role of the invention disclosure form in framing scientific ideas will be analysed. The section will then follow the sequence of displacements and transformations of invention disclosures and patents into performance indicators, their aggregation at level of HESA and the linking between performances and innovation funding via *formula-based funding*. Finally the consequences and effects of linking performances to funding will be discussed.

### **5.1.1 An overview of technology transfer practices**

Technology transfer offices represent a central part of the commercialisation activities carried out by British universities in the pursuit of the so-called universities' third mission of wealth creation. As discussed in Chapter 3, Technology Transfer activities have gained prominence since the late 1990s in the UK. Their emergence was also enabled by changes in the regulation of intellectual property rights arising from academic and publicly-funded research.

The organisational arrangements for technology transfer can take different forms. In some cases technology transfer activities are carried out by commercial vehicles which are wholly owned by the university, in other cases they are partly or fully outsourced to public listed companies specialised in technology transfer, and in which the university holds a minority stake.

These arrangements are motivated also by the fact that public universities in the UK are registered as charities whose primary purposes are teaching and research. The fact of carrying out commercialisation activities such as intellectual property licensing and trading as part of universities' third mission hence generating profits have raised in the past several concerns. This is due to the potential conflict between the charitable status

and the commercial activities, together with the fiscal treatment of the profits arising from such activities. Due to a lack of clarity characterising the fiscal and charity regulation of such aspects (Hatakenaka 2004, p. 30), universities opted either for the creation of wholly owned subsidiaries in order to undertake the commercial activities, or for outsourcing the management of their intellectual properties portfolio to third companies operating in the technology transfer sector. The first option –i.e. a wholly owned subsidiary- is the case for *Top University 1,2,4,5*, while the second option –i.e. outsourcing to a public listed company- is the case for *Top University 3*. The empirical part of the section on technology transfer will draw on the accounts from these universities.

Broadly speaking, the range of activities that falls under the remit of technology transfer offices involves the identification, evaluation and protection of intellectual property (IP) and its commercialisation through licensing and the formation of spin-out companies. There is usually a division of labour within technology transfer offices such that different teams are assigned to different tasks. The licensing executive of a top ranked British university illustrates the point as follows:

“There are two types of team. There is the me type who goes out and talks about technology transfer and how we can help academics to develop the technology and file patents on that, find the licensee and then license the technology. And then there are other colleagues that go out to the schools and explain them about the process of making a disclosure to the centre and how we would assess if we file a patent on that" (#22 – Licensing executive)

As suggested in the quotes, a central part of technology transfer offices’ activities has to do with engaging/communicating with academics on a regular basis, either in the form of one-to-one meetings or in the form of networking events and workshops. The issues involved in interacting with academics are related to the difficulties of engaging them in the activities of technology transfer, partly because of academics’ focus on research and teaching and partly because of the reputation attached to technology transfer offices sometimes. As a technology transfer manager of a top British university put it:

“The university tech transfer offices don’t have the best reputation [...] I think historically there has been a perception that they have been quite unrealistic about what they can achieve [...] But that does not mean that there has not been a reputation of tech transfer offices to be difficult or slow or heavy [...] And when this kind of offices at universities are slow it is either because they have been asked a question they don’t know the answer, or we are permanently always snowed under and it is difficult. And so if

[academics] want to opt out that's fine" (#28 – Technology Transfer Manager)

Another important task of technology transfer offices involves 'capturing' inventions/technologies generated by the academics, which means amongst the other things assessing the commercial potential of an invention/technology and protecting the invention by means of intellectual property rights. The Director of IP of a top ranked British university stresses how a piece of research is not necessarily considered to be an invention and how not all the inventions have necessarily a commercial potential:

“[Our] role is to identify intellectual property from academic research, so we have a team of people whose job is to talk with academic researchers to understand when their research might lead to an invention and when it does lead to an invention to make sure we determine whether that invention has commercial potential or not, so just because you made an invention does not mean that there is a potential of generating income and when we think there is good potential we will consider to protecting that IP, it might be by patenting, copyright, trade secret, design right” (#15 – Director of IP)

The characteristic of having a good commercial potential is a necessary pre-requisite to patent filing, i.e. the beginning of the whole patenting process.

“So we see about 300 inventions a year here at the university and then we focus down on those which we think have greater commercial potential and we work closely with those” (#15 – Director of IP)

Another issue related to capturing inventions/technologies has to do with deciding the pathway that an invention/technology can take once the patent has been filed. This type of decisions characterises the space of technology transfer too. The options, which will be discussed later, consist in either licensing the technology to an existing company or creating a spin-out company.

This chapter will consider the practices of transferring 'innovative' academic science to industry from the perspective of accounting. The chapter will show how accounting contributes to the circulation (i.e. transferring) of innovation by providing the tools to assess the economic value of transferring technology. In so doing, accounting translates the vision of universities as inventive and creative institutions into numbers that can be negotiated and acted upon. Technology transfer offices represent costly structures put in place by universities in order to capture scientific ideas generated by academics and frame such ideas in economic terms. As a result of such framing, scientific ideas are translated into *economic entities* (e.g. spinouts, income from licensing), thus becoming *economised* in a way that they can speak the language of economic actors such as investors, public agencies, and the industry.

To identify the economic entities fabricated while transferring technology, the chapter will explore how technology transfer offices act as *centres of calculations* providing data that is aggregated and passed on to other centres of calculation within and beyond the university (e.g. the Higher Education Statistics Agency (HESA) and the Higher Education Funding Council for England (HEFCE)). Once reached these centres, indicators are aggregated and form figures (e.g. Income from research councils involving business collaboration) on the base of which financial resources are allocated.

The next section will discuss technology transfer as a space characterised by tensions rationalised into calculations of performance, that is the tension between publishing and commercialising research on the one hand, and the tension between licensing and spinning-out technologies on the other hand. First, the section will discuss invention disclosure and patenting as devices aimed at framing scientific ideas and enrolling academics into commercialisation programmes, the latter finalised at either licensing or spinning-out technologies. Second, the section will trace the transformation of invention disclosures, patents, and spin-outs into performance indicators (e.g. invention disclosures count, patents count, and spin-outs count). Third, the section will account for the collection and aggregation of data about universities' innovation performances at HESA level. The section will argue that it is by linking performances to funding via *formula-based funding* and by assigning *weights* to research and innovation performances that local tensions can either arise or dissolve.

## 5.1.2 Characterising technology transfer as a place of tensions

“From [industry] standpoint [technology transfer] is a good thing. Whether UK ltd reputation will continue to be excellent is an interesting question. I am worried slightly there is a paradox here: we [industry] go to universities [to collaborate], why do we go to universities? Because they are brilliant. Let's take [TopUniversity#1], in the moment we fund a contract, we don't want them to publish papers –you see what I mean? And if they don't produce any papers their standing goes down. It's a paradox”

– Head of Technology Strategy (#3)

The opening quote is indicative of a contradiction that characterises the space of interrelations between university and industry. It offers an intellectual puzzle where technology transfer and more in general university collaborations with industry, while

being encouraged by the government, can affect research and academic publishing in paradoxical ways. This section analyses the emergence of a tension experienced by academics between publishing their research and commercialising it. This tension is often coupled with a pressure posed on technology transfer office executives to enrol academics into research commercialisation programmes.

How are paradoxes, tensions, and contradictions created in the space of technology transfer? And has accounting a role in producing rather than mediating such tensions? To answer these questions the remainder of the section will look first at the devices which are used to frame academic ideas, that is devices which are deployed to make ideas visible in such a way that they can be commercialised. Second, the section will look at how such devices are displaced/transformed into performance indicators and how this implies them travelling across different centres of calculations, such as universities' finance offices and HESA, i.e. the Higher Education Statistics Agency.

### *Framing innovation through the invention disclosure form and patent application*

“The frame establishes a boundary within which interactions –the significance and content of which are self-evident to the protagonists –take place more or less independently of their surrounding context”

–Michel Callon (1998c, p. 249)

Research contracts, invention disclosure forms and patent applications represent attempts to capture scientific ideas and inventions put forward by academics in the course of their normal job. As suggested by the opening quote, contracts bring resources (e.g. ideas, researchers, technologies, equipment, etc.) into a demarcated stage within which said resources come to play a specified role, which is self-evident to participants. This means, for example, that after an invention disclosure is signed, the scientist is aware of the fact he will not be able to disclose his idea at conferences without letting the technology transfer office know about it. In this sense one can say that resources and the interactions between them are framed by disclosure forms and contracts.

The next section will show the role that accounting plays in framing scientific ideas. Revenue-sharing agreements, cost-sharing agreements, and economic valuations are few instances of how accounting has contributed to shape the space of technology transfer.

*Patents Act 1977*

The first device designed to control the flow of scientific ideas generated by universities' employees is a law device. The licensing executive at *Top University 4* illustrates the latter as follows:

"I think it's in 1983 [sic 1977] with the copyright act which stated the employer owns the intellectual property. So for instance if you are an academic at the university, you are employed to do research and in a sense through your research you are expected to invent new things and anything you invent belongs to your employer. However, if you were administrator, or cleaner, or secretary and you invented something that didn't relate to your **normal work** then you would own it because it's not been invented through the course of your normal duty" (#22 –emphasis added)

It was under the Patents Act 1977<sup>8</sup> that academic and publicly-funded academic research started to be assigned to universities as direct consequence of the employment contract. However, not all the universities in the UK assume almost automatically that the IPs are owned by the Universities. There are a few exceptions in the landscape of higher education institutions, as explained by a technology transfer manager at *Top University 1*:

"[T]he other thing which is quite different to others is that **we don't assume that the university owns the IP, but we don't assume that scientists own the IP either**. Some people think that [name of university] owns the IP, that's not true. We don't try and decide who owns the IP, we simply put in place a piece of paper which says "any rights at the university that all the scientists have are all assigned to [tech transfer office]" **so all the rights are in one place** and that means that we can either go further and commercialize on behalf of the university and the inventors or we can assign it back to the scientists that want to opt out, but it means that is all gathered in one place. Where there is a lot of **other universities that assume they own the IPs** and then once something is commercialized they have to go back and just check, which is not necessarily ideal" (#28 –emphasis added)

The other device in place to capture the flow of academic ideas is the invention disclosure to which the chapter will now turn.

---

<sup>8</sup> Section 39(1) of the Patents Act states that an invention made by an employee shall be taken to belong to the employer if: (a) it was made in the course of the normal duties of the employee, or specifically assigned duties, from which an invention might be reasonably expected to result; or (b) it was made in the course of the employee's duties and because of the nature of the duties, a special obligation to further the employer's interests.



## *Capturing ideas through the Invention Disclosure Form*

A practice in place in most of the British universities is the one of asking academics/inventors to fill in a form through which they disclose their invention to the university's technology transfer office. There is some variation across universities in the content of the form. However, the purpose remains the same:

"It's really to capture as much relevant information as we can about an invention" (#22 - licensing executive)

As shown in the sample provided in Appendix 2, the form is made of several boxes which are to be filled in by the academic/inventor. Commercial, technical, and legal elements characterise this piece of documentation. Appendix 2 provides a general template of what is usually to be found in a disclosure form. The form usually contains a box where inventors provide a summary of the technology, avoiding "*too many graphs, details, and equations*" (#22 -licensing executive) because technology transfer managers would not necessarily be of the same specialist area as the inventor and too many details would be therefore difficult to grasp. Another box asks the inventor to disclose whether the technology has already been presented at conferences etc. If a decision is made to apply for a patent, i.e. the technology has a commercial potential, then other extra boxes need to be filled about the commercialisation strategy to be pursue (e.g. licensing, spin-out formation, etc.), the competitors, any existing company to approach for licensing, and any existing sponsor (in case they might have first right on the invention). In some cases the disclosure contains an agreement to revenue sharing of the kind shown in Table 5.1 below.

**Table 5.1: Example of revenue sharing agreement**

NET REVENUE	INVENTOR(S)	DEPARTMENT	UNIVERSITY
£1 - £2,000	100%	0%	0%
£2,001 - £42,000	60%	20%	20%
£42,001 - £200,000	50%	25%	25%
>£200,000	30%	35%	35%

Yet, in some cases (e.g. *Top University 4*) a box containing the clause "*School/Faculty agrees to cover 1/3 of the costs of patent filing and maintenance*" is inserted in the invention disclosure form. The reason for including this box is explained by a licensing executive as follows:

"We ask the schools to provide some funding to cover the cost of the patent –filing and maintenance- and the reason for that is to match funding. So the

centre [University] pays two third of the cost [of patent filing and maintenance] and we ask the school to pay a third and if the school says no we are not paying the third, we have to ask the question why. It is because the academic got a reputation for saying he's got this fantastic invention but he hasn't, so we are looking for the school to make sure that the technology is as good as it can be" (#22 - licensing executive)

What the 1/3-2/3 ratio does in this context is to inscribe different views of what the inventive reputation of an academic is and of what constitutes a good technology.

Not all the academic ideas are 'eligible' to be disclosed and to be entered in the universities' databases. As seen before, academics can decide not to disclose an invention either because they are not interested in the commercialisation path or because they prefer/opt for liaising directly with a company bypassing the technology transfer office.

However, also technology transfer managers operate some sort of skimming strategy and as a consequence of that not all the 'informal' disclosures result into a formal invention disclosure to be entered in the university's database. On this point a technology transfer manager at *TopUniversity#1* argues:

"Even in *University1 Enterprise* [technology transfer office] we all view all these things slightly differently, so if an academic talks to you, you could log it into the system as an invention disclosure" (#28 )

There seems to be 'tacit' selection criteria which managers apply when an academic talks to them in order to disclose his invention or simply to ask for advice:

"But I don't tend to log that unless I think that there might be a patent. So, I was talking to this guy about how his project needs to develop and funding that he needs to apply for and whether or not he should have a confidentiality [agreement] and whether there would be an opportunity to patent. I didn't log that. The disclosure is a little bit **artificial** because it is very person to person dependent on what you consider as a disclosure" (#28 –emphasis added)

As noticeable in the technology transfer manager's words, it is "artificial" and "very person to person dependent" to establish what count as an invention disclosure.

### *Patenting application process*

Once an invention is disclosed to the technology transfer office then a decision needs to be made as to whether filing a patent, i.e. applying for the patent. As seen earlier, a practice within technology transfer offices consists in formalising the disclosure only for those inventions that are potentially patentable. However, the final decision as to

whether filing a patent in some cases is not made neither by the manager nor by the academic individually, but by a panel like the one at *Top University*#4. This is to avoid the risk that too many patents with “*no real commercial value*” (#22) are filed. A risk ranking is usually performed by the commercialisation panel on the basis of factors such as the level of maturity of a technology, how far the markets are, how big they are, how easy is to penetrate into the market, how many competitors, what the perceived demand from people is.

However, the overall ranking is only part of a “narrative”, as the licensing executive explains:

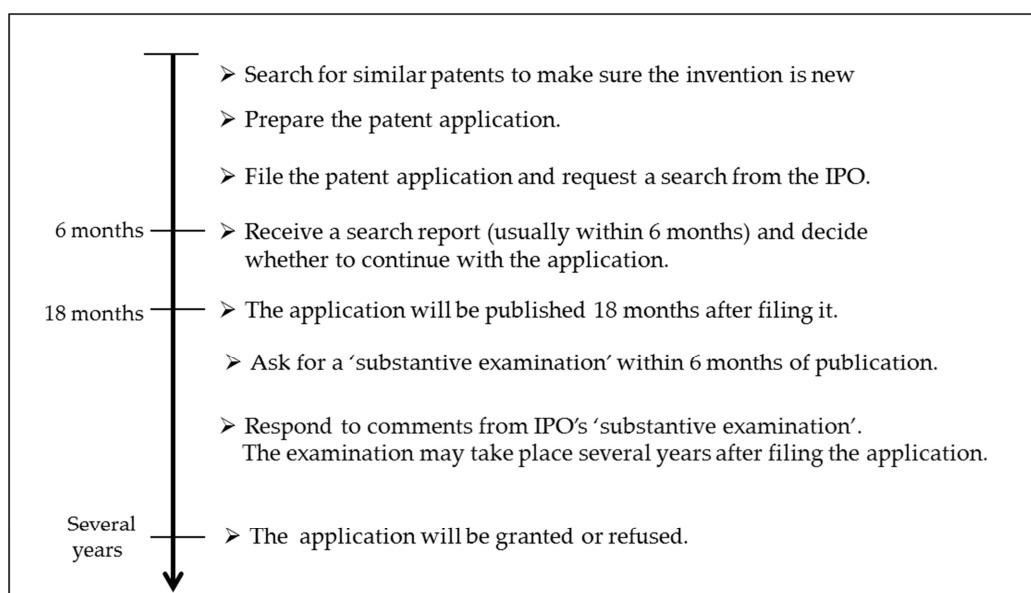
“I don’t think that you can say that anything that scores less than three doesn’t get funding. It’s more complicated than that. And part of this has also to do with academics whether they are keen on commercializing or they have a track record of commercializing or whether they are difficult to work with. It becomes a multi-faceted [decision] and although this ranking I think it is much more like a narrative than as being a number. So I don’t think I can give you an answer on what the cut-off is. So many factors **it’s almost the decision of my committee - if you like- is influenced by the ranking**” (#22 –emphasis added)

Timing also constrains the decision making process and if an academic goes to the technology transfer office close to a publication or conference deadline, then technology transfer managers find themselves rushing into patent application decisions. This point is illustrated by a technology transfer manager at *Top University 1* as follows:

“[A]part from invention disclosure which is a very personal thing, filing a patent again you are pushed into it because you don’t have enough time to really consider the invention disclosure” (#28)

Once the decision to file a patent is made, the process, as regulated by the Patent Office, is described in Figure 5.1 below.

Normally, the routine for a technology transfer office would consist in filing a patent and a year later the application enter the Patent Cooperation Treaty (PCT) which establishes a filing date in all contracting states. Six months later it becomes published on the internet. Twelve months after that it enters the national phase and will automatically go on the public records. At this point it is not possible to withdraw the application (#22) and decision will then be made by Patent Office (or any other regional/national office) as to whether granting or rejecting the patent application.



**Figure 5.1: The patenting process flow**

**Source:** adapted from <https://www.gov.uk/patent-your-invention/overview> (accessed 25/04/2015)

In terms of costs, the more expensive part of the process is –according to some respondents- the PCT application and not the initial filing. As shown in the invention disclosure form (see Table A-1, Appendix 1) some universities require the department/school to contribute (e.g. one third) to the cost of patent filing and maintenance. However, the PCT application involves an amount between 5-6 thousand pounds (Intellectual Property Office 2015) and this represents the make or break point for the patent application, i.e. the point at which the technology transfer office together with the academic has to decide whether to carry on with the PCT filing or not.

### *Licensing and 'spinning out' pathways*

Once the academic/inventor together with the technology transfer office decide to take the commercialisation path, another important decision has to be made as to whether licensing or spinning out the technology. Commercialising academic research can take either the form of licensing a technology to an existing company or the form of licensing the technology to a newly formed company, i.e. start-up, in which both university and the academic/inventor (and further investors if it is the case) have an equity position. When undertaking the licensing path, the academics usually provide the link with potential companies:

“There is an old rule of thumbs that 80% of contacts for licensing technologies come from the academics, because they work in the field already and 20% comes from the technology transfer office” (#22)

However, licensing a technology also depends on the priorities of the company to which the technology is licensed:

“[The] question is then do we go to any of the big pharma and say we have this lead compound, we have done some work on it, looks very exciting do you want to license it? And they say ‘yeah maybe’ and they give you a little bit of money for it and maybe they don’t have that in their priorities and forget about it” (#22)

The spin-out route instead takes more ‘commitment’ on the side of academics both in terms of developing the technology and also in terms of attracting rounds of investments/funding:

“Or you go down the spin-out route and form a spin-out company, you are driven....you want this route to be developed so all your attention is focused on it, you find research development funding for it and investment funding for it and you’ll be on board in the management team and you develop until you’ve got evidence that it works, that has grown its value and then you license it” (#22)

Spin-out formation requires developing a **business plan** which sort of ‘crystallises’ and puts numbers on the “commitment” to develop the technology (e.g. a drug):

“With a business plan you say this is our spin-out company and then if there is a commitment to develop the drug in the next five years, you have to work out what your costs are gonna be, almost working out month by month what the cash flow is, where the money is going to come from, and month by month how much you are gonna spend” (#22)

Moving from each individual licence story or spin-out story to universities’ top levels, each commercialisation story becomes *disentangled* from local relations and contingencies (e.g. the technology, the academic career of the start-up founder, etc.) quantified and inscribed into a set of performance indicators (e.g. number of spinouts, total income from licensing) which are used within universities for different purposes. The latter range from constructing narratives about the standing of the university as inventive and impactful institution, to accounting for internal resources and acting upon them. The next section will show how spin-outs stories are made visible at an aggregate level within universities and how this process is not free from tensions.

## *Transforming disclosures and patents into performance indicators*

“My boss would say the management doesn’t really care about what we do on a daily basis, what they want to see are metrics because **they have the numbers so they can see** – you know- if there is a trend from 5 years ago, going up or going down”

–Licensing executive (#22, emphasis added)

This section will show how individual disclosure forms and patent applications are transformed and displaced into performance indicators. The passage implies moving numbers from technology transfer offices to the actors at the top of the organisation (i.e. university’s top managers). This is done by accumulating information about inventions and patents in order to make them visible and manageable to the eyes of those placed at the top of the organisation (i.e. the university management). The section will look at how and where *invention disclosures count*, *filed patents count*, *licenses count*, and *spin-outs count* are created.

### *Key performance indicator: the ‘invention disclosures count’*

‘Invention disclosures count’ is a performance indicator which is often used by universities both for internal reporting and also in order to comply with the HESA (Higher Education Statistics Agency) data requests. However, disclosure counts as a performance indicator means different things to different people. As the Director of IP at *Top University 5* illustrates:

"So, some stats: I said that there are 370 inventions a year and there are 3300 researchers here. This tells us about one in ten researchers has an invention that we capture here. So 370 for me is a good number and is certainly above university norms. **But that’s really saying that one in ten academics have an invention or that they get engaged with the tech transfer office somehow.** We could also say that 9 in 10 are completely disconnected with the tech transfer office, don’t have ideas –not to be a bit harsh- it is fair to say that amongst the priorities that academics have –researching, teaching, ensuring that their knowledge is used in useful way- research and teaching for many academics are primary objectives that’s what they want to do" (#15 -emphasis added)

As the quote above suggests, invention disclosures count can mean different things to different people. A technology transfer executive might take it as an indication of the “*level of engagement with technology transfer offices*” (#15). While a university’s top executive might interpret invention disclosures count as a measure of the “*level of*

*inventiveness*” (#14) of the university. In these different guises the same performance indicator can contribute to building different stories, like the following one:

"The more inventions the university gets the greater standing it feels it has as an inventive institution" (#15)

A licensing executive from *Top University 4* instead emphasises how the number itself is not a measure of the quality of the portfolio of technologies. However, he stressed the importance of keeping the number high:

“If you have 10 disclosures per year and they are all absolutely excellent and you are able to file a patent on four tenth of them, and license four tenth of technologies out to companies, then disclosure number wouldn’t really matter too much because you get that flow of ten good ones every year. But you don’t get ten good ones, you get in our case about 100 and some are poor, some are OK, some are really good. So you need to keep that flow coming through. So **you need that number** [invention disclosures] **to be relatively high**” (#22 –emphasis added)

To sum up, the decision as to whether formalising an invention disclosure can be “*very personal*” (#28) in that it depends on what the executive considers to be a disclosure (e.g. a serious and analytical conversation about the project, or else) and whether the executive thinks there might be a future patent. The fact that the count of the disclosures produced in one year is used as a performance indicator can perhaps influence that personal judgment. In other words, the number of invention disclosures as a performance indicator can generate the effect of pushing both academics to engage with technology transfer offices and managers to formalise that engagement/interaction under the form of an invention disclosure. However, the meanings attached to the final figure (e.g. 370 disclosures in a year) can range from indicating the level of inventiveness of a university to indicating the level of engagement between academics and technology transfer offices.

#### *Key performance indicator: the ‘filed patents count’*

Each university keeps record of the number of patents that have been filed in a year. Such performance indicator is often reported in universities’ annual and strategic reports. Similarly to what happens with the number of invention disclosures, also the number of filed patents tends to be contested on the ground that is not indicative of the level of innovation. Criticism about this performance indicator is usually based on the fact that filing a patent does not necessarily mean that the patent will be granted. As a Head of Legal and Operations at a charitable sponsoring agency points out:

"The metrics that I have are a bit clumsy because they are counting patents, it needs to be more subtle" (#30)

At *Charity Foundation 1* the percentage of grants (awarded by the charity to academics for translational research) which result in patent application is used as performance indicator, which nevertheless is subjected to contestation within the charity itself:

"I worry some time that the figures that I see –we ask whether they have filed any patents- and something like **15% of grant holders said that they filed patents**. I find it very difficult to believe, it might be actually true, but they might have just abandoned it straight away cause –you know- in any university scientists have great ideas, they go to the tech transfer offices and say “I want to publish, I want to present at the next conference” and the tech transfer officers say “oh we need to file a patent! We need to file a patent!” It costs thousands of pounds and then nothing happens for another year and then they’ve got to spend extra ten or fifteen thousand and so they will abandon it. So, you know 15% is great but I don’t think it is reflective of whether that actually turned into something. And we haven’t worked out how to fine tune that, follow that up as the patent really turns into anything" (#30, Head of Legal and Operations –emphasis added)

What *Charity Foundation 1* is struggling to measure is whether the awarded grants have turned into any commercial output. In this respect filed patents is not reflective of the amount of awarded grants that turned into commercial outputs. Nevertheless, other institutions such as *Top University 1* regard filed patents, if anything, to be reflective of the work that has been done to file the patent. The number of PCT application is instead regarded as a better indicator when it comes to measure the outcomes of commercialisation efforts:

“[I]f you put in a patent application is kind of performance indicator... you know you put a lot of work into it, cause these things don’t just happen but actually when it comes to assessing whether or not you identified the technology that you are really going to pursue, I think the PCT application is better” (#28)

This section has discussed the case of filed patent count as performance indicator. It has shown how they can mean different things to different actors and how they contribute to build different type of narratives. From the point of view of the individual manager, the number of patent applications in fact can be used to monitor the performance of managers because they are supposedly “reflective” of the work that has been carried out to file a patent, but they are not “reflective” of the success of a technology. However, in the university’s annual report, the number of patent application



constitutes a *key* performance indicator which helps to build the story of economic and social ‘impact’.

*Key performance indicators: ‘spin-out companies count’ and ‘licenses count’*

Within *Top University 4*, the spinning-out route is made visible at the level of Innovation Board, at the level of the university council, and at the level of the university executive board by means of a number of indicators. The Innovation Board is essentially an investment committee, while the council of the university is a body composed by external people who “*have an interest in the running of the university and advise the executive board on the running of the university*” (#21 –Spinout Portfolio Manager). As explained by the Spin-out Portfolio Manager at the *Top University 4* the different bodies within the university want to see “*any events that you can put numbers on*”. The numbers which are usually produces are:

"How many grants they received, how much income, what the sales effort, what turnover. All those kinds of information. Depending on the company, how many employees, whether they have expanded or reduced [...] Every single one, what is their cash position, how stable is the cash position. If they get no more sales or no more incomes how long are they going to survive. That is something we would always report. The asset value of the company, are they in positive or negative asset position? Should we be concerned? [...] We develop our own indicators every time" [#21]

Performance indicators can serve different purposes, depending on the narrative in which they become embedded. As to case of “cumulative investment over time” (i.e. investments into spin out companies) the Spinout portfolio manager at *Top University 4* explains:

“One of the indicators that we use is the cumulative investment over time. To me, I am not convinced by this indicator. I don’t think it is particularly useful [...] For example if you had a lot of money, lots of investments going into a company that has died, that’s not mentioned [...] It doesn’t indicate, it is pointless about how the investment was...because the investment is wasted” (#21).

On the one hand, the performance indicator is used to construct a narrative about “*This is us. This is what we achieved*” (see quote below) as university. On the other hand, from the perspective of the individual manager, the performance indicator does not support a narrative made of “true business indicators”. The Spinout Portfolio Manager illustrates the point as follows:

“It is just a cumulative figure that gets bigger every year. And to be honest that’s the point of it: it gets bigger every year and so it looks interesting. I would not say that this is a true business indicator. It’s “this is us. This is what we achieved” and to be honest I think this is unnecessary. But how much investments have been secured in this time frame, that’s a useful indicator. But not a cumulative, year after year, getting bigger and bigger” (#21)

The illustrations so far have showed how individual licence stories or spin-out stories become *disentangled* from local relations and contingencies (e.g. the technology, the academic career of the start-up founder, etc.) and are transformed into sets of performance indicators (e.g. number of spinouts, total income from licensing).

The next section will account for the collection and aggregation of data about universities’ innovation performances at HESA (Higher Education Statistics Agency) level.

### *From “individual indicators” to “portfolios of KPIs”*

Looking through the pages of the “ten-year university strategic vision” of *Top University 5*, there is a detailed breakdown of each strategic area into sets of key performance indicators (KPIs) and targets. *Intellectual Property commercialization* is one of the key performance indicators oriented toward the goal of carrying out “world-class research”. The correspondent target is a “*weighted portfolio of measures*”, ranging from number of invention disclosures to number of licences and spin-outs. Talking about the exchange of accounting information between the technology transfer office and the university, the Director of Intellectual Property at *Top University 5* explains:

"We [Technology Transfer Office] have agreed certain performance metrics with respect to the university, so the university wishes to see so many inventions per year, to file so many patents, to do so many license deals, to form so many companies. Those are the kind of metrics they are looking for. Or to secure so many million pounds of income, these are all the kind of metrics that university is keen to see" (#15)

These measures are then used to construct narratives about the university. The Director of IP provides some examples of such narratives:

“They [performance metrics] are all surrogates for evidencing that the university is on the one hand an **inventive institution**, but on the other hand an institution that is **connected with industry** and transfers his knowledge and research to industry for the benefit of society, to achieve impact from research...that’s very important things for the university, that’s what funders require to the university" (#15)

However, when asked to interpret what a “*weighted portfolio of measures*” means the participant seems not to be aware of such weighted portfolio:

"I am not quite sure how we do that honestly. I am provided with row information about these things here and what we do we look at those in a number of ways. What they are very keen to do is to compare our performance with the performance of other universities and a peer group both in the UK and internationally [...] I'm challenging the use of word “weight” in there, there is a portfolio of measures...I don't know whether that is just loose language or whether the university is doing something. We need to have a good level of performance across a broad number of indicators" (#15)

In other words, the Director of IP had a problem in making sense of what the weights of the portfolio of measures are. When the recorder is off, the director argues that if TopUniversity#5 (i.e. his employer) tells him to produce a certain performance indicator he would produce it and give it to them because that is what they want and not because it actually ‘makes sense’ to him. He also warns that one must be very careful to enforce certain measuring exercises because they can trigger a risky and distorted behavior. Similar sets of performance indicators are also in place at *Top University 4*. According to one of the licensing executives:

“We [IP commercialization office] are measured on a number of metrics including number of patents filed, number of disclosures, how much license income reporting per year, how many spinouts have been formed, how much the portfolio of spinouts is worth, how many patents have been filed...” (#21)

The licencing executive who works within the IP commercialisation office at *Top University 4* makes sense of the numbers that they are asked to provide to University top managers as follows:

“My boss would say the management doesn't really care about what we do on a daily basis, what they want to see are metrics because they have the numbers so they can see –you know- if there is a trend from 5 years ago going up or going down” (#22)

The idea of applying *weights* to the portfolio of performance indicators is a practice that can be found in at least other two different, yet interconnected, devices which will be discussed in the next section. The first device is the Research Excellence Framework (REF) and similar exercises which have been performed by the government since the mid-eighties. Systems of weights are the central part of such devices and provide the mechanism (i.e. the formula-based funding) through which research commercialisation

performances are linked to resources allocation. The second device, which will be discussed in the next section, is the Higher Education Innovation Fund (HEIF). Also HEIF device employs a system of weights in order to allocate funding to support the third stream mission of universities (i.e. wealth creation).

The next section will discuss how REF and HEIF have not only provided the tools for assessing the economic value of transferring innovative science to industry, but also have generated a number of tensions.

### *Linking KPIs to funding: the formula-based funding device*

#### *Device: the Research Excellence Framework (REF) and formula-based funding*

Public funding for research in the UK works under a dual system (House of Commons Science and Technology Committee 2002). On the one hand the Higher Education Funding Councils –under the aegis of the Department of Education and Skills- administer and allocate funding to Higher Education Institutions (HEIs) in the form of blocks grant distributed on the basis of research assessment. On the other hand the Office for Science and Technology (OST) –under the aegis of the Department for Trade and Industry- provides funding to the UK Research Councils which would then allocate research grants on competitive basis.

#### *The 65%-20% weights as inscriptions: embedding governmental tension and creating local tensions*

This section will argue that the system of weights used in the assessment exercises inscribes the political will to *economize* academic research. The system of weights however not only inscribes certain modalities of conceiving research (e.g. research as marketable), but also has the effect of generating the tension experienced by academics between publishing and commercialising.

In order to understand the effects of REF 2014, it seems useful to explain the overall mechanism for attributing weights under REF2014. The overall quality judgments revolve around three main elements, namely *outputs*, *impact*, and *environment*. Of interest here is the weights assigned to outputs and impact and the effects that they can generate. According to REF guidance, the research *output* is defined as follows:

“The sub-panels will assess the quality of submitted research outputs in terms of their ‘originality, significance and rigour’, with reference to

international research quality standards. This element will carry a weighting of **65 per cent** in the overall outcome awarded to each submission” (HEFCE 2012, p. 6, emphasis added)

While *impact* is characterised as follows:

“The sub-panels will assess the ‘reach and significance’ of impacts on the economy, society and/or culture that were underpinned by excellent research conducted in the submitted unit, as well as the submitted unit’s approach to enabling impact from its research. This element will carry a weighting of **20 per cent**” (HEFCE 2012, , p. 6 -emphasis added)

Finally *environment* is defined in REF guidance as follows:

“The sub-panels will assess the research environment in terms of its ‘vitality and sustainability’, including its contribution to the vitality and sustainability of the wider discipline or research base. This element will carry a weighting of **15 per cent**” (HEFCE 2012, p. 6, emphasis added)

Research output is the one carrying the highest weight, i.e. 65%. This means that the quality expressed and measured in terms of research output (i.e. publications) carries the highest weight. The emphasis on commercialising academic research through licensing, spinning out, consultancy, and so on is most evident under the “impact” element. Examples of suggested measures for sub-panels considerations –in relation to economic impact- are presented in Table 5.2 below.

What do these measures represent? First, the indicators in Table 5.2 make knowledge/science visible by linking it to economic concerns for business and market performances (e.g. “a new business sector has been created”, “the performance of an existing business has been improved”, “and licences brought to the market”). Second, the overall score of economic impact is assigned a weight of 20%. However, 20%, far from being an objective number, mediates/inscribes different sets of governmental concerns which relate to the progress of the economy and society.

In particular, the 65%-20% weights together seem to embed a tension which is present at governmental level and which is clearly summarised in the following quote:

"From a business perspective, there are some principles that the Government should take into account [...] World-class excellence across all types of research should be recognised and rewarded by the RAE and Research Council peer review process. Excellent research undertaken with industry or other users **should be recognised as being of equal value** to excellent academic research" (Lambert 2003, p.86, emphasis added)

RAE 2008 weighted the overall quality (see Figure 5.2 below) in terms of research output (70%), research environment (20%) and esteem indicators (10%).

**Table 5.2: Excerpt of measures of economic impact under REF 2014**

REF 2014 - IMPACT	EXAMPLES OF MEASURES
<b>Economic Impact</b>	Licences awarded and brought to market
	Jobs created or protected
	Investment funding raised from UK and/or non-UK agencies
	A business or sector has adopted a new or significantly changed technology or process, including through acquisition and/or joint venture
	The performance of an existing business has been improved
	A spin-out or new business has been created, established its viability, or generated revenue or profits
	A new business sector or activity has been created.
	Performance has been improved, or new or changed technologies or processes adopted, in companies or other organisations through highly skilled people having taken up specialist roles that draw on their research, or through the provision of consultancy or training that draws on their research.
	Potential future losses have been mitigated by improved methods of risk assessment and management in safety or security critical situations

**Source: (HEFCE 2012, p. 49-52)**

The criticism to RAE 2008 in terms of ‘equalling’ excellent research with industry and excellent academic research was based on the fact that:

"[T]he guidance for panels and sub-panels of RAE2008 did not however, indicate to assessors with any great weight that collaborative applied research with industry should carry **similar weighting** to applied research carried out by a purely academic researcher" (House of Commons Trade and Industry Committee 2005, , p. 22 emphasis added)

It was, therefore, recommended that:

"[A]ny future guidance provided to the panels should carry a section on the treatment of applied research with business or other outside institutions. This should provide that, given the work is of a sufficient quality, it should be considered **in the same way** as if it had been carried out in a purely academic environment" (House of Commons Trade and Industry Committee 2005, p. 22, emphasis added)

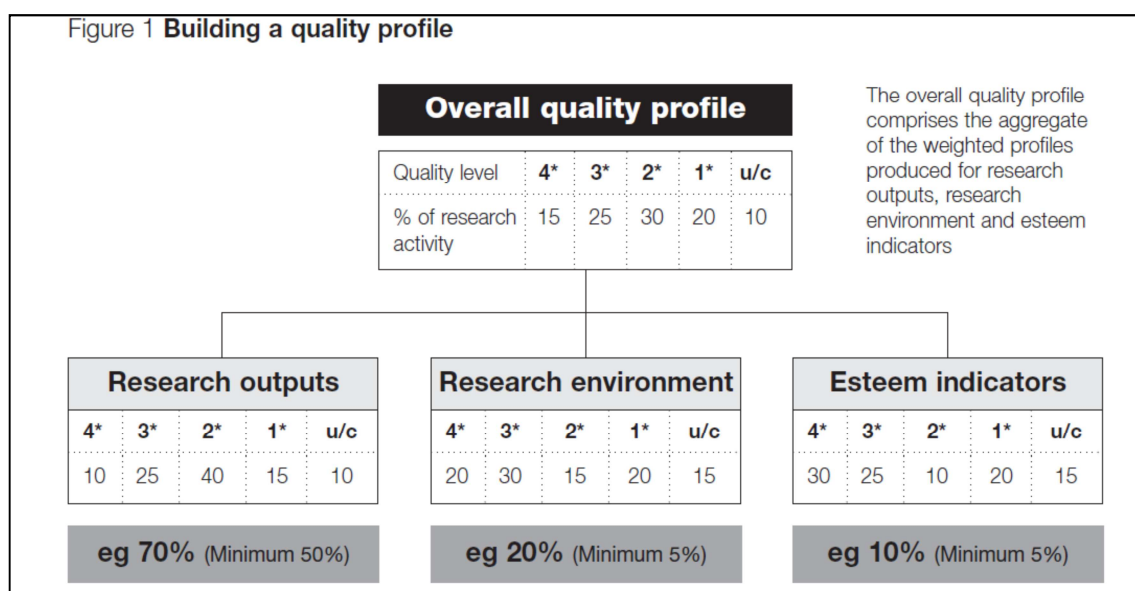


Figure 5.2: “Quality profile” under RAE 2008

Source: (HEFCE 2005a, p. 32)

An opposite concern was also expressed at governmental level in relation to a “too aggressive” commercialisation/innovation agenda:

“We are concerned that driving an innovation agenda too aggressively through universities may have diminishing returns with regard to commercialisation and **risk damaging the academic research** that is working well. We recommend that the Government’s objective should be to create a commercial demand for university engagement **to which they are already primed to respond**” (House of Commons: Science and Technology Committee 2013, p. 40)

If on the one hand REF 2014 did provide more indications of measures of “impact” of the kind presented in Table 5.2 above, on the other hand the 65%-20% inscribes the political tension toward the commercialisation/exploitation of academic research without solving that tension. REF 2014 did not seem to solve the tension framed as “applied research carried out by a purely academic researcher” versus “applied research carried out with industry”. Therefore, in this respect one can say that the controversy seems to remain open.

However, the 65%-20% proportion not only inscribes more governmental sort of discourses but, as analysed in the next section, it also creates (unintended) effects at a more local level.

### *Tension between publishing and commercialising academic research*

Earlier in the chapter it was mentioned how technology transfer offices were struggling to enrol academics into commercialisation programmes. The adopted strategies involve usually “educating” or “persuading” academics on the importance and the “utility” of commercialising their technologies/inventions. The difficulty of doing this lies in the tension that academics constantly face between publishing and commercialising their research. Academics have been historically –at least since 1986 with the first Research Selectivity Exercise- assessed on the basis of the publications they produce. Yet research commercialisation has become since the 1990s an extra source of pressure for academics. As seen in the previous section, the 65%-20% weights used in REF 2014 *embed* the political tension to equate purely academic research with applied research carried out with industry, without solving it.

To what extent are those weights productive of more local tensions between publishing and commercialising? According to a relatively recent study (PACEC-CBR 2010), there has been a significant change between 2001 and 2008 in the perception that academics have of the importance of publications for their career, paralleled by a starker change in their perception of the importance of commercialisation activities for their career (see Table A-3, Appendix 3). There are a number of elements to consider in order to investigate whether the weights imposed by the REF 2014 perform local tensions between publishing and commercialising.

First, the major problem is that disclosing an invention and the related process of filing a patent etc. can delay publications. Conversely, publishing prevents any opportunity to commercialise the research because “*nobody can take preparatory positions on something that has been published, because it has been published*” (#30). This means that if a research idea has been already disclosed through publications or through presentations at conferences, there would not be any company or any other investors willing to invest into something that has been publicly disclosed before getting protected with IP rights. According to the Head of Technology Strategy of a multinational corporation, technology transfer from academia to industry carries positive/beneficial effects to the industry. However, there seems to be an intrinsic paradox caused by the contractual arrangements in place between the university and the corporation whereby the latter can ask academics/scientists involved in the projects to withhold publications. The paradox is effectively illustrated in the opening quote of section 5.1.2 and comes from the fact that the pressure on academics toward both



commercialising their research and collaborating with industry run parallel with the pressure to publish. Nevertheless companies collaborating with academics usually ask them to delay publications because they “*want to keep stuff secrets*” (#3)

Second, to add more complexity, even for those academics who would like to collaborate with industry and commercialise their technology there can be obstacles. As an Industrial Partnership Manager at *Top University 2* observed:

“The question is: is [commercialization] an extra burden for [academics]? Because **for getting the impact the process hasn’t changed, you still have to get the high impact publications** and that actually makes it more difficult to work with the industry because first the industry they don’t come with big funding, they have a lot of processes, a lot of demands [and then academics] suddenly start to get stressed out because [the commercialization process] doesn’t go that fast and they are not publishing such good papers, so they fall off the academic path which is extremely strict and very competitive. So if you are running into that process and you get distracted by something else and you fall off and then it is very difficult to come back” (#29 –emphasis added)

Third, according to the manager part of the problem in “persuading” academics to commercialise is that:

“[T]he non-academic path is not defined. So [tech transfer offices] are encouraging academics to work with the industry but [they] do not tell them what they can expect for their future, for their development, for their job security” (#29)

The tension is experienced on the side of sponsoring organization sometimes as an excessive emphasis put on publishing, which in turn undermines any attempt to engage academics into commercialization activities. As the Head of Legal and Operation at a charity foundation explains:

“[It]is really frustrating for me. I mean [publications] are really important. You know, when I was an academic it was critical, and one of our concerns in [CharityFoundation1] is that [academics] are encouraged so much to have publications that it restricts the ability to do something different – commercializing the research, because they are worried where the next grant is coming from and need publications cause they need to have a continuing track record. (#30)

As pointed out by a licensing executive at *Top University 4* the drive to publish is important for academics, but the extent to which this is critical depends on REF:

“I think there is a first point to make and it depends on timing. You’ll be aware of REF exercise which is coming to a close. So there is a rush to get paper submitted and accepted before the deadline. And so patents become rushed, there is more pressure to file them now. Once REF is out of the way, clearly academics still need to publish because that’s what makes their

careers and need to publish paper in order to get good chance to get the next grant funded. So **there is always a drive to publish but -how critically- it depends on REF**" (#22, licensing executive –emphasis added)

The rush of getting papers published can also lead to rushing the patent application. Conversely, in order not to rush a patent application, technology transfer office tries to “persuade” academics to delay publications:

"There are pressures. So you need balancing almost on a case by case basis. Identifying if the academic is held on publishing now, then we have to work with them to get the patent filed now; or if they can be persuaded to leave [publishing] for a little while" (#22)

There are other effects generated by REF, as the Head of Legal and Operations at *Charity Foundation 1* explains:

"[Research Excellence Framework] remains a difficult exercise because you cannot have all the information that you need in a timely manner. You actually had to get at some point where you have **to threaten the grant holders that we hold back 10% of their award** unless they provide us with information that they will only get at the end of their award. They are under **persuasion** to provide us with the information and the difficulty with all this sort of information is **that it is difficult to be objective with research that you have done**" (#30 –emphasis added)

One the one hand, sponsoring agencies and technology transfer offices see academics as being put under too much pressure to publish such that they do not have any incentive to commercialise. On the other hand according to some, REF puts too much pressure on academics toward commercialisation objectives such that the quality of their research can be affected. This point is well illustrated by the former Head of Technology Strategy of a multinational company in the advanced manufacturing sector:

[Participant#3] Because we [industry] can kill the thing, the reason why we have gone to them in the first place. It could be a downward spiral. And the REF, Research Excellence Framework, arguably could drive the wrong behaviour or less good behaviour such that our standing in the world as a country [decreases]. [Publications] is the way the academic world judges its karat, is the number of papers you produce, the number of citations you get, OK? That’s the way they judge it. **And we are trying to add stuff [like]"have stuff gone out to the market?**

[Researcher] So the two things may be conflicting?

[Participant#3] [nodding] because we [industry] want to keep our stuff secrets”

(#3, Head of Technology Strategy –emphasis added)

The formula-based funding device and the system of weight is also to be found in other devices used by the government in order to control research commercialisation at a distance and act upon it. The next section will look at the Higher Education Innovation Fund, which constitutes a stable source of funding for the universities' third mission of wealth creation.

*Device: the Higher Education Innovation Fund (HEIF) and the Higher Education Business Community Interaction Survey (HE-BCI)*

The third mission of universities was designed and encouraged throughout the 1990s to cover all those activities related to “knowledge exchange”. Third stream policies were designed “*to develop linkages and promote networking and other activities to allow the co-evolution of activities and processes in HEIs and external organisations in the public, private and voluntary sectors, and in wider society*” (PACEC 2009, p. 1). Beside the dual funding system to allocate public funding for research, since the late 1990s, a third leg of funding has been devised to support universities' third mission.

The HEROBC (Higher Education Reach-Out to Business and the Community) fund was created by HEFCE in 1999 as part of the *Our competitive future* (Department of Trade and Industry 1998) white paper. Since 2000 HEROBC has been incorporated into the Higher Education Innovation Fund (HEIF) (HEFCE 2011), which is provided by the Office for Science and Technology and HEFCE (House of Commons Science and Technology Committee 2002). Since then HEIF has become a permanent third stream of funding for Higher Education Institutions.

Since 1999, the subject of the third mission, i.e. the inter-actions between universities and business, public services and the wider community have been described and measured in the *HE Business and Community Interaction* (HE-BCI) survey (House of Commons Science and Technology Committee 2012; HEFCE 2013). The linkage between HE-BCI survey and HEIF via formula-based funding started to be drawn in 2006:

"Initially HEIF was awarded to projects, to support innovation and improve understanding of good practice. However from the outset our intention was **to move towards formula-based funding** so that knowledge exchange was driven forward by institutional mission and strategy, leadership, priorities and partnerships. This would enable a diversity of knowledge exchange activities to be delivered, reflecting the diverse economic and social needs of the country. In 1999 we began to measure knowledge exchange activity through the **Higher Education-Business and Community Interaction (HE-BCI) Survey, to inform policy and eventually funding allocations.**

The first formula-based HEIF allocations were made in HEIF 3 in 2006, together with a selective project element. From HEIF 4 in 2008, all HEIF has been allocated by formula" (HEFCE 2011, p. 5)

The components of the formula funding in the 2008-2011 round of funding were three: potential and capacity building (measured by the number of full-time equivalent staff members), external income, and activities not best measured by income. The “capacity building” component recognizes staff members as an ‘asset’ in developing knowledge and technology exchange and innovation activities. Capacity building is measured by the number of full-time equivalent academic staff members of universities. The component “external income” aims to recognize –by means of a proxy such as external income- the overall performance in third streams activities (e.g. collaboration with industry). The third component includes all the activities that cannot be ‘captured’ by income indicators and in HEIF 3 they are measured, for example, by the level of engagement with non-commercial organisations and small and medium-sized enterprises (SMEs), and by students placement (HEFCE and OST 2005).

As shown in Table 5.3 below, the progressive shift to performance/external income have characterised the three round of funding (HEIF 3, 4, 5). The shift toward performance/external income was particularly evident in the changes to the weights attributed to the component in the formula-funding. The weights attributed to performance/external income increased throughout the years from 45%, to 100%, where 100% means that all the funding is allocated on the basis of external income/performance. According to HEFCE report (HEFCE 2011) the way in which external income and performance are calculated remains unaltered.

**Table 5.3: Components and weights in HEIF 3, 4, 5**

Components	Weights		
	HEIF3 (2006-2008)	HEIF4 (2008-2014)	HEIF5 (2011-2015)
Capacity Building	45%	40%	-
Performance (income)	45%	60%	100%
Activities not best measured by income	10%	-	-

**Source: (HEFCE 2011; HEFCE and OST 2005; HEFCE and DIUS 2008)**

*Centres of calculations: from Universities to HESA*

As discussed earlier in the chapter, universities collect every year a variety of data which feed into internal database. Data include indicators such as the number of filed patents, the number of granted patents, the number of invention disclosures, the income

from licensing, etc. However, these measuring exercises are not performed only for internal purposes. The same data reach other centres of calculations such as the Higher Education Statistics Agency (HESA) which collects a variety of data including those to be entered in the Higher Education Business Community Interaction Survey (HE-BCI). As shown in Table 5.4 below, the Higher Education Innovation Fund has been basing its measurements of the external income/performance component on HE-BCI data.

**Table 5.4: Higher Education Statistics Agency measures of external income/performance under HEIF 3, 4, 5**

<b>MEASURES OF EXTERNAL INCOME/PERFORMANCE IN HEIF 3, 4, 5</b>
HE-BCI data for income from contract research, consultancy and equipment services (where the residual ambiguity in the three definitions is mitigated by aggregation)
HE-BCI data for regeneration and development income
HESA data for income from non-credit bearing courses
HE-BCI data for income from intellectual property
Data for income from Knowledge Transfer Partnerships

**Source: adapted from (HEFCE 2011)**

As a Spin-out Portfolio Manager at *Top University 4* describes:

"There are figures that I need to report not just within the university but also **outside the university to HEFCE**. They also have the higher education business community interaction survey HE-BIC. That's how **they monitor** how many employees all the companies have, what turnover the companies have, how many companies have survived for more than three years, how many have been formed, and all this sort of data need to be monitored and collected for this survey" (#21- emphasis added)

Licensing and spinning out are often seen in local technology transfer offices as two alternative pathways, each of which bears different sets of meanings. The question here is: what becomes of the local tension between commercialising and spinning out once spinouts and licenses data reach HESA/HEFCE centres of calculations to then be entered in HEIF's formula?

### *Making the tension between licensing and spinning-out invisible*

What the external income/performance weights (45% in HEIF3, 60% in HEIF4, 100% in HEIF5) do is to include the income both from licensing to existing companies, and from licensing to new spin-outs under the same category “Intellectual Property Income” which together with other forms of income are assigned the same weight. At that point both streams of income are made to weight the same.

However, licenses and spin outs do not have the same ‘weight’ at a more local level, where the commercialisation pathways can mean different things to different organisations. For *Top University 4* licensing to external companies is important not only because of the income, but also in terms of “going out to the wide world”. The point is made by a licensing executive at *Top University 4*:

“I think that from the University point of view [spinning out] is not the same as a company **licensing** technology out there. Okay we get **some royalty income** if we license technology out, but also this is the kudo of having developed the technology here and **going out to the wide world and doing some good**...you wouldn’t have [name of technology] in hospitals. [...] So the fact that the technology has gone out and it is pretty much in every hospital around the world, it has a fantastic impact for [Location 4]. So **for all those things licensing is important** for the university” (#22 –emphasis added)

Conversely, at the level of Location 4’s city council and at regional level, spin-outs generation seems to play a much more important role compared to licensing:

"From the City Council’s point of view I imagine spin-outs would be more important for them for two reasons: **a license can go anywhere** in the world –we had a license in America another one in Brazil. It could be anywhere and that brings **benefit to the UK** because it comes to the University. But if you form spin-outs, the chances are they will be around [Location 4]. So the more **spin-outs** you form –say in medtech sector- the more you **create a critical mass in the region** for medtech, the more likely is that investors outside the region will come in, see the value of what’s going on and want to invest, and it becomes a virtuous spiral really. So, by starting up new companies from the university you’ve got **employment**, you pretend you get **investment into the region**, so the whole thing will build a **positive story**" (#22 –emphasis added)

In summary, the section showed how innovative scientific ideas are *overflows* that happen all the time. In order to regulate their circulation, scientific ideas need to be framed by means of devices such as publications, invention disclosures, and patents. Framing allows both their value (whether scientific or economic or other) to be appropriated by actors and financial resources to be mobilised precisely because of that value. However, the difference between publications and other framing devices such as

invention disclosures is that publishing promote a version of value of scientific ideas that is not qualified as *economic*, but based on criteria such as academic rigour. While disclosing an invention constitutes an early stage attempt to identify the market potential of scientific ideas. To be sure, invention disclosures (but also business plans) are mobilized to prove the *economic* reality of such ideas by assessing their commercial potential.

However, evidencing the reality of scientific ideas is a costly activity, which requires putting in place a complex apparatus of which technology transfer offices are part. The chapter showed how through a chain of displacements from individual commercialisation stories to performance indicators and formulas, innovation data is shaped and made to travel across centres of calculations (e.g. technology transfer offices, finance offices, HESA). The effect of linking innovation performances to funding allocation mechanisms consists in producing (and sometimes dissolving) local tensions between publishing and commercialising research, and between alternative commercialisation strategies (e.g. licensing and spinning-out).

## Conclusion

As discussed in Chapter 3, the intersection between problematics of economic growth and increased demand for accountability in public spending characterising the 1980s, created the conditions for the emergence of academic research commercialisation as a space. This is the context against which technology transfer programmes (analysed in this chapter) and incubation programmes (analysed in the next chapter) are to be understood.

This chapter explored technology transfer practices within universities and how, in this context, accounting has contributed to the framing of science in economic terms. As illustrated in Table 5.5, accounting has contributed to making inventions/technologies within universities visible and quantifiable by means of different devices. Such devices included invention disclosure form, performance indicators, and weighted average formula funding.

First, the *invention disclosure form* is a device which combines accounting and legal components. Within such device accounting contributes to frame inventions in terms of costs and revenues. It makes possible to make agreements around technologies and therefore to act upon them. In fact, once identified, costs and revenues are shared

between university departments, university as a whole, and the academic/inventor by means of legal agreements.

Second, accounting contributes to making spinout companies and licences visible at the level of central university. *Performance indicators* like patents count and invention disclosures count re-construct the reality of research commercialisation so that it can be ‘seen’ by the executive board of universities. Accounting is also mobilised by the university management in order to build narratives of the university as “inventive institution”.

Third, accounting makes possible the allocation of funding by means of the *formula-based funding* device. Performance indicators travel from universities, understood as *centre of calculations*, to other centres of calculations such as the Higher Education Statistics Agency (HESA). Here performance indicators are framed in terms of Research Excellence Framework components, that is *research outcome*, *impact*, and *environment*. To each component, a weight is assigned. By assigning a 65% weight to research outcome (which is measured in terms of publications) and a 20% weight to impact (which is measured –amongst the other things- in terms of number of patents, licenses, spinouts, invention disclosures etc.) the formula-funding device ends up creating a tension at local/organisational level. The latter consists in the ‘dilemma’ that academics face between commercialising and publishing their research. The REF –via component weights- also inscribes the governmental tension between the position that wants to equal the weight for academic research conducted purely by academics and the weight for academic research conducted in collaboration with industry, and the position which is instead worried about the “too aggressive” commercialisation agenda posed on academics/universities.

A similar formula-funding mechanism links the results of the Higher Education Business and Community Interaction survey (HE-BCI) to the allocation of the Higher Education Innovation Fund. The HE-BCI survey collects through HESA *centre of calculation* data from universities related to the commercialisation of academic research. Performance indicators such as those discussed earlier (e.g. patents count, invention disclosures count, spinouts count, licenses count) not only are used for internal purposes at the level of universities but they also reach HESA where they become linked to HEIF funding via a system of weights.

The effect of such system of weights however is one of making local tensions ‘invisible’. In other words, there seems to be a tension at level of universities between



spinning out and licensing as two possible commercialisation strategies. On the one hand these strategies are treated ‘equally’ in terms of components’ weight. In fact both spinouts and licenses contribute to form the overall *external income* score to which a 100% weight (under HEIF 5) is attributed. On the other hand at local level – spinouts and licenses ‘weight’ differently depending on the type of actors. Universities in fact seem to put more emphasis on licensing as commercialisation strategy, while city councils and other regional institutions put the emphasis on spin-outs in that they contribute to the regional economy through improving job creation.

**Table 5.5: Characterising Technology Transfer through accounting devices**

Accounting device/ Characterisation	REF	HEIF	Universities' KPIs portfolios	Invention Disclosure Form
<b>Descriptive elements</b>	Components of formula-funding: research outcomes, impact, environment	Components of formula-funding: external income/performances	Patents count, invention disclosures count, spinouts count, income from license, cumulative spinouts investments, etc.	Legal and commercial components
<b>Embedded frames</b>	Objectives, input, output, outcomes framework	Objectives, input, output, outcomes framework	Objectives, input, output, outcomes framework	University ownership model, linear model of innovation
<b>Underlying practices</b>	Formula funding, KPIs	Formula-funding, KPIs	Weighing KPIs	Revenue sharing, market potential
<b>Inscriptions</b>	65% -20% outcome-impact weights	60%, 45%, 100% external income weights	Weights (% not disclosed)	1/3-2/3 patent filing and maintenance costs, % of revenue sharing
<b>Effects</b>	Inscribing governmental tension, performing local tension, controlling at a distance	Making local tensions invisible, controlling at a distance	Making research commercialisation visible, controlling at a distance	Making technologies visible, acting upon them

The next chapter (Chapter 6) will move from universities’ technology transfer sites, to universities’ technology incubation sites. Both transferring and incubating technology are central to the innovation activities carried out by universities (in collaboration with industry and government). The next chapter will explore programmes for incubating innovation within university technology incubators in the UK. The chapter will analyse the different types of funding arrangements, governance mechanisms, and performance measurement practices in place within a number of university incubators. Different ways of calculating incubation can result into tensions and the role of accounting in creating, mediating or dissolving tensions will be analysed. Examples of calculative

frames are the public intervention/economic development frame and the commercial/free market frame. The interplays between accounting and innovation are discussed in the context of the calculative infrastructure (or metrological framework) put in place to realise the multiple values of incubation, the underlying calculative frames, and their effects.

# CHAPTER 6 CALCULATIVE FRAMES: THE ROLE OF ACCOUNTING IN FRAMING UNIVERSITY INCUBATION PRACTICES IN THE UK

---

## Introduction

“The challenge for incubators and their funding bodies is to **capture some of the value created for incubatees**. Generating revenue from services when clients are resource constrained is often not possible without subsidies from public bodies. [...]. Incubators with mixed funding may encounter principle-agent problems as they attempt to meet multiple objectives”.

(Dee et al. 2011, p. 7)

Descriptively, incubation undergoes a variety of business models that can be represented in a continuum of activities from renting laboratories and office space to tenants (e.g. start-up/spin-out companies), to providing technical and specialist services such as those offered by contract research organisations, accounting firms, and strategy, innovation and marketing consultancy and providing access to university expertise and venture capital funds (Dee et al. 2011; Hackett and Dilts 2004).

As argued in the opening quote and in the academic literature on incubation (Hackett and Dilts 2004), incubating innovation poses challenges in terms of how to capture the value produced for (and by) incubatees. This chapter will suggest that accounting shapes innovation within incubators by providing the metrological framework to realize, not just a single, but the *multiple* values of incubating innovation. In this respect, the notion of value is better understood and investigated as the outcome of processes of co-production between contingent social and technical elements. This means that the value

of incubating innovation depends on the configuration of the network of incubator's stakeholders, their goals, the financial and non-financial resources they mobilise, and the calculative frames they use. Given such premises, the chapter will trace the nature and origins of differences in measurement practices and the underlying calculative frames. The study identifies at least three emergent calculative frames, i.e. commercial frame, public intervention/economic development frame, and finance/investment frame, which contribute to the construction of the incubator as a "business", a "capital efficient environment", and the "biggest employer in the region". Each calculative frame is constituted by different models, analogies, choice of metrics, and categorization which are mobilised and inscribed into key performance indicators and targets, and also into non-accounting devices such as incubator's entry mechanisms.

The value(s) of incubating innovation emerges in the process of translating such frames into numbers. Numbers can compete or coexist in the production of value, and the dominant versions of value are often linked to the ability of actors to mobilize financial resources within the incubator. The chapter will show how accounting, as performance indicators and targets, has a role in translating calculative frames into numbers. Accounting contributes to creating and mediating the tensions between different versions of the value that is generated through programmes for incubating innovation.

Other than locally situated socio-material practices, the chapter will also show how different calculative frames arise from the co-production of historical and political contingent forces, which will be examined in the next section.

## 6.1 Exploring the origin and nature of differences in incubation practices

“This incubator [*Incubator#7*] has a **different model** from a lot of other incubators for sure” (#13 -Chief Executive Officer)

“We [*Bioincubator#1*] need to show that **we are different**, we need to show that we are unique” (#32 -Chief Executive Officer)

As suggested in the opening quotes, creating an incubation programme that is “different” and “unique” from all the other existing programmes is predicated like a mantra in most of the incubators analysed throughout this chapter. However,

incubation's variable and multiple characters are not the direct consequence of the claims to be "different" and "unique". The section advances that the differences in incubation practices are more the outcome of processes of co-production of historical and locally contingent forces, than the result of implementing unique business models. The rise and fall of regional development agencies across the UK and the creation of university commercial subsidiaries are two amongst the factors that have influenced how incubation programmes have been configured through time. Since these factors are highly contextual, they can vary across sites and result into 'different' arrangements.

This section will show that the conditions for the emergence of multiple and variable practices of incubating innovation are also historical, political, and institutional. Such conditions include the set of policy and legal arrangements which designed university incubators as commercial and trading subsidiaries of universities; the rise and fall of a network of governmental agencies (i.e. the Regional Development Agencies) across the UK responsible for implementing national and European regional development programmes; the establishment of funding devices such as the European Regional Development Fund (ERDF), and underlying principles (e.g. the so called "logical framework"). Such conditions have influenced the emergence of certain ways of framing incubation, i.e. different ways of identifying and measuring the value of programmes for incubating innovation. For example, establishing programmes for incubating innovation as part of universities' commercial subsidiaries contributed to the emergence of a *commercial* way of doing incubation. Furthermore, the Regional Development Agencies (RDAs), the local government, the Research Councils, and the European funding bodies had a pivotal role in funding programmes aimed at incubating innovation, while contributing to the emergence of a *public intervention* frame.

#### *The legal form of Universities' subsidiaries*

As shown in Chapter 3, the rise of universities' third mission and the increasing role of universities in the commercialisation of research have created the problem of how to reconcile universities' charitable status with the potentially profit-making character of their trading/commercial activities. Most of the university incubators analysed in the chapter are constituted as commercial vehicles or commercial arms of universities and charitable research institutes. Public universities in the UK have charity status, however the activities that they carry out can be both charitable and non-charitable. Depending on this divide, activities are classified either as primary purpose or non-primary purpose

activities. Usually, charities' primary purpose activities are exempt from tax. Universities often set up wholly owned subsidiary companies in order to carry out trading activities that fall out of the charitable status hence out of the tax exemption regime (BUFDG 2014). Historically, commercial subsidiaries (also known as "related companies") had been established for many reasons as highlighted in the below passage:

"The activities of related companies can vary considerably. Some take advantage of specialist skills by selling training and consultancy expertise; others **exploit the commercial potential of research and intellectual property**. Some retain ownership of activity and intellectual property, whilst others attract private funders to share in the risks and rewards of ventures which institutions may not otherwise be able to fund. Some institutions are now experienced in generating commercial income from spin-out companies or the licensing of intellectual property, whilst many others are actively developing mechanisms for this purpose" (HEFCE 2005b, , p. 6)

It is against this context that one can better understand the reason why universities set up their own commercial vehicles.

One of the legal forms that usually these vehicles take is the *company limited by guarantees* form (HEFCE 2005b). This is the case in Incubator#5 and Incubator#2, which will be analysed later on in the chapter. Broadly speaking the implication of setting up a company limited by guarantees is related to the treatment of the *surpluses* (i.e. profits) generated by the incubator through rents and other services such as laboratory services, conferencing space, networking event etc. Any surplus in fact should be put towards the company's social purpose at the aim of furthering it. Surpluses cannot therefore be distributed among the members.

Another legal form that subsidiaries companies –constituted as universities subsidiaries- can also take is that of *companies limited by shares*. In this case the profits (i.e. surpluses) arising from incubation activities can be distributed among shareholders. This is the case in Incubator#6, which will be analysed later on in the chapter. Incubator#6 is owned and managed by TopUniversity#5 wholly owned subsidiary. The incubator's main mission is claimed to be the creation of value for the university/shareholder. Its profits are in fact distributed to the shareholder –i.e. the university.

Either way –whether it is a company limited by guarantee or by shares- a university subsidiary is run as a self-sustaining business. This implies that, as one participant once put it, being a commercial subsidiary "*you have to be self-sustainable, [which means*

*that] a charity [or university] can't constantly top up a trading subsidiary, it has to stand on its own"* (#30 – Head of Legal and Operations).

Being a self-sustainable business can have implications for the choice of the activities carried out by the subsidiary/incubator. In this respect, I will talk later about how incubators activities/practices seem to be shaped by a commercial frame which translates into distinctive calculative styles (e.g. key performance indicators such as breakeven, occupancy level, etc.) and how these can compete with alternative frames such as “quality” and “public intervention”. For the time being what is helpful to bear in mind is that the legal arrangements behind commercial/trading subsidiaries of university constitutes a condition of possibility for the emergence and diffusion of certain styles of calculating incubation.

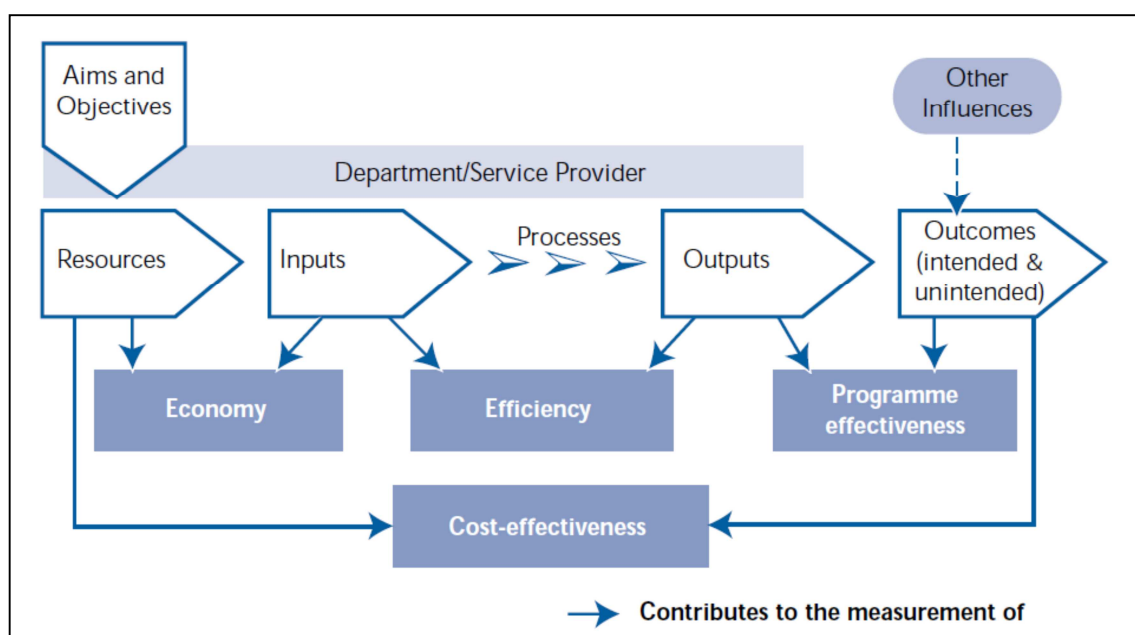
### *The rise and fall of Regional Development Agencies (RDAs)*

The rise of RDAs is relevant to the discussion of incubation practices in the UK in that it provides insights on the historical and political conditions which led to the emergence of a public intervention/economic development frame within incubators across the UK. Incubators were often the target of RDAs investments as part of regional strategies for economic development. As this section will be discussed, the accountability regime to which RDAs were subjected has created the conditions for framing incubation programmes in a distinctive way.

Toward the end of 1990s under the newly-formed Labour government and with the aim of promoting economic development across UK regions within an accountable and strategic regional framework (House of Commons 2002), eight Regional Development Agencies (RDAs) were established (House of Commons 1998) covering eight England regions (East Midlands, West Midlands, Eastern, London, North East, North West, South East, South West, Yorkshire and the Humber). Modelled on the existing bodies/RDAs for Wales and Scotland that have been set up by the Labour government of the 1970s (Bache 2008, p. 99), the network of RDAs was designed in a way that would make them responsible to the regional chambers, but operationally separate, acting as their executive arm in the area of economic development (House of Commons 2002, p. 9). RDAs also had a board appointed by the regional chambers and was conceived “*to represent wide regional economic interests, including local authorities and business, co-operatives, banking and trade unions*” (House of Commons 2002, p. 9; Regional Policy Commission 1996).

RDA were in charge of designing, implementing and keeping under review a five-to-ten year Regional Economic Strategy. Their budget would be based on a “Single Pot” of resources to which several departments contributed (e.g. Department for Communities and Local Government, Department of Innovation, Universities, and Skills, etc). In addition to this, RDAs would also manage the European Regional Development Fund (ERDF) and the Rural Development Programme.

The accountability regime within which RDAs were to operate was based on standard models of monitoring already in use within the European Commission and the National Audit Office (see Figure 6.1) (Department of Trade and Industry 2006).



**Figure 6.1: Relationship between inputs, outputs and outcomes**

Source: (National Audit Office 2001, p. 2)

In 2002 a new guidance on the performance evaluation framework for RDAs was released by the Department of Trade and Industry (House of Commons 2002). It set out the targets “to be delivered by [RDAs] in exchange for greater flexibility under the *Single Pot*”. Under this framework performances would be assessed based on a set of “key regional indicators” (see Table 6.1) and a three-tier target framework. The latter to be broken down in tier 1 regional objectives, tier 2 regional targets (outcomes) and tier 3 milestones (outputs).



**Table 6.1: RDA activity indicators**

Indicator	RDA purpose
Number of jobs created and safeguarded	Economic development and employment promotion
Net hectares of derelict land brought into use	Physical regeneration
Number of business start-ups and survival rates	Business support
% of medium/large organisations recognised as Investors in People	Competitiveness & skills
Value of private finance attracted	Private sector involvement

**Source: (House of Commons 2002, p. 28)**

Amidst a controversy surrounding the issue of sub-national governance in economic development policy, the performances of RDAs and of the so called “quangos” (quasi-autonomous non-governmental organisations) a number of reports and enquiries (House of Commons Business and Enterprise Committee 2009; PricewaterhouseCoopers 2008) were commissioned by the UK government. In 2012 the government took the decision of dismantling the network of RDAs (Sandford 2013).

For more than a decade, before dismantling RDAs and the related idea of a decentralised system of regional development, the complex accountability regime based on the input/output/outcome framework have shaped incubation local practices. This shaping was made possible through the funding devices mobilised under the Single Pot budget in order to support university incubation programmes. The Single Pot budget provided the motivation for implementing assessment exercises aimed at “capturing” the “value” of incubation programmes. The input/output framework was translated into the space of incubation not only through the Single Pot budget, but also through the European Regional Development Fund, which will be discussed in the next section.

#### *European Regional Development Fund (ERDF)*

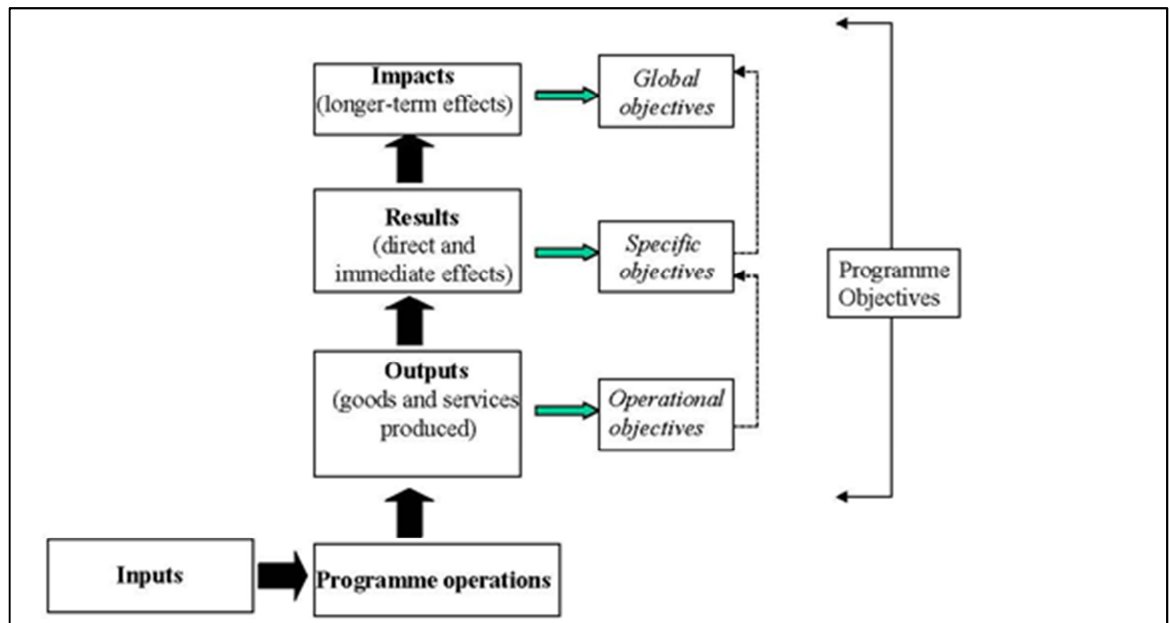
The European Regional Development Fund (ERDF) was first implemented in 1975 as one of the main pillars of EU’s Structural Funds. Funding under ERDF is managed through three main strands: convergence, regional competitiveness and employment, and European territorial co-operation. ERDF allocated overall €201 billion between 2007 and 2013, of which €3.3 billion (approximately £2.8 billion) were allocated to England through the RDAs. Since 2011 responsibility for managing the ERDF in England has passed from RDAs to the Department for Communities and Local Government (DCLG) (House of Commons 2012). Five are the priority areas of

ERDF: stimulating enterprise and supporting growth in target sectors and markets, exploiting innovation and knowledge, creating the conditions for sustainable growth, growing and accessing employment, and technical assistance.

The linkages between ERDF and the activities of RDAs are twofold. First, one of the eligibility criteria for ERDF is that applicants must provide match funding which can originate both from national public funders and private funders. Match funding cannot originate from other European funds (Department for Communities and Local Government 2012). RDAs would traditionally play an important role in this respect by providing the match funding through the Single Pot (House of Commons 2012). Second, the alignment between ERDF and RDAs activities is noticeable in the similarity of the frameworks governing the allocation, monitoring, and assessment mechanisms of resources under ERDF and under RDA's Single Pot. There is a striking similarity between the criteria for monitoring and evaluating RDAs represented in Figure 6.1 and the principle that guides ERDF monitoring and evaluation infrastructure is the so called "Logical Framework" (see Figure 6.2). Initially adopted by the United States Agency for International Development (USAID) in 1971, it has subsequently been used by many other aid agencies (including the European Commission DG VIII) to assist with project and programme planning (Wiggins and Shields 1995). According to some authors (Wiggins and Shields 1995, p. 2) its origins can be traced back to the "management by objectives" approach popularized by Peter Drucker in the 1950s.

The logical framework was conceived originally as an aid to thinking which allowed project planners to identify the logical linkages between a set of means and a set of ends for describing a given project (Coleman 1987). In the context of the ERDF the logical framework serves to structure an intervention programme in terms of inputs, outputs, results, and impact. The framework is essentially organised around two main activities, i.e. monitoring and evaluating, which are aimed to support management in the effective running of the programme and to capture the effects of the intervention programme (European Commission 2015).

Given the similarity between the logical framework used for ERDF assessment and the evaluation model used for RDAs assessment (see Figure 6.1), combined technical notes have been produced in order to regulate the production of output/outcome/impact indicators (Department for Communities and Local Government 2008).



**Figure 6.2: The logical framework**

**Source: (Office of Project Appraisal Training 2011, p.5)**

Beside the logical framework there are other principles governing the ERDF application, monitoring and evaluation process, such as the principles of *additionality*, *market failure*, and *value for money*, which in turn are rooted in economic theory.

Nevertheless, the calculative efforts mobilised to “capture” the value of programmes funded through ERDF are challenged by the continuous overflows, as the quote below suggests:

"Assessing the value for money of ERDF is inherently problematic, partly because it is so difficult to separate out the impact of ERDF funding from all the other factors affecting regional economies" (House of Commons 2012, p. 14)

Most of the incubators analysed in this chapter have been funded both through ERDF and RDAs funding. These funding devices acted as a condition of possibility for the translation of the “public intervention” frame into incubation local calculative practices.

The next section will analyse incubation as a space characterised by multiple participants, each carrying distinctive sets of goals, objectives, and aspirations which translate into distinctive *calculative frames*. Calculative frames, as Beunza and Garud (2007) advanced, are mobilized by actors in the process of attributing economic values, and are made of “analogies, categorizations, and choices of metrics” (Ibid., p. 33)

## 6.2 Accounting, framing, and the multiple values of incubating innovation

The multiple values of incubating innovation emerge from framing practices that are contingent to incubators' ownership, legal, and managerial configurations. This section will show how these configurations translate into different sets of objectives, aspirations, categorizations, and choices of metrics, i.e. into different calculative frames (Beunza and Garud 2007). In this regard, incubation can be simultaneously framed as a “*capital efficient environment*”, as a “*timely, efficient, and cost effective business*”, as a “*commercial entity*”, as a “*quality-based incubator*”, as the “*biggest employer in the region*”, and also as a way to address economic development objectives in “*convergence areas*”.

Furthermore, these different *visions* of incubation embed different versions of what the value of incubating innovation is. These different versions of value tend to clash within the same space and/or time, hence creating tensions and instability. Incubating innovation come to being as a place of tension where different calculative frames compete and become the object of negotiation among actors. As Chapter 7 will also discuss, powerful actors are those who are able to shape incubation not only by bringing financial resources, i.e. funding, but also by inscribing their goals and objectives into accounting numbers that can speak for them. Incubating innovation is a process characterised by ongoing negotiations about what innovation is and how it should be measured.

The remainder of the section will focus on these different ways of constructing and calculating incubation, and how accounting devices made it possible for certain frames, hence certain forms of value, to become more powerful than others. The section will present five emergent frames which have translated into accounting practices, ultimately shaping incubation. The first frame constructs incubation as a space for public intervention, where objectives such as economic development and jobs creation can be addressed. The second frame constructs incubation as a commercial and free-market space. The third frame conceives of incubation as a space where finance and investments construct a capital efficient environment. Finally, the quality and health-outcome frames are confined to the margins of incubation, where they struggle to produce accounting numbers that can represent them.

## 6.2.1 Tensions between the public intervention frame and the commercial frame

This section will investigate the emergence of two distinctive calculative frames within Incubator#2 and Incubator#4, i.e. the public intervention frame and commercial (or financial sustainability) frames. Each frame embeds distinctive forms of accounting, distinctive notions of what incubating innovation means and how its value should be calculated. When multiple frames are mobilized within the same incubator, this can lead to tensions. By inscribing frames into performance indicators, accounting provides tools for negotiation and mediation. Within Incubator#2, for example, the breakeven target plays the role of mediating between the “free-market” approach adopted by the incubator manager and the economic development remit of the incubator’s funders. While within Incubator#3, the tension between the public intervention frame, encapsulated in the number of jobs created, and the commercial frame, measured in terms of profit and occupancy levels, remains unsolved.

### *Mediating the commercial and public intervention frames through the breakeven target*

Incubator#2 is a joint venture between the government, the local health board, the local council, and TopUniversity#6. The joint venture was founded in 1994 and had received initial support also through the European Regional Development Fund (ERDF) through a match-funding mechanism. Since all the stakeholders sitting on the board are public bodies, the remit of the incubator is predominantly oriented to create:

“incubation facilities that support start-up companies that are located in [location#6] and hopefully will stay in [location#6] and will potentially generate a reasonable amount of jobs, and high quality jobs” (#2 –Director of Innovation)

TopUniversity#6 and the local Health board carry a further set of concerns:

“University have an interest because they want to generate spin out companies and for those to be successful this is obviously a good home for early start up that come up from the university departments. Similarly with the local [Health Board], the law changed recently to allow NHS [National Health Service] Trust to commercialize technologies so they are quite interested in that aspect as well” (#2 –Director of Innovation)

The incubator is a not-for-profit entity. As such the surpluses generated from the incubation activities (e.g. from rent and services) cannot be distributed among the members, while they can be re-invested in the incubator itself (e.g. infrastructures, etc.).

The performance indicator that most inscribes such arrangements is the *breakeven*, which is also a target against which the performance of the Director of Innovation is judged. The decision to set the breakeven as a target comes from the Director himself and not from the Board:

“When I arrived the organization was in significant deficit, so what I achieved in the two years since I’ve been here was to turn that around so we are breakeven [...] The reason why we are breakeven is because we have more tenants, a great diversity of tenants, but if I’m honest this isn’t something that was really being pushed on me by the Board, but it’s something that I pushed on the Board” (Ibid.)

To describe his vision of how the incubator should be managed, the Director often refers to the “commercial” and the “free market” frame. This is clear, for example, in the decision of “educating” the “20 year old” Board to move from having fixed rental rates to rental rates based on ratchets. The aim is to encourage tenants (i.e. start-ups) to ‘graduate’ from the incubator as soon as they can. As the Director put it:

“I’m taking a **free market approach** to that. Basically if you introduce **incentives that are commercially orientated** then people will react to those because it is coming directly out of their pocket” (#2, Director of Innovation –emphasis added)

Rental rates act here as a device which inscribes the commercial frame adopted by the director. Nevertheless, applying a commercial frame entails a lot of work in terms of “pushing” the Board to increase rent and to have an independent audit of the level of service charges. Only the independent audit could prove the reality of missed revenues:

“I wanted to have a concrete report from an independent auditor that said this is what the service charge is. We did that exercise and now we are charging probably two pounds less than we ought to be charging per square foot. So clearly we’re **missing out on legitimate revenues** we could genuinely have been generating [...] **we are very transparent about it**, the report is published” (#2, Director of Innovation –emphasis added).

Running the incubator in a “commercial” way is also inscribed in a set of performance measures such as the amount of square feet assigned to each tenants (i.e. not more than 10 sq. ft.), and the maximum number of employees (i.e. 10) as a measure of companies’ growth. Other non-accounting devices developed by the Director of Innovation include the “queue” mechanism designed to create competitiveness at the entry level of the incubator. According to the Director by creating a queue, existing tenant companies are pressured to graduate as soon as possible. At the same time the queue acts as a “quality” control device for those in the queue in that it takes the

willingness to stay in the queue for long periods as a ‘negative’ sign. The process is described by the Director as aiming “*to generate a pipeline of active enquires for people wanting to come in*” (#2).

Board meetings are depicted by the Director as “one-man shows”. The performances which are usually presented at the Board are:

“Every time we have a board meeting what I try to do is to demonstrate some kind of progress from one quarter to another, so it might be in terms of employees or new contracts, patents that have been filed or new products that have been launched, so it is quite a comprehensive assessment of how companies are doing.” (#2 –Director of Innovation)

“One of the things I saw in previous board papers and I was very unsettled because they weren’t very...they didn’t give the board full information. Not deliberately, I’m saying they weren’t particularly comprehensive” (Ibid.)

To sum up, incubation management practices at Incubator#2 seem to be shaped by the tension between the ‘public intervention’ remit of the incubator (rooted in the not-for-profit set up), and the struggle of incubator managers (i.e. Director of innovation) to run the incubator like a “commercial” business. The Director’s commercial background from venture capital industry and technology transfer highly influence his way of framing how innovation should be incubated. In this case accounting, in the form of breakeven target, inscribes both the commercial and the public intervention frame, in so contributing to mediating the tension between the two frames.

#### *Inscribing frames into indicators: profitability versus number of jobs created*

Incubator#3 operates as the wholly-owned trading subsidiary of a public funded research institute. Registered as a charity, the research institute decentralises all the commercial activity to Incubator#3, which is instead a limited company. The commercial subsidiary is described in the institute’s website in terms of number of spinouts, number of active commercialisation projects, number of commercialisation projects that have been licensed to companies for further development and marketing, and amount of income coming from licensing.

The research council plays a central role in funding the incubator and this is clearly reflected in the ways in which the performances of the incubator are defined. As it is often the case in incubators where the government has a stake, the emphasis is predominantly on *jobs creation*. There is a tension here between how the CEO would measure the performances of the incubator and how the research council measures performances. On the side of the research council, what matters is the *impact* of public

funded research. Impact is to be understood, according to the incubator's Chief Executive Officer both as social and financial impact. However financial impact is ultimately what seems to matter. This is most evident when the benefits for the society and community are proved in financial terms.

On the side of the incubator manager, the incubator should be run as a commercial entity. This means that what matters is not how many jobs have been created, but rather how much profit has been generated through rents and how much space have been occupied (or how much space is void).

Here the tension seems to be between measures of impact, exemplified by indicators such as number of jobs, number of spinouts, number of patent filed on the on hand, and profitability measures together with occupancy levels (e.g. percentage of void space, number of people on the campus) on the other hand. Profits are not a concern for government, but they are for the CEO of the incubator who regards the incubator as a commercial venture:

“Because of my commercial background- I aim to make a profit, but the government might not be interested in me making the profits, all they ask is creating the maximum number of jobs and growth” (#8 –Chief Executive Officer)

What is the origin of the concern for capturing the return of government funding and government funded research? According to the CEO:

“[The government] worries that suddenly a company will take up something funded by the government and make a huge amount of money out of it and there is no return to the organization who invented it” (#8 – incubator CEO)

In conclusion, Incubator#3 is constructed as a space for public intervention, where the commercial style of framing the “value” produced through incubation struggles to emerge. Whereas the public intervention frame, embedded in the number of jobs created and the number of spin-outs created through public funding, is more powerful.

## **6.2.2 Tensions between the public intervention frame and the health-related outcome frame**

This section will show that the incubation of innovation at Incubator#4 can be interpreted as a space where different sets of aspirations, concerns, and objectives are translated into performance indicators and targets. However, not all the aspirations and objectives become translated into accounting numbers. The section will show how a



lack of equipment in terms of accounting tools, makes certain actors and their aspirations more powerful than others in realising the value of programmes for incubating innovation. In practical terms, in the case of Incubator#4, a version of value based on economic indicators prevailed on a version of value based on the effects of innovation on human health.

*Inscribing the public intervention frame into output, outcome and impact indicators*

Incubator#4 is formally owned by the local university (University#4) college of medicine. It receives funding from the local health board, the local government, and the ERDF (European regional development fund). The ERDF resources are allocated through the Local European Funding Office (LEFO). The same organisation also carries out the monitoring and assessment activities for the ERDF funded projects in the country. The reason for collecting and reporting the data required by the European Commission is to facilitate the assessment of the progress of the programmes and make comparison between Structural Fund interventions and other type of assistance provided by the local government.

The aspiration to boost regional economies is at the core of EU and local government's funding initiatives. The commercial manager of Incubator#4 explained the remit of the local government and the European Union, which are Incubator#4 main stakeholders:

“You have to go back to be able to see the whole objective behind the European funding that has to do the **narrowing of the gap in the GDP per head**, so the reason why we are getting European funding in [region] is because of the fact that our GDP per head is only about 85% of the average for Europe which is not good. So how can we narrow that gap, **how can we move from 85% say to 95%** and there has been a lot of criticism earlier on in the year about the fact that despite all the European money coming into [region], we have not been able to narrow the gap. So how does the [local] government through the European funding try to narrow the gap? It is trying to encourage **the development in growth and jobs** which are high level, better earning jobs, so you are creating more wealth and how you actually create more jobs is through the development and growth of businesses” (#5 – Commercial Manager, emphasis added)

Narrowing the gap in the Gross Domestic Product per head in the local region represents one of the concerns of the government. The effect of regional development policies –implemented through funding initiatives such as ERDF- are identified, measured and monitored by means of a detailed framework which revolves around three types of indicators: output, outcome/result, and impact indicators:

“The monitoring indicators are the outputs and results; **outputs** are the activities undertaken by the project and results are the direct consequence of the activity. The **results** follow from the activities, and reflect the key aims of your project. The evaluation indicators are the **impacts**; the impacts are the longer term consequence of the activity and follow on from the results. The result and impact indicators, therefore, are the most important types of indicator” (Local Government, 2013, p. 2)

At application stage, the applicant is asked to fill in a spreadsheet, which includes accounting information about the project such as deliverable outputs, expenditures and sources of fund (both in the form of revenues and capital). The information included in the spreadsheet aims to:

“**capture** essential information about the project which, **once agreed**, will form part of the terms and conditions of any offer of funding and therefore the basis on which the project's progress and performance are measured. Failure to spend in accordance with the agreed plans may result in **grant being withdrawn**. It is therefore essential that they are both **realistic and accurate**” (Department for Communities and Local Government and European Union 2012, , worksheet 3, emphasis added)

Following these procedure, back to 2007 at the stage of bidding for European funding, the parties (i.e. the LEFO and Incubator#4 project applicants) agreed on the indicators presented in Table 6.2. It was also agreed that the results would be delivered in two phases. The choice of deliverable outputs and results was consonant with the indicators outlined in the ERDF programme guidance (Welsh Government 2013; Department for Communities and Local Government 2008).

The indicators in Table 6.2 below represent the attempt to *identify* and *measure* the overflows generated while incubating innovation by means of EU funding. In the context of monitoring and evaluation exercises, Incubator#4 was asked to provide “evidence” that “650 new jobs are created” (#5 –Commercial Manager). *650 new jobs created* acts as an inscription in that it translates into numbers what the local government, the European Union, and Incubator#4 agreed to achieve as part of projects aimed at incubating innovation. Only by providing such “evidence” the incubator would be able to unlock further funding:

“We were able to evidence that over the course of the project we were able to help companies to create 209 jobs, we helped 206 companies, we were able to get an increase in turnover of £14,7 million” (#5 –Commercial Manager)

Evidence is provided by means of detailed spreadsheets, which include data on jobs created broken down into number of jobs created in each enterprise<sup>9</sup>. The effects of incubating innovation through EU funding are therefore captured predominantly by economic indicators. However, the next section will discuss the emergence of another type of frame mobilised within the incubator to capture the value produced through innovation, that is the health-outcomes frame.

**Table 6.2: Indicators reported by Incubator#4 to the Local European Funding Office**

Phase of development	Indicator	Target	Actual	% of target achieved
Phase 1	New jobs created			
	Companies advised in R&D/Innovation			
	New companies created			
	Increase in turnover			
	Collaborative research projects			
	New patents/trademarks			
Phase 2	Enterprises assisted			
	Individuals assisted			
	Collaborative R&D			
	Innovation centres			
	Open access points			
	Gross jobs created			
	Enterprises created			
	Profit benefit			
	Product, processes, services registered			
	Product, processes, services launched			
	Product, processes, services launched			
	Equality strategies			
	Environmental manufacturing systems			
	Investment induced			
Enterprises accommodated				
Jobs accommodated				

### *Struggles in translating the health-outcomes frame into numbers*

Economic development indicators represent only one way to identify and measure (i.e. frame) the value produced through programmes for incubating innovation. Economic development indicators aim to capture the effect of ERDF and government funding using the categories and vocabulary of economics. New products, enterprises, jobs, and

<sup>9</sup> A new job is defined by the EU/government as “A new post which is expected will exist for at least 12 months and did not exist prior to the Structural Fund activity. This does not include jobs which have been relocated” (Welsh Government 2013, p.58)

investments are deemed to be the effects, i.e. overflows, of investing public funding in incubation and innovation. Putting the emphasis on economic indicators, such as the number of enterprises or jobs created, implies that the economy is the target of such overflows, and public funded incubation is the source. As one respondent put it:

“If you look at how the relation with stakeholders is functioning, because of the European Union funding we have certain outputs to achieve. So part of those outputs –well, the majority of those outputs- are related to **economic growth rather than the development of new treatments in human and health science**” (#5 –Commercial Manager, emphasis added)

Therefore, accounting shapes the value of programmes for incubating innovation by translating the aspirations and objectives of local government and the European Union into economic targets:

“For me, because we are European funded then we have to meet those particular [economic] targets. In terms of [Incubator#4], you noticed none of those [pointing to the computer screen which shows the indicators represented in Table 6.2] really relate to improvements in health, they all are economic development objectives” (#5 –Commercial Manager)

Other possible ways of framing incubation practices and the effects they generate could have focused –according to the Commercial Manager- on health-related objectives and outcomes.

All in all, the case of Incubator#4 shows that the ability of the public intervention/economic development frame to impose itself as the dominant calculative frame lies in the power of its calculative equipment (e.g. economic performance indicators). The prevailing version of value, i.e. value expressed in terms of economic development, is one where the *economy* is the target of the overflows generated through innovation. Differently, the version of value where human *health* is the target of the overflows struggles to emerge. The causes of such struggle might lie either in the lack of ‘measurement tools’ available to the proponents of the health-related outcome frame, or in the absence of a calculative space where both frames (health-related and economic) can be represented and mediated by measurement tools. Overall, the version of value produced by those providing the financial resources, i.e. the EU and the local government, prevails on the version of value that could be produced by scientists, i.e. those generating the ideas/innovation.

### 6.2.3 Public intervention, commercial and quality frames

This section will analyse how accounting is involved in incubating innovation at Incubator#6. Accounting, in the form of performance indicators, contributes to realising the multiple values of incubation while translating public intervention, commercial, and quality frames into accounting numbers. As a consequence of such translation, not only do different forms of value arise, but also different realities are constructed (e.g. *economic* reality). Incubator#6 is TopUniversity#5 wholly-owned incubator and is managed through a university subsidiary, which is a limited company. The subsidiary was funded in 2004/5 at the time of the merger between two universities to form TopUniversity#5. The incubator spreads across five sites, each of which is dedicated to a specific field (e.g. biotechnology, life sciences, IT, etc.).

#### *Inscribing the commercial frame into profitability indicators*

In TopUniversity#6's financial report the incubator is accounted for as an investment in subsidiary undertaking. The fact that the incubator is owned and managed through a commercial vehicle –a limited company- not only has consequence in terms of fiscal treatments (i.e. the vehicle is subjected to Value Added Tax and Corporation Tax), but also has consequences in terms of the calculative frames mobilised within the incubator. A former managing director of the incubator explains the way in which the incubator was run as follows:

“We were a for-profit company and essentially our model revolved around two sources of revenues. One was the occupancy – the rental, and the other one was through conferencing and events. Later I did some consultancy for the World Bank and stuff like that and the money went to the company as well” (#18 –former Managing Director)

Occupancy level was an important target in that the higher the occupancy the higher the income from rents. Being a for-profit company implied that the central target was “at least” to breakeven:

“We basically set up for profit to have a business plan that we would at least breakeven on the basis of occupancy” (Ibid.)

The governance of the incubator was said to be separate from the university. In this regard, the incubator has a board composed by “university people” and two non-executive directors, described as “independent non-university people”. The former managing director described the relation with TopUniversity#5 as follows:

“So [we had] separate governance but still under the framework of...you know we had only one stakeholder –the university [...]. So everything we did was to provide stakeholder value for the university. So if we got any profit the money would go to the university, and the university would decide whether to give it back to us, to reinvest it or to spend it in research and development somewhere else” (Ibid.)

The objective for the incubator management was to make profits –i.e. to create value for the university. The surpluses would therefore be distributed to the University. However, there was a practice in place where:

“Usually [TopUniversity#6] would leave it, to be fair. So the money would get reinvested and you still have to cover your operating costs and operating costs are going up all the time” (Ibid.)

The commercial/business approach to incubation consisted also in having in place a bonus scheme:

“So you were running like a **proper business**. And you need to incentivize to motivate your team. I remember every year we had bonus every year, so we hit the target every year [...] I think we were **incentivised**, we had a **bonus scheme**. So personally I was incentivised to make that profit and then I did not care if they took the profit or not” (Ibid., emphasis added)

The bonus was to be distributed upon the achievement of certain targets, such as occupancy level, breakeven, and number of companies spun out from the university.

To sum up, the commercial frame gives visibility to a certain notion of value produced through incubation, which is value understood as profits. Putting the emphasis on profits means that incubating innovation is regarded as an activity whose effects are projected into the realm of the economy. By providing profitability measures, accounting contributes to framing the incubation of innovation as an activity whose value is mainly *economic*.

Other than the university, Incubator#6 had also other stakeholders such as the Regional Development Agency (RDA) and the European Regional Development Fund, who both provided funding for constructing the Incubator#6 buildings. The next section will explore what notions of value are embedded in the set of aspirations and objectives mobilised by actors such as the RDA and the EU and what forms of accounting are involved in realising the value of incubation. The next section will also explore whether the version of value produced within the commercial frame, i.e. value as profitability, comes into conflict with the value realised in the context of the public intervention frame.

### *Inscribing the public intervention frame into number of jobs created*

In virtue of their investments in incubation buildings, the Regional Development Agency (RDA) and the European Union (through the European Regional Development Fund) constituted, alongside the university, the relevant stakeholders for Incubator#6. As the former Managing Director of the incubator explains, the incubator did not need to pay the ERDF and RDA's capital investment back and how this was central to the incubator's business model:

“The model was around revenues. So we had the capital money, so we didn't have to pay any of the capital money back. So the 15 millions pounds for the original incubator came from the ERDF,[Charity Foundation#1], and the university.

The 15 millions for building one and the 25 millions for [building two] we didn't need to pay them back. That's really important when you think of the business model. Cause if we had to pay 40 millions pound back over 10-20 years that would have meant a different model” (#18 –former Managing Director)

A contributing factor to the emergence of the public intervention frame within Incubator#6 was constituted by the 15 million and 25 million funding injected into the incubator by various stakeholders. Without such funding devices none of the stakeholders –university, RDA, and EU- would be able to mobilise their metrological tools (e.g. sets of performance indicators) and contribute to realising the value(s) of incubation.

The rise of the public intervention frame within the incubation space was paralleled by a programmatic shift in the role that universities came to play within the regional economy in late 1990s and early 2000s. In this regard the former Managing Director of the incubator stated:

“Suddenly there was a realisation that universities play a very important role in job creation for the local community, hospitals. Universities sometimes are **one of the biggest employers** so they have a huge impact on the region” (#18 –former Managing Director, emphasis added)

Not only had the RDA and the ERDF contributed to incubation with a £40 million investment, but also they set up a calculative framework aimed at capturing the value produced while incubating innovation. As seen previously in the case of Incubator#4, at the stage of applying for European funding, a set of economic indicators (which aims to “capture” and visualise the activities carried out through incubation projects) has to be

chosen within the range of indicators<sup>10</sup> suggested in the ERDF application guidelines (Department for Communities and Local Government 2011). For each of the selected deliverable indicators, a target figure is then proposed by the applicant (i.e. Incubator#6). Contextually, the management team also commits to achieve certain target indicators such as *number of jobs created*:

“So you know how European money works or regional development agency...we had 11 millions from the regional development agency and 7 millions from the ERDF...**you have to commit creating 1000 jobs. So we created in 10 years over 1600 jobs, so we hit the target**” (#18 –former Managing Director, emphasis added)

Another indicator was the level of *sales* produced by the companies that the incubator was assisting. However, when it comes to companies operating in the biotechnology sector, such indicator is not applicable. It is a widely accepted fact in the field that biotechnology start-ups “do not make any sales”. As a consequence, a negotiation was needed in order to substitute the sales indicator with an equivalent one:

“[Biotech companies] They get investments and **we were allowed to use the investments that these companies got as a sales target**. So we had a sales target of 60 millions. [Spinout#4] alone had 60 million investments from venture capital and created 250 jobs” (Ibid., emphasis added)

Additional indicators that the incubator’s management team proposed and agreed to be monitored against were:

“There were also more soft things like do they fund PhD students at the university, how many collaborations do they have with the university, are they engaging with the region?” (Ibid.)

Overall, the effect of the public intervention frame in the case of Incubator#6 is to construct the incubator as “one of the biggest employer in the region”. Such aspiration was inscribed into the *1,000 jobs created* indicator. This means that the effects of incubating innovation have, as a target, the economy of the region. By expressing the value of innovation in terms of jobs created, a piece of economic reality is constructed.

---

<sup>10</sup> Applicants can also provide supplementary indicators which are not included in the ERDF technical guidance, however they should still follow the output-outcome/results-impacts framework. This point is made clear in one of the notes in the guidance: “*The Technical Note takes account of practitioners' practical experience of data collection and builds on existing information systems in a proportionate manner so that the indicators are consolidated and linked to make them manageable and useable and to rationalise the data collection requirements. It does not cover any supplementary outputs, outcomes/results or ERDF impacts that the Regions may choose to use in their programmes*” (Department for Communities and Local Government 2011, p. 5)



An economic reality where incubation (and innovation) is valued for the number of jobs it creates.

Whereas the commercial frame envisioned the incubator as a commercial entity (as a “proper for-profit business”), the public intervention frame envisioned the incubator as an employer. The process of constructing the incubator according to these frames was crystallised into different sets of targets, as the Managing Director effectively stated:

“So you have a number of red amber green level targets. There were different targets for different stakeholders. The university wanted us to breakeven, to make profit, the academic-industry engagement. The ERDF and regional development agency they wanted jobs and academic impact” (Ibid.)

Both the commercial frame and the public intervention frame project their aspiration onto the realm of the economy. Accounting provides categories and indicators such as profits and jobs created, in so contributing to realise the economic values of incubation.

The next section will discuss another way of identifying and measuring the overflows produced through incubation. While the commercial and public intervention frames identify the economy as the target of innovation’s overflows, the quality frame encounters difficulties in being translated into economic terms.

### *Struggles in translating the quality frame into numbers*

The value of incubating innovation, according to the commercial frame, is captured by key performance indicators such as profits from rent and occupancy levels. The latter is defined as the percentage of incubation space which is rented out to start-up and spin-out companies. As mentioned before, the higher the occupancy level is, the higher the income from rent payments is likely to be. Higher income means that the incubator will be able to cover the operating costs (e.g. bills).

However, according to Incubation#6 Managing Director an excessive emphasis on occupancy level and rents risks to undermine what he calls the level of “quality” of the incubator. In this respect, he argues the following:

“In [Incubator#6] I had to breakeven and cover all my operating costs otherwise I had to fire staff. If you look around the UK, most of the incubators in the UK go down the model of having to fill the building and so **quality** is not the most important criteria or KPI [key performance indicator]. The most important KPI is occupancy level and ‘can you pay your bills?’. That’s fundamental and that’s one of the issues around incubation globally” (#18 –former Managing Director, emphasis added)

The concern of the incubator manager is that framing incubation in a commercial way, hence focusing on profits/breakeven and occupancy, not only undermines quality but also risks being the standard model for incubation:

“And it’s really important to understand that the [Incubator#6] business model was “[name of managing director] fill the building, pay the bills, give us some profit!”[...]. And my worry is that most of the incubators in the world are driven by this business model and they forget about the **quality** very quickly because they are driven to just pay their bills. So the model is wrong, is flawed” (Ibid., emphasis added)

To make his point stronger, the incubator manager draws on the story of Incubator#4’s flagship company, i.e. Spinout#4, and its trajectory from success to failure. Success was narrated by the manager in terms of number of people employed and market capitalisation:

“[Spinout#4] went from 2 to 200 people, when it went to the stock market it was listed £300 millions, it was the biggest biotech in Europe, in our incubator, still” (Ibid.)

Failure, instead, was narrated in terms of technical milestones and number of employees:

“And then [Spinout#4] went to phase III clinical trial and failed and lots of trials failed, and the company went from 200 people to death” (Ibid.)

This story of success and failure is drawn upon by the Managing Director in order to show how the focus on quantitative targets such as number of jobs and market capitalisation/amount of investments etc., can drive the attention away from what, to him, really matters which is quality. The proposed solution lies in challenging the commercial and public intervention concerns for profits, breakeven, jobs creation, enterprises creation by redefining how the potential value of an incubated company (i.e. a start-up) should be identified:

“What we are trying to do now is to say “well maybe we need to create a different kind of biotech”. It has to be stronger, it has to be more viable, the process has to be a bit more diligent on the filtering so that companies that are gonna fail shouldn’t get £60 millions of VC [venture capital] funds” (Ibid.)

Framing incubation in terms of quality, however, is difficult partly because quality cannot be easily translated into key performance indicators and targets and partly because it is not clear how quality should be identified and measured. The quality frame

struggles to emerge because neither the University nor the European Union have been successfully enrolled in such programme

To draw a parallel with the account from Incubator#1 (analysed in Chapter 4), the quality frame was indeed mobilised by participants and translated into a KPI which was the number of Intellectual Property related tenants. In that context, the ability to mobilise the quality frame can be attributed to a specific funding device, i.e. a government loan, which was specifically set up to cover Incubator#1's operating costs for the first three-four years of activity. In that case the commercial concern for profits and breakeven is less emphasised if compared to the centrality of the quality frame. As Bioincubator#1 Chief Executive Officer points out:

“Because we have government money here [in Bioincubator#1] the objective is to be different, not to fill the building up with CROs [contract research organisations], but really focus on the problem that is **the lack of IP-based research** on life science, biotech, med-tech companies” (#25 –Chief Executive Officer)

Since the quality frame struggles to emerge, public intervention and commercial frames dominate in realising the value(s) of incubating innovation within Incubator#6. The latter is hence expressed in economic terms, i.e. in terms of profitability and job creation. The public intervention and commercial frames create versions of value which apparently do not conflict with each other, while dominating over alternative versions of value such as quality. In the case of Incubator#6, by providing tools such as performance indicators, accounting contributes to shaping innovation by realising multiple versions of its value (e.g. jobs created, profits generated).

## 6.2.4 Tensions between the investment frame and the commercial frame

This section will explore how accounting contributes to framing the innovation incubated within Incubator#7 and Incubator#5. By translating frames into numbers accounting makes it possible to realize the multiple values of incubation, which in turn correspond to different ‘visions’ of incubation. Envisioning incubation as a commercial space implies that the value of incubating innovation is captured by performance indicators such as profits from rent and occupancy level. Whereas envisioning incubation as a “capital-efficient” environment entails investing in the equity of tenants by means of investment funds. The latter can have the form of either incubator's

wholly-owned fund or incubator's minority shareholding in investment funds. The value of innovation in an incubation environment that is "capital-efficient" is captured by short term performances, such as the ability to raise funding.

In more detail, the section will map out the actors who mobilize the commercial and finance frames, what goals they aim to achieve, what accounting devices are used in order to realize the value of incubation under different calculative frames. Since finance and commercial frames are simultaneously mobilized within the same incubation space, this clash can result into tensions and conflicts. The section will also investigate whether accounting, in the form of performance indicators, contributes to creating, mediating, or solving such tensions.

#### *Linking the commercial frame to the percentage of shareholding*

Incubator#7 is 100 percent owned by TopUniversity#3 by means of a commercial vehicle which has the legal form of a limited company. The board of the limited company is composed mainly by people from the university, i.e. academics. The managerial aspects of the incubation are outsourced by the university to *TechTransfer Plc*. The latter was used to be, from 1986 to 1997, the university's technology transfer office. In 1997 it became a wholly-owned subsidiary of TopUniversity#3 and subsequently became registered in the Stock Exchange. The university still retains the 30,4 percent shareholding in TechTransfer Plc (as per the university annual report 2011-2012).

In outsourcing the managerial aspects of the incubator to TechTransfer Plc, the university pays a service fee to the public company for managing the incubator. As part of these arrangements, the CEO of the incubator is employed by the technology public company. The reason for running the incubator separately from the university is motivated by the incubator manager as follows:

"The system of big colleges does not suit an incubator, because incubators we are doing businesses so this means that we have to act **like a business**. Time, efficiency, cost effectively...we have director of the company, we have board of directors and my job is to report quarterly to the board of directors on all of these companies here and how they are getting on, prospects of the company etc., and show that we are doing something good"  
(#13 –Incubator manager, emphasis added)

What the incubator manager reports to the incubator Board and what the Board wants to know revolves around three main aspects: the percentage of occupancy (i.e. the percentage of incubator space which is occupied by start-ups and contract research

organisations, etc.), “*whether the company is able to pay rents and how long it will take to them to successfully graduate*” (#13 –Incubator Manager). The incubator Board has set the target at “*more than 90% occupancy*”, which is also the target that the incubator manager is made responsible for.

The commercial performances of the incubator (e.g. occupancy, rental income) are also dependent on tenants’ commercial performances. For this reason, the board of Incubator#7 exerts direct and indirect controls on tenants. One form of control is exerted directly through the incubator manager. As the incubator manager put it:

“In terms of [tenant companies’] performances you know, I’ve been talking with the companies so I have to report [to the incubator’s board] how they are doing.” (Ibid.)

However, the attempt to frame tenants’ performances relies on what the tenants’ CEOs decide to disclose to the incubator manager:

“What I see might not be the full picture [...] And I can only report what that [company] CEO tells me –to the board.”

“I don’t have any idea of what’s going on in the [tenants’] board meetings, and when I meet them I’ll ask them how they are doing and they will tell me” (#13)

Despite the efforts to “encourage” tenants to disclose information, the CEO doesn’t have any power to mandate tenants to provide full disclosure. Such privilege is for the board of the company/tenant and for Tech Transfer Plc. The latter has in fact a stake and a board position in most (i.e. 90 percent) of the incubated companies. In virtue of this investor/investee relation TechTransfer Plc can have a direct control over the performances of the company. As the incubator manager put it, the privilege of direct control over companies, which implies also setting and monitoring milestones, does not characterise the relation incubator manager-incubatees.

However, in the case of Incubator#7 the incubator’s board can exercise a more indirect control (or control at a distance) over the performances of the tenants. This is in virtue of the shareholding position (i.e. 30,4 percent) that the incubator has in TechTransfer Plc. This shareholding position acts as a form of indirect control over the ability of tenants to pay the rent:

“[I]n my old incubator people [tenants] would give you a business plan, they would give you their financials and everything is rosy and then if they are in trouble the first person they don’t pay is the landlord [incubator] and they would do anything not to pay. While here [Incubator#7] we don’t have that

problem because **we know when the company is going to have any problem because we often are on the board**” (Ibid., emphasis added)

When the incubator manager say “we are on the board”, what he means is not that the incubator holds directly a board position in start-ups/tenants’ boards. What he means instead is that TechTransfer Plc can have a board position in invested companies, and the university is a shareholder of TechTransfer Plc, holding a 30,4% stake. Such percentage inscribes the right of the incubator to know the performances of tenants, hence their ability to pay the rent to the incubator. The ability to pay the rent is important for the financial sustainability (and profitability) of the incubator. The commercial frame is inscribed in indicators such as the level of occupancy and the ability of tenants to pay rent. Through the shareholding percentage, the incubator is therefore acting upon the uncertainty of rental income.

#### *Translating the investment frame into start-ups’ value*

These shareholding arrangements have an influence on the way in which the incubator is constructed. In Tech Transfer Plc annual report (2013), while illustrating the strategies for coping with risks, it is stated:

“Technology companies may take longer to raise money and may find it more difficult to sell products. Mitigation: ensuring that companies are not formed until funding can be raised to take them to a clear value inflection point and only moving companies from the **capital efficient environment** of the incubator when co-investors and sufficient funding are in place” (doc#6, p. 19, emphasis added)

From the point of view of the technology transfer company the incubator acts as a ‘mitigation’ device, that is to say a device that contributes to mitigate the “*potential negative impacts of the economic environment*” (doc#6, p. 19) on technology investments.

The idea of incubation as a capital efficient environment is embedded in one indicator, which is the percentage of tenants in which TechTransfer Plc has an equity position. In fact the 90 percent of tenants receives (equity) investments from the technology transfer company. 90 percent is also the number of companies that spun out from TopUniversity#3 and are now tenants at Incubator#7. Although it is not necessarily the case that all the spin-outs are backed by TechTransfer Plc, still the percentage of Tech Transfer Plc backed spin-outs tends to be high. As the incubator manager pointed out:

“[A] lot of businesses we have here are funded by VC [venture capital], which means that before they move in here they’ve got enough funding to keep them here for one or two years before the next funding round. So it means that we have a little bit less risk than we had an incubator open to just outside companies”

The investment funds mobilised by TechTransfer Plc is based on funds raised in the financial market.

However, there are also cases where the investment funds are raised through the incubator. In this respect, Incubator#5, which is a university owned incubator, re-invests the surpluses from the incubation activity (e.g. income from rent) in an on-purpose vehicle that acts as the incubator’s investment fund. Alongside the commercial activities such as space rental and services, the incubator invests on selected tenant companies which correspond approximately to the 10% of the tenants. The Chief Executive Officer of Incubator#5 explains the model as follows:

“So if we are busy making all these companies successful then it is great that we can share in the rewards because they take more space and more revenues and more services, but actually we decided that we could share a reward in the capital appreciation of the companies so we have equity in the companies as well. So **we get two benefits: the revenue benefit** [i.e. rent] **and the capital appreciation benefit** (#11 –CEO, emphasis added)

While investing in early stage and helping create future tenants, Incubator#5 captures part of the value created by tenants both in the form of equity and in the form of rent:

“[O]ur investment helped [Startup#3] be created, other people put 80 thousand pounds on top of us, so that was good because **it helped create [Startup#3] but also it created a tenant for** [Incubator#5], which gives us the money back” (Ibid., emphasis added)

“For us it is important to have a separate vehicle to hold the investments, to hold the shares. And I mean our goal now is to having sort of proven that principle and it’s now to go out and raise a lot of more money so we can have a fund of 30-40 million pounds to invest in the companies alongside providing the facility” (Ibid.)

Whether the investment funds raise money through rents or in the financial market, the frame used to identify and measure the value of the innovation developed within the incubator is based on financial tools. In more detail, under the investment frame the value produced by tenants is usually identified and measured by *milestones*. Milestones can be both technical/scientific milestones and also financial milestones. An example of technical milestone is provided by the director of Incubator#5’s investment fund:

“Spinout#9 here [in Incubator#5] is developing a drug delivery technology and so one of its key milestones was in the **proof of efficacy** in its

technology and so they had to show they can get a certain amount of drug into the blood stream with a certain volume of delivery metrics and they did that and that was an absolutely crucial milestone if they hadn't done that the company would have probably folded because everything was centered on that. So that's important milestone" (#11 –Director, emphasis added)

Technical milestones such as the proof of efficacy capture the effects of a technology on human body (i.e. blood stream). While financial milestones focus on the ability of tenants to raise money:

“**[R]aising money** is always a key milestone because companies, particularly those developing new products, are always trying to raise more money because they usually don't have a revenue stream, very little income and so they have to depend on raising the next tranche of cash in order to keep going.”(#11 –Director, emphasis added)

How does the ability to raise money and technical milestones translate into financial value? To determine the value of start-ups (i.e. tenants), investors (e.g. venture capitalists) usually deploy the so-called capitalisation table (see Table A-4, Appendix 4), which consists in analysing the founders' and investors' percentage of ownership, equity dilution, and value of equity in each round of investment. As the Director of a venture capital (VC) firm explains:

“[T]he capitalization table [shows] who are the shareholders and what's the pricing of an investment round, so what's the **pre-money valuation**, imputing the value to each of the shares, and how much money we're putting in. So pre-money plus the funding makes the **post-money valuation** and then what value you add to that to get an exit before you do another funding round. That is actually a cool part of the investment paper because **we want to see value** and we want to make sure that we get good value from the investment (#10, Director, emphasis added)

Pre- and post-money valuation are, therefore, essential in order to “see value”. Pre- and post- money valuation are a central part of the so-called *venture capital method*, which is often used, alternatively or in conjunction to the discounted cash flow method, to determine the “value” of start-ups (i.e. tenants). Pre money valuation consists in discounting the *terminal value* of a start-up (i.e. the value at the time of VC's exit, which is usually in the short term) at a discount rate which is not the traditional cost of capital used in discounted cash flow formula but a *target rate of return*<sup>11</sup>. The target rate of return is the yield that the VC “*feels is required to justify the risk and effort of the particular investment*” (Keegan 2008, p. 171). Other factors that contribute to the pre

---

<sup>11</sup> According to Keegan (2008), the formula for discounting the terminal value is: Discounted terminal value = terminal value/ (1 + target)<sup>years</sup>



money valuation are the strength and completeness of the management team and the potential competitive advantage of the technology/drug (Keegan, 2008). Post money valuation, instead, simply adds the VC investment to the pre money valuation and is used as a base for further rounds of funding.

### *Tensions between the investment and the commercial frames*

The fact that an incubator provides both facility and equity type of funding all at the same time can potentially generate a conflict between the commercial and investment frames. The Managing Director of Incubator#6 explains the point as follows:

“We kept the fund and the landlord/tenancy separate. We still did business mentoring, coaching and support but in terms of ...sometimes **it is more important to keep the two roles separate because there might be conflicts of interests**. If you have investments and equity positions in a company that cannot pay the rent, how do you deal with that? It’s difficult, there can be conflict” (#18)

“[I]t might be that we have a stake in this company [start-up/tenant] but it doesn’t mean that I’ll always put them above other companies because my job is to work with all the companies here” (#13)

Across the accounts of incubation presented so far a number of calculative frames, i.e. commercial, public intervention, finance, and quality, emerge. Each of them entails different visions of what an incubator should do and how it should be represented and calculated. The concluding section below will discuss in detail how these different ways of framing incubation creates a metrological framework and what consequences derive from such framework.

## **Conclusion**

### *Translating calculative frames into value: the construction of a metrological framework*

“Overflows are devoid of economic significance unless they give rise to evaluations and measurements. The theory of externalities requires a metrological framework –i.e., measuring instruments- that allows the different agents to negotiate an agreement by calculating their respective interests” (Callon 1998a, p. 259)

The question of how to best capture the value produced from incubating innovation often appears in academic and practitioner oriented debates (Dee et al. 2011). However,

this chapter showed that there is no single and absolute version of value, while there are multiple versions, which are mostly dependent on how different agents frame, calculate, and negotiate their interests and aspirations by means of accounting. The chapter demonstrated how accounting shapes innovation by providing the metrological framework that produces the multiple values of incubating innovation. Ultimately, what constitutes the multiple values arising from incubating innovation is shaped by the same indicators that are deployed to identify and measure those values. Where the choice of metrics and indicators depends on models and categories that are historically contingent, and situated in local practices.

This section will discuss the constitutive elements and effects of the metrological framework that emerges from the analysis of the role of accounting within the space of incubation. As summarized in Table 6.3, this chapter contributed to mapping out and characterizing the calculative frames that were mobilized in order to capture the multiple values of incubating innovation.

The table accounts not only for differences in the practices of valuing incubation, but also for those conditions that trigger such differences. To this aim, calculative frames have been traced in terms of the conditions that enabled their emergence, and the accounting devices and inscriptions deployed by incubator managers, funding bodies, and scientists in order to translate their objectives and aspirations into numbers.

**Table 6.3: Mapping out incubation metrological framework**

Calculative frames	Accounting devices	Inscriptions	Conditions of emergence
<b>Commercial/financial sustainability (incubator as a business)</b>	KPIs, rental mechanism (fixed/ratcheted, market/subsidized)	Percentage of occupancy, breakeven, revenues, profits, tenants' graduation time	Universities' third mission, universities' commercial vehicles
<b>Investment (incubator as a capital efficient environment)</b>	Investment Fund, KPIs, capitalisation table	Technology milestones (e.g. proof of efficacy), financial milestones (e.g. n. of licenses, money raised)	Venture capital industry
<b>Public intervention (incubator as the engine of regional economies)</b>	ERDF, Government grants	N. of spin-outs created N. of new jobs created N. of enterprises assisted	ERDF logical framework, regional development policies
<b>Quality</b>	KPIs	Percentage of IP-related companies	Struggle to emerge
<b>Health</b>	KPIs	Health-related outcomes	Struggle to emerge

The conditions that enabled the emergence of a public intervention/economic development frame trace back to the setting up of Regional Development Agencies in late 1990s. Accounting was drawn upon in order to translate regional development

objectives and aspirations into key performance indicators and targets such as the number of spin-outs, turnover, number of new jobs created etc. It is through these numbers that the overflows arising from the innovation produced through regional development programmes, or better the value created through incubation programmes, is identified and measured.

The rise of universities' third mission, universities' increasing role in research commercialization programmes, and the creation of universities' commercial subsidiaries as surpluses/profits generating businesses constituted the conditions for the emergence of the commercial frame. Within such frames accounting is mobilized to provide the tools for managing incubators as "businesses" through performance indicators such as breakeven, profits, revenues and percentage of occupancy.

Traditionally, venture capital firms have represented a relevant source of financing for start-ups/tenants. However, a more recent trend (Ernst & Young 2014) sees incubators taking equity positions in clients/tenants through on-purpose investment funds, at the aim of capturing part of the value produced by incubated companies (Dee et al. 2011, p. 7). These phenomena have led to the emergence of a way of framing incubation that is typical of investment funds. As Dee et al. (2011, p. 7) noted, behaving like an equity investors means prioritizing short term returns rather than long term performances. As illustrated in the chapter, short term performances are usually measured in terms of technical and financial milestones to be achieved by the investee/incubatee before proceeding to other rounds of investments. The vision of incubation as a "capital-efficient environment" is embedded in the investment frame and is inscribed in a short term version of financial value, i.e. value estimated only at the time of investment's exit by means of the so-called *venture capital method*.

Overall, the stories of incubation presented throughout the chapter showed how multiple frames operate simultaneously within the same space. For this reason each frame summarized in Table 6.3 should not be considered separately. Rather, at level of practices, frames can enter into conflict with each other, or simply coexist. In this respect, incubation can be theorized as a space characterised by multiple forms of value which might sometimes conflict with each other. Ultimately, the stability of the space depends on the ability of accounting to inscribe frames into numbers and mediate the tensions between different calculative frames, hence between different versions of value.

The chapter showed how the commercial, economic development, and finance frames identify the *economy* as the target of innovation's overflows. So to speak, the economic development/public intervention frame measures the effects of incubating innovation in *economic* terms, i.e. in terms of number of enterprises and jobs created. So does the commercial frame, where the effects of incubating innovation are measured in terms of profits. Differently, those frames that struggle to emerge, i.e. health and quality frames, do not target the economy, but other domains such as health. In the latter case, accounting does not provide tools for inscribing quality and health into indicators. The consequence is that the dominant frames are those where the economic effects of incubating innovation are translated into economic values. Therefore, mapping out incubation's metrological framework contributes to identifying those objectives, aspirations and actors that struggle to represent their version of value.

#### *The effects of incubation's metrological framework*

This section will discuss the effects of the metrological framework that emerges from translating the different goals and aspirations of public and private stakeholders into numbers. Performance indicators and targets such those discussed hitherto, have the power to *shape* reality by inscribing certain calculative frames and translating their referents (i.e. innovation) into *economic entities*. To prove the point, when regional development agencies and other public funding bodies establish and agree the indicators for monitoring and assessing incubation projects, not only do they aim to capture the overflows generated through public funded innovation. But also they choose to give visibility to *a* type of overflows over others, that is overflows that have the economy as a target. By choosing "economic development indicators", funding bodies project the effects of incubation and innovation onto a purely economic plane, and frame the value of them in economic terms. This means that by setting economic targets such as 1000 jobs created, the intended effect is to create 1000 jobs, which is also used to prove the economic value deriving from incubating innovation. In this sense, the economic targets set by funding bodies, in agreement with project applicants, are *intendedly* performative.

However, measures (for which a target is not set) can also become *unintendedly* performative. In this respect, Incubator#3's Chief Executive Officer argued that number of filed patents and the number of jobs created (per company as opposed to the totality of jobs created) can lead to a situation where "*you get what you measure*":

“We don't create jobs here [Incubator#3], we create the environment for other organisations to create jobs. So if I go back to the government or the local authority and say there has been twelve jobs created here, we had a discussion that the measure is not the number of jobs but is the number of company creating those jobs. So they are much more interested in 4 companies producing three jobs each than one company producing twelve. So is it better one company producing 12 jobs or four companies producing three jobs each? [...] **And so you get the situation where you get what you measure**” (#8 – incubator CEO)

Measuring the number of spin-outs created in a given incubator generates the effect of increasing the number spin-outs. However, counting the newly created companies is, to the CEO, a meaningless indicator:

“With most government things there is always some metric that they want and for a long time it was used to be “spin-out companies” as a metric of university innovation which I always thought is a meaningless measure.

[...]Because there is a big difference between having something of innovative value and having enough to create a company. They are different” (#8 – incubator CEO)

Measuring spinouts do not simply ‘capture’ a form of economic value, rather it contributes to performing the economic reality, i.e. more spinouts are created as a consequence of the measure.

Furthermore, certain choices of indicators such as those related to commercial, economic development, and finance frames were interpreted by participants as a “numbers game”, that is a game characterized by a strong appetite for the production of numbers. In this “game” participants agree to produce certain type of numbers (e.g. number of jobs, number of enterprises created), but they do not necessarily agree on the meaning attributed to such numbers by their superiors. The former Managing Director of Incubator#6 explained “the numbers game” as follows:

“Number of IPs, number of spinouts...it became a number, number, **number game! That's not quality, that's just quantity.** If you look back at that period [early 2000s], yes there were a lot more spinouts, but those who survived ...[were just a few] it's crazy!” (#18, former Managing Director, emphasis added)

“and I think we went too far down the road of creating a numbers game **where we have to have more patents, more spinouts.** And then someone will look back ten years later and say: well, how much of that led to **real commercialisation and economic impact?**” (Ibid.)

The so called “numbers game” can be interpreted as the consequence of the dominance of certain calculative frames, such as commercial, economic development, and finance, which all realize the value of incubating innovation by means of quantitative measures

(e.g. number of spinouts, number of patents). The growing appetite/anxiety for producing numbers that capture the economic value of incubation, has contributed to performing the economic reality in such a way that conform to the measures, i.e. “a lot more spinouts...more patents”. This holds particularly true where the measures also becomes a performance target and it is used as a device for evaluating individuals and organisations.

In conclusion, similarly to the case of technology transfer analysed in Chapter 5, incubators can be interpreted as costly initiatives aimed at capturing the economic value(s) of innovation. While adopting a pragmatic approach to valuation, the chapter aimed to trace the different ways of realising the multiple values of innovation within incubators, and the *economic entities* created thereby. Following such approach, incubation is conceptualized as the outcome of the continual re-configurations of networks of stakeholders (e.g. investors, managers, etc.) and the resources they mobilise (e.g. performance indicators, financial resources).

Such networks are highly contingent and co-produced by historical and political conditions. In this respect, the chapter has shown that commercial, public intervention, finance frames emerged first of all as a result of historical and political contingent conditions such as the creation of universities’ third mission, the rise of universities’ commercial subsidiaries, and the establishment of a network of regional development agencies (RDAs) responsible for conceiving and implementing regional development strategies.

Funding devices such as the ERDF, but also funds coming from the RDAs’ Single Pot budget and venture capital firms brought different visions of the roles of incubation in the economy. Accounting devices such as key performance indicators and key regional indicators contributed to translating these different visions of incubation into numbers. As a result of such translation, incubators were constructed as the biggest employers in the regional economies, as capital efficient environments, and as “proper” businesses. The chapter has discussed how these different ways of framing incubation never operated in isolation, but often coexisted within the same space resulting in some cases in tensions and struggles.

The chapter has also shown how the metrological framework that was constructed in the translation of frames had different qualities and produced different effects. One effect was crystallised in the powerful expression “you get what you measure”, which means that what ultimately constitutes value is shaped by those same indicators that

were initially deployed to identify and measure that value. Therefore, the value of incubating innovation is multiple and the choice of metrics and indicators ultimately depends on calculative frames that are situated and historically/politically contingent.

Chapters 4, 5, and 6 investigated the circulation of innovation through processes of *discovering*, *transferring*, and *incubating* scientific ideas. The chapters showed that an essential part in these processes was played by accounting. Accounting devices such as performance indicators contributed to realizing and capturing the multiple values of innovation. Building on the empirical evidence presented in Chapters 4, 5, and 6, the next chapter will discuss the paradox “controlling innovation, innovating control” by analysing the sources, origins, and effects of controlling innovation.

# CHAPTER 7 CONTROLLING INNOVATION, INNOVATING CONTROL: SOME REFLECTIONS

---

---

## Introduction

Considering how hotly debated is still today the issue of whether the technological inventions developed across the 18<sup>th</sup> and 19<sup>th</sup> centuries had the effect of bringing about an “industrial revolution” (Hartwell 1990), it is perhaps less than surprising to observe 21<sup>st</sup> century economists, managers, and policymakers still struggling with identifying and capturing the *effects* of innovation. Innovation is often pictured in economic theories and policies as a society-wide powerhouse that can foster entire economies and close technological and economic gaps between national and regional economies.

Parallel to such claims comes, however, the realization that in today’s society, perhaps, even the existence of a powerhouse is proved only when we are able to *see* its effects, whether these come in the form of electric lighting or in the form of electricity bills. However, proving the effects of innovation, hence *controlling innovation*, entails multiple efforts which have been restlessly put forward in the past three decades by different agencies of governance across the economy and society. This collective concern for capturing innovation, which is evidenced by the rapid spread of innovation measures, indexes, surveys, and assessment exercises, is also paralleled by the diffusion of government and corporate policies and programmes aimed at fostering innovation across regional and national economies. Seemingly, *controlling* innovation while *promoting* innovation has become the mantra of a society that is constantly reminded not only to invest on innovation (and knowledge) in order to progress, but also to realize innovation’s multiple effects.

The progressive agenda dictated by the innovation-driven economy has posed, however, a significant challenge to accounting, which is called upon in order to aid



government, corporations, and non-for-profit organisations to realize the multiple values of innovation. For it is only by capturing innovation's multiple values that innovation can be proved. The hypothetical paradox addressed in this thesis, i.e. *controlling innovation, innovating control*, aimed to address such collective concern for controlling innovation in terms of the roles and forms of accounting mobilized.

While investigating the role of accounting in controlling innovation, this study contributed to tracing and characterizing economic action in the field of innovation by shifting the attention away from the effects of innovation on the *economy*, to the question of what entities and actions are regarded as *economic* in the realm of innovation. Where economists have been studying for a relatively long time the impact of innovation on the economy through their models of economic growth, this study has adopted a different approach. This study aimed to analyse innovation not from the point of view of its effects on the economy, but from the point of view of the economic agencies that both constitute and control innovation. To investigate what configures economic agencies of innovation and the role of planning, budgeting, and valuation devices in such process of configuring, the thesis sought to identify the entities of innovation that have been rendered *economic*.

Nevertheless, to say that accounting is implicated in formatting the capacity to act of individual and collective entities implies that some form of interaction between accounting and such entities takes place. The questions of how accounting interacts with other entities, and what the effects of such interactions are, imply that accounting entities can have some form of agency too. Not all the conceptualizations of agency in social sciences allow this passage and this is why Michel Callon's concept of agency (2008) proved particularly useful in this thesis. Following Callon's formulation of agency, an economic agent is constituted by drawing together both human and non-human entities and observing the arrangements between them from the point of view of their capacity to act and give meaning to action.

One of the advantages of Callon's conceptualization of agency is that it leaves the characterization of agency open. In this regard, this study contributed to characterizing the economic agencies of innovation by categorizing them in terms of the *modalities of attributing action* (i.e. what or who organizes action?), the *content* of action (i.e. to what extent is action calculative?) and the *effects* it produces. Such categorization is consonant with the role that the French pragmatist tradition attributes to the interactions between human and non-human entities in the enactment of subjectivity. In simpler

terms, humans do not act in isolation, but rather perform various types of action (e.g. piloting an airplane, monitoring an innovation project) aided by a network of other humans (e.g. the pilot and the cabin crew, the innovation project's assessor and applicant) and devices (e.g. the radar, SMART objectives). Agency is therefore performed collectively through the *interactions* between the various entities participating in a network.

The remainder of the chapter will discuss the findings related to the question of whether accounting has changed its concepts and instruments in order to account for innovation, i.e. "controlling innovation, innovating control".

First, the chapter will analyse the action of controlling innovation in terms of the source, content, and effects of action. In this respect, the findings suggest that the governance of innovation as a social and technical phenomenon is enacted in the form of *distributed* efforts/action oriented toward *realising* the multiple values of innovation and constructing economic markets for innovation. The findings related to the forms of controlling innovation are summarised in table 7.1 and 7.2. Table 7.1 identifies what the sources of action are in the realm of innovation (e.g. individuals or collectives) and what types of entity perform such action (e.g. humans or non-humans). Table 7.2 categorizes the *consequences* (or effects) of controlling innovation according to the type of economic exchange from which they arise. Such consequences are conceptualized as tensions occurring between different modalities of framing the interactions among the human and non-human entities participating in innovation.

Second, the chapter will discuss whether the progressive agenda of accounting has brought about innovations in the forms of accounting that are used to control innovation as a phenomenon. In this respect, the findings suggest that rather than innovating its instruments and tools, accounting has *adapted* to the innovation rationale in virtue of accounting properties of combinability and fluidity. Furthermore, the evidence show how the interactions between human entities and non-human entities (e.g. accounting tools) do not merely rely on competent and creative and skilled actors (Çalışkan and Callon 2009) in order to take place, but also on a number of properties that the accounting tools possess, namely *fluidity* and *combinability*.

## 7.1 Controlling innovation

The findings discussed in the following sections contribute to understanding the types of economic agency that underlie the multiple efforts of controlling innovation. The term ‘controlling’ is used here to indicate a range of calculative actions whose content and source cannot be determined *a priori*, but rather observed in the specific circumstances of action. The findings suggest that the forms of economic agency that constitute innovation are mainly *collective* and action is *distributed* across a multitude of non-human entities (e.g. performance indicators, budgets) and human entities (e.g. finance directors, incubator managers). The forms of collective agency observed in the field range from R&D funding programmes (e.g. European Regional Development Fund) to financial models and valuation tools. The architecture of these collective agencies will be discussed in the next section by looking at the mechanisms for organising action within agencements (e.g. economic principles, accounting tools) and the content of calculative action performed within agencements (e.g. budgeting and monitoring)

### 7.1.1 Characterising the economic agencies of innovation as *socio-technical agencements*

As discussed in Chapter 2, Michel Callon advanced the notion of *socio-technical agencement* to denote heterogeneous arrangements, comprising both human and non-human entities, considered from the point of view of their capacity to act (Çalışkan and Callon 2010, p. 9). The central questions in tracing an agencement are: who participates to action? And with what effects? While addressing these questions Table 7.1 and 7.2 contribute to identifying the entities participating in the action of controlling innovation and to understanding of how agencies’ capacity to act is configured and the role of accounting in this process of configuring. By identifying the content, distribution, and effects of economic action in the field of innovation, one can better understand the contribution of performance measurement, budgeting, and valuation devices to the emergence and development of the economic agencies of innovation.

In addressing the questions of what entities participate to innovation, what type of calculative action they perform, and with what effects, there lie both challenges and opportunities. The challenge consists in the fact that origins, content, and effects of action can only be observed in the particular circumstances of action, with the

consequence that the configuration of agency is contingent to the specific settings under observation. This also implies that it is not possible to determine *a priori* how and by whom/what agency is enacted, for this depends on the particular arrangements under study. Therefore, how innovation is monitored and evaluated and who/what perform these actions can be traced only by observing the enactment of specific funding programmes, technology incubation programmes, etc.

Nevertheless, addressing these questions provides the opportunity to include in the configuration of economic agency any attempt to calculate/control innovation, with no *a priori* categorization of what should constitute economic action and what should not. Furthermore, leaving the characterization of agency open has the advantage, in the cases analysed here, of considering accounting tools as central to the processes of configuring economic agency. As noted before, including non-humans entities in the analysis of economic action, such as accounting principles and instruments (e.g. management by objectives principle, time value of money, discounted cash flow formulas, key performance indicators) allows us to observe how they interact with other entities such as incubator managers, scientists, technology transfer executives, and policy makers. In so contributing to unveiling the content, properties, and effects of accounting tools themselves.

Table 7.1 presents the findings related to the content and sources of economic action in the field of innovation. Since the contribution of this study lies also in the choice of categories to characterize agency, it is useful to elucidate the rationale for the analytical categories proposed in the table. Subsequently, the section will proceed with discussing the findings of the empirical analysis.

First, the table lists the heterogeneous entities, i.e. human and non-human entities, participating in the action of controlling innovation. Tracing non-human entities that participate to controlling innovation is as much relevant as tracing human entities, for they all together constitute the arrangements through which calculative action is performed. Moreover, including non-human entities such as managerial and accounting tools in the analysis of action allows us to understand what effects the latter have on configuring economic agency.

Second, the table characterizes the agencies of innovation by evidencing the content of the calculative action performed by human and non-human entities. The table sheds light on how budgeting instruments, managerial principles, and valuation tools on the one hand and humans on the other hand together participate in the actions of controlling

innovation. The interactions between humans and devices are a central feature of the type of economic agency conceptualised by Callon such that he conceives of the agency as an interactive one (Callon, 2008, p. 39). By interactive agency Callon means that individuals constantly engage with other entities such as procedures, rules, regulations, accounting and non-accounting devices.

Third, table 7.1 addresses the question of what the mechanisms for attributing action are. In so it contributes to identifying what entities/mechanisms attribute and organize action in the realm of innovation. Identifying mechanisms for organizing action within agencement is important because: "*all action is collective since it is distributed; what vary are the mechanisms for attributing the source of the action. The shape, content, and architecture of the agencement, with the equipment that facilitates the action to a lesser or greater degree, from a distance decisively influence the modalities of attributing action. So does the inclusion of specific legal or regulatory texts which distribute responsibility or property*" (Ibid., p. 10).

Finally, table 7.1 contributes to characterizing the economic agencies of innovation by identifying specific modalities of framing the interactions between entities, namely *calculative frames*. The concept of calculative frames here deployed aims to capture any patterns of regularity in the mechanisms for organising action within the agencement. The concept of calculative frame has been recently advanced by Beunza and Garud (2007) in order to show how the different versions of *Amazon.com*'s financial prospects provided by financial analysts were a consequence of the different sets of analogies, categories, and key metrics deployed by said analysts. The authors identified analogies, categories, and key metrics as the central components of what they call *calculative frames*. According to the authors, the internal consistence of the calculative frames that they observed was provided by the interaction between a stable set of elements, i.e. key metrics, analogies, and categories.

Compared to Beunza and Garud's conceptualisation, the calculative frames that emerge from this study (i.e. financial sustainability, public intervention, and investment valuation frames) identify patterns in the modalities of attributing action within the socio-technical agencements of innovation. In this regard, the findings suggest that a stable set of entities, i.e. economic, managerial and finance principles (e.g. management by objectives, input-output framework, time value of money) and managerial and accounting devices (e.g. logical framework, discounted cash flow technique) jointly organise and distribute action within agencements.

The remainder of the section will discuss the findings (see Table 7.1) related to how the action of controlling innovation is performed.

**Table 7.1: Socio-technical agencements of innovation**

CALCULATIVE FRAMES	MODALITIES OF ATTRIBUTING ACTION	MANAGERIAL AND ACCOUNTING DEVICES	HUMAN ENTITIES	CALCULATIVE ACTION	KEY PERFORMANCE METRICS
PUBLIC INTERVENTION	Management by objectives, logical framework, ERDF, REF, and HEIF guidelines (regulatory text)	SMART objectives, Options analysis, GANTT chart, Input/Output/Impact categories, formula funding, weights	Incubator managers, ERDF assessors (RDAs), technology transfer executives, REF assessors, scientists	Setting deliverables, monitoring and assessing performances	N. of jobs created, N. of enterprises assisted, N. of start-ups created, N. of patents
FINANCIAL SUSTAINABILITY	Accounting principles of financial sustainability, financial model	Budget, financial plan	Incubator managers, incubator board members, incubator chief financial officer, finance directors	Setting key assumptions, creating financial sustainability scenarios	N. of contract research organisations (CROs), breakeven, rental income, occupancy rate, profits
QUALITY	Principles of budgeting	Budget, wish list, financial attrition, strategic report, innovation objectives	Finance directors, scientists, incubator managers	Listing, prioritising, and costing innovation activities	N. of IP-related companies, N. of proof of concepts
INVESTMENT VALUATION	Time value of money, drug discovery and development stages	Discounted cash flow, R&D costs estimates, estimates on drug rate of success	Finance directors, scientists, venture capitalists	Assessing the commercial value of early stage drugs	Value inflection points

*Controlling innovation and the public intervention frame*

Controlling innovation is discussed in this section by looking at the monitoring and assessment practices performed in the context of R&D programmes such as the European Regional Development Fund (ERDF), Higher Education Innovation Fund (HEIF), and Research Excellence Framework (REF) (see Chapters 5 and 6). ERDF, REF, and HEIF are conceptualised here as involving forms of *collective agency*, for their capacity to allocate funding, to monitor and assess performances is embodied in a variety of entities such as application guidelines, managerial and economic principles, accounting devices, and human entities.

The findings indicate there is a pattern in the mechanisms for organising, assessing and monitoring actions, which is called here *public intervention frame*. Action within

the ERDF, REF, and HEIF agencies is attributed and organised through the following entities: the management by objective (MBO) principle, the logical framework, and the market failure principle. MBO was initially introduced by Peter Drucker in the 1950s and subsequently has come to inform the practices of project appraisal and monitoring in the context of public sector programmes. The principle, which consists in setting objectives and monitoring the progress toward them, emphasizes the attribution of responsibilities to managers on the basis of goals and objectives that managers themselves set up. As highlighted in Chapter 6, the management by objectives principle informs the *logical framework* (see Fig. 6.2), which is an instrument often used in the monitoring and evaluation of public funded projects. As discussed in Chapter 6, the framework aids actors in framing projects' objectives in terms of the inputs, outputs, outcomes, and impact. MBO and logical framework interact with a third entity, i.e. the principle of market failure. Broadly speaking, market failure concept originates from economic theory and usually refers to situations in which markets fail to deliver and there is a need for the public sector to intervene (Department for Communities and Local Government 2012).

In the context of ERDF, the interactions between MBO, logical framework, and market failure principle are encapsulated in the ERDF application and monitoring guidelines. The latter constitute a form of regulatory text that establishes the content of action and the mechanisms for attributing responsibilities for action. Guidelines require funds applicants to set up objectives, performance indicators and for monitoring the performances during the course of the project. In line with the MBO principle, the actions of setting up project objectives, measuring and monitoring project performances are distributed across individuals and organisations, which are held responsible for the ERDF application process (e.g. incubator managers) and for delivering the objectives during the monitoring stage of ERDF funded projects. MBO constitutes a source of calculative action also for those public bodies that are held responsible for allocating ERDF and for monitoring ERDF funded projects (e.g. Welsh European Funding Office, Regional Development Agencies). In setting up objectives and indicators, individuals and organisations interact with accounting and managerial tools provided by ERDF guidelines. Such toolkits or, as Callon (2008) would call them, *prostheses* comprise managerial tools for the identification of project objectives, such as the SMART technique. The latter is a managerial technique that aids manager in setting objectives that are “Specific, Measurable, Achievable, Realistic and Time bound”. Where SMART

objectives technique is aimed to evaluate the “strategic fit” of a project’s objectives, the “options analysis” allows project managers and applicants to rank alternative project options on the basis of categories such as risks, advantages, disadvantages, impacts on costs and deliverables. Furthermore, in setting the objectives of a project, applicants also need to provide evidence that the project addresses a market failure, hence requires public funding.

The findings show that the non-human entities such as ERDF managerial devices and principles modify courses of managerial action in that project managers (e.g. incubator managers) would normally favour sets of metrics that are different from those based on public intervention objectives (e.g. economic development indicator such as number of jobs created, number of companies created and assisted). If it were not for ERDF procedures, the interviewed incubator managers (i.e. ERDF project applicants) would put more emphasis on metrics different from economic development, such as profitability (e.g. rate of occupancy, rental income generated) and health-related outcomes.

In the context of REF and HEIF, the interactions between the MBO principle and the logical framework are embedded in regulatory text, i.e. programmes guidelines. As discussed in Chapter 5, the calculative action undertaken in the context of REF and HEIF consists in measuring research and innovation performances, attributing weights to performances, and ranking higher education institutions. Similarly to ERDF, action is framed in accordance to the logical framework, which is embedded in both REF and HEIF guidelines. The logical framework influences measurement practices within universities by conceiving of research and innovation as linear processes. Calculative action is directed toward evidencing how the financial resources (e.g. public funding) that are injected in the process produce measurable outputs and impacts on the economy and society. Compared to ERDF where MBO and logical framework are coupled with devices such as SMART method and option analysis, in the context of REF and HEIF, the MBO principle and logical framework interact with the formula-funding device.

The mechanisms of attribution (and distribution) of responsibilities for action is central to our understanding of relations between the entities participating in innovation. These include entities such as pieces of regulatory text (e.g. guidelines), application and monitoring procedures, but also entities such as funded and applicant organisations, which are held responsible for interpreting guidelines, setting up projects objectives, choosing and measuring projects outputs, outcomes and impacts, monitoring them



against targets, compiling spreadsheets and tables for reporting periodically the progress toward the objectives. The ‘collaboration’ (in a sense of interacting) between the managerial tools provided in the ERDF, REF, and HEIF guidelines on the one hand and human entities such as incubator managers, assessors on the other hand, contributes to assembling agency as a distributed one. Although regulatory text included in ERDF, REF, and HEIF guidelines might lead to imputing responsibility for monitoring and assessing projects to specific individuals or organisations, calculative action is distributed across the collective entities listed above.

Furthermore, interactions between entities within the public intervention frame result into a distinctive set of metrics. As showed in table 7.1, metrics such as the number of jobs created, number of enterprises assisted, and number of start-up companies created inscribe in a simple set of measures the complex arrangements occurring between the entities participating in the enactment of ERDF, REF, and HEIF.

Overall, the section discussed how controlling innovation is performed by collective agencies that participate in the distributed and calculative action of monitoring and assessing public-funded innovative scientific projects. The section discussed how humans, accounting devices, managerial and economic principles interact in configuring ERDF, REF and HEIF as collective agencies. The findings showed how the interactions between the management by objective principle, the logical framework, and the market failure principle are central to framing interactions in terms of public intervention objectives. A distinctive choice of metrics, such as number of jobs created and number of companies assisted and created, emerged out of such interactions and inscribed the complex interactions underlying the public intervention frame. The role of accounting within the public intervention frame consists in translating managerial and economic principles such as management by objectives and market failure into a distinctive set of metrics that inscribe the complex arrangements between entities.

### *Controlling innovation and the financial sustainability frame*

Controlling innovation is discussed in this section by looking at the planning and budgeting actions performed in the context of programmes for incubating technologies arising from university and industry, and funded by both industry and government (see Chapters 4 and 6). The section discusses the arrangements related to financial plans and budgets by analysing them from their capacity to act and influence courses of action. To this aim financial models are conceptualised here as involving forms of *collective*

*agency*, for their capacity to act (e.g. to list, cost, and prioritise activities) is embodied in a variety of forms and entities (e.g. accounting categories such as profit, revenues, costs, funding requirements etc.). The findings suggest the existence of a pattern in the modalities of attributing action, which is called here *financial sustainability frame*. The section will present the findings related to the financial sustainability frame by discussing the mechanisms for attributing action within such frame and the content of action, i.e. the extent to which action is calculative, distributed and collective.

Compared to the public intervention frame where the source of action is distributed across managerial principles (e.g. management by objectives) and devices (e.g. logical framework) that are embedded in regulatory text (e.g. programme guidelines), within the financial sustainability frame the source of action is provided by accounting principles of financial sustainability and the *financial model* device. In the context of technology incubation programmes, financial sustainability is mostly defined in accounting terms, that is the “*capacity to obtain revenues in response to a demand, in order to sustain productive processes at a steady or growing rate to produce results and to obtain a surplus*” (León 2001, p. 11). The principle of financial sustainability influences decision making, hence courses of action, only when embodied into the financial model device because it is only in the context of the financial model that key assumptions about rental and services charges, occupancy rates, operational costs, and funding requirements are set out. Once the key assumptions are made, the time when financial sustainability will be achieved and extent to which it will be achieved are both influenced by those assumptions. Since different assumptions lead to different scenarios of financial sustainability, different versions of the model are usually produced. Creating different scenarios, ranking their likelihood, and choosing which one to perform and by what means constitute forms of calculative action.

Although one might be prone to think of chief financial officer as the sole actor responsible for creating, running, and implementing an incubator’s financial model, the evidence suggests that creating and implementing a financial model is a type of *distributed* action. It is distributed because it involves not only the CFO, but also other individual entities such as incubator managers, who are held responsible for meeting the targets set out in the model. Creating a financial model also involves the interaction of the CFO with collective entities such as institutional investors who commit to secure funds for the incubator.

The findings show that revenues and profits are the key metrics used within the financial sustainability frame. Not only do these metrics inscribe the financial sustainability principle, but also they inscribe the whole set of arrangements that enact financial sustainability, i.e. rental and service charges, funding requirements, operational costs, investors' commitment to provide funds, managers' commitment to meet targets.

Overall, the role of accounting within the financial sustainability frame is to provide the principles for organizing (calculative) action, i.e. incubation businesses make key assumptions about pricing and costing based on the financial sustainability principle. Accounting also provides the devices for performing calculative action, such as operational budget, profit and loss accounts. Finally, accounting also provides metrics that inscribe the financial sustainability arrangements. The most relevant here is the number of Contract Research Organisations (CROs) that rent space within the incubator. As highlighted in Chapter 6, being CROs a fee-for-service type of business, they represent a stable source of income for incubators and are therefore vital to the financial sustainability of an incubator.

#### *Controlling innovation and the quality frame*

Controlling innovation is discussed in this section by looking at the planning and budgeting practices performed in the context of R&D and innovation activities within incubators and corporate R&D (see Chapters 4 and 6). Similarly to the other types of calculative action discussed so far, R&D planning and budgeting is a form of *distributed* action, which means that action is spread across a variety of human and non-human entities. Human entities include finance directors, chief executive officers and scientist, who are held responsible for the R&D and innovation budgets. Finance directors, chief executive officers, and scientists are individual actors who participate to the action of budgeting together with non-human entities such as accounting devices, i.e. budgets, wish lists and financial attrition, and managerial devices, i.e. strategic reports and objectives. Not only is R&D budgeting a form of distributed action, but also it is calculative because it involves tasks such as listing the R&D activities necessary to carry out a R&D project, ranking such activities according to priorities, and costing such activities.

The findings suggest the existence of a pattern in the modalities through which action is distributed in the context of R&D budgeting. Such pattern is called here *quality*

*frame*. Within the quality frame, calculative action is organised according to principles of budgeting such as participation, simplicity of objectives, and conservatism. The principle of participation organises calculative action by requiring scientists and incubator CEOs to list, cost and prioritize R&D activities and to agree on the percentage of such activities to be approved in the final budget. Such percentage embeds the principle of conservatism in that it is based on historical rates, i.e. financial attrition rate. This means that the managerial space of possibilities, which is expressed by the R&D activities they wish to undertake in the course of a project, is influenced by the principle of conservatism by means of the financial attrition device.

Furthermore, the quality frame is characterized by a distinctive choice of metrics such as the number of IP-related businesses, which is the number of incubator tenants owning intellectual properties (e.g. patents), and the number of proof of concepts, which represents the number of drugs that have successfully passed Phase I and IIa (see Figure 4.1 in Chapter 4) of development (i.e. drugs have passed safety, dosage, efficacy, and side effects tests). Both metrics encapsulate the budgeting principles of simplicity in setting objectives, since they are the lead indicators used to measure the *quality of the scientific environment* within incubators.

Overall, the role of accounting within the quality frame consists in providing the principles, i.e. principles of budgeting, which distribute and organize calculative action within and across arrangements. Accounting also provides the devices, i.e. budgets, wish lists, and financial attrition, through which calculative action is performed. Finally, accounting provides the metrics, i.e. number of IP-related companies and number of proof of concepts, which inscribe the idea of a *high quality scientific environment*.

#### *Controlling innovation and the investment valuation frame*

Controlling innovation is discussed in this section by analysing the action of assessing the commercial value of early stage drugs that arise from university and industry (see Chapter 4). The section sheds light on valuation devices by analysing them from their capacity to act and influence courses of action. To this aim, valuation processes are conceptualised here as forms of *distributed* action. This means that valuation is performed by a variety of entities ranging from R&D costs estimates to the time value of money principle. Such entities span across different arenas and go beyond the organisation or the individual ‘formally’ responsible for enacting the valuation. Entities such R&D costs estimates and success rates, which are drawn upon in order to perform

the valuation, are located in the arena of health economics, hence ‘outside’ the boundaries of the organisation performing the valuation.

The findings suggest the existence of a pattern in the mechanisms for organising the action of assessing the potential commercial value of drugs. Such pattern, i.e. the investment valuation frame, is observable in the interactions occurring between a finance principle, i.e. time value of money, and a non-accounting device, i.e. the drug discovery and development chain. The section will present the findings related to the investment valuation frame by discussing what constitutes source of action within such frame and the content of such action, i.e. the extent to which action is calculative and distributed.

The modalities for attributing action within the investment valuation frame are distributed across different entities. The time value of money principle and the drug discovery and development chain jointly organize calculative action, i.e. the assessment of the future commercial value of a drug. The time value of money principle states that a certain amount of money at the present time is worth more than the same amount in the future due to its earning capacity. In the context of pharmaceutical innovation, such future is structured into phases of drug discovery and development (see Figures 4.1 and 4.2 in Chapter 4) from preclinical till the launch in the market. Time value of money and drug discovery and development stages are both embedded in the discounted cash flow (DCF) formula according to modalities that will be discussed in section 7.4. Of relevance here is the fact that, while estimating the value of drugs, the DCF device organizes the distribution of financial and non-financial resources across the drug discovery and development chain. For example, investors will enter and exit arrangements (i.e. rounds of investment) on the basis of DCF estimates for a specific drug. To be sure, while qualifying a drug by its potential commercial value, the DCF device has the effect of influencing the regime of circulation for that drug. The regime of circulation is represented by the rounds of funding and the number of public and private investors that the developmental drug mobilizes, in virtue of the DCF estimate.

Overall, accounting performs the investment valuation frame by embedding into the DCF formula (see section 7.4 for a more detailed discussion) the entities responsible for organizing action, i.e. time value of money and drug discovery and development chain. Accounting, through the DCF formula, plays also the role of mediating the exchanges between financial resources and developmental drugs.

The findings presented so far reveal, first of all, how controlling innovation involves multiple calculative actions, such as monitoring, assessing, budgeting, and financial modelling. They are calculative because they involve tasks such as listing possible states of the world, prioritizing them, and making decisions about the actions to undertake in order to realize those states of the world (Callon 1998c, p. 4).

Second, as evidenced in the section, controlling innovation is a distributed type of action because it spreads across human entities such as managers, directors, and scientists, and non-human entities such as accounting and non-accounting devices and principles.

Third, the findings show that the forms of economic agency implicated in controlling innovation have a collective nature. This holds particularly true in the cases of collective agencies such as ERDF, HEIF, REF, and incubators' financial models. This means that the arrangements mobilized within ERDF, HEIF, etc. perform calculative action collectively. Although specific arrangements might attribute specific responsibilities for calculative action to individuals (e.g. a budget holder), action is ultimately performed collectively, i.e. by a multitude of entities.

Fourth, the architecture of economic agencies of innovation is highly contingent. This means that agencies differ in the type of entities, in the interactions occurring between them, and also in the mechanisms for attributing action. The findings show how such mechanisms can lie in a set of principles, or in accounting devices, or yet in the combination of both.

Fifth, the findings suggest that different arrangements can also share the same mechanisms for attributing action. To account for such regularities in the mechanisms for organising calculative action, the arrangements composing ERDF, HEIF, REF, incubator financial models, and R&D budgets, and DCF agencies have been grouped according to different calculative frames, i.e. public intervention, financial sustainability, innovation, and investment valuation. The concept of calculative frames is advanced to denote a pattern in how action is distributed within arrangements. The evidence shows how the principles of management by objectives, market failure, and the input-output framework are central to the distribution of action within the public intervention frame. While the principle of financial sustainability and the finance model device play a central role in the distribution of action within the financial sustainability frame. And again, the principle of time value of money and the representation of the

stages of drug discovery are central to the attribution of action within the investment valuation frame.

As Callon stated, the notion of socio-technical agencement leaves the characterization of agency open, because agency can only be observed in the circumstances of action (Callon 2008). The section so far contributed to characterizing the calculative agencies of innovation by analysing their source and content. The next section will contribute to characterizing the economic agency of innovation in terms of the effects it produces. More specifically, the effects of the interactions between the calculative frames hitherto discussed will be analysed in the context of the economic exchange between money (i.e. public and private funding) and value(s).

### 7.1.2 The consequences of controlling innovation

“Fixing a price is always the outcome of a struggle between agencies trying to impose their modes for measuring a good's value and qualities”

(Stark (2009) as cited in Çalışkan and Callon 2010, p. 16)

This section aims to contribute to our understanding of the economic agencies of innovation by identifying and categorizing the *effects* of the interactions between the entities involved in controlling innovation. It is in fact by investigating the effects of interactions between the economic entities listed in table 7.1 that we can understand the role of accounting metrics in creating goods and services (e.g. innovative incubation projects, innovative scientific projects, etc.) that can be exchanged in the economy. The effects of interaction between entities are here conceptualized in terms of the tensions that arise between different calculative frames (i.e. inter-frame) and tensions that occur within the same frame (i.e. intra-frame).

While the majority of tensions found in this study occurs in the context of the exchange of public financial resources (in the form of performance-based grants allocated by public bodies, or EU regional development funding) for value, a significant source of variation within such exchanges was found in the type of value that was being negotiated. The type of exchange where public financial resources are exchanged for value reminds of the expression "value for money". Often used in public sector context, "good value for money" is defined as the optimal use of resources to achieve the intended outcome (NAO, 2015).

In order to understand what counts as value in the context of innovation, the next sections will show how innovation has a set of different repertoires, i.e. frames, for constructing value for money. While observing frames to overlap in the exchange of value for money, the next sections will account for the tensions arising in the negotiation of different versions of value. As summarized in Table 7.2, there are four types of tension emerging from the empirical cases and these can be divided into tensions between different calculative frames (i.e. financial sustainability frame versus public intervention frame, quality frame versus financial sustainability frame) and tensions emerging within the same frame (i.e. licensing versus spinning out, commercializing versus publishing scientific research).

**Table 7.2: The consequences of controlling innovation**

TYPE OF EXCHANGE	CALCULATIVE FRAMES	TYPE OF TENSION	TYPES OF VALUE	ROLE OF ACCOUNTING
Value for public money	Financial sustainability frame versus public intervention frame	Inter-frame	Value as n. of jobs and companies created versus value as profitability	Accounting mediates the tension through breakeven target
	Public intervention frame: commercializing research versus publishing research	Intra-frame	Value as n. of publications versus value as n. of spin-outs, n. of invention disclosures and income (£) from licensing	Accounting embeds the tension through the weighted average formula funding
	Public intervention frame: licensing technologies versus start-up creation	Intra-frame	Value measured in terms of n. of start-ups created versus value measured as n. of licenses	Accounting dissolves the tension at governmental agencies level
Value for public and private money	Quality frame versus financial sustainability frame	Inter-frame	Value as n. of patents versus value as profitability	Embedding the tension between frames by means of a ratio (the IP/CRO ratio)

*Tensions between financial sustainability and public intervention frames*

The first type of tension to be evidenced emerges from the interaction between the financial sustainability frame and the public intervention frame. The effects of such interaction are mostly visible at the level of metrics mobilised within each arrangement.



To assess the value of a project (e.g. technology incubation) means listing its properties and assigning a value to them.

The public intervention frame (i.e. ERDF, HEIF) qualifies incubation programmes by providing a version of their value that is based on new jobs created and on new companies created and assisted. This version of value is one that qualifies the incubator in terms of the effect that this can have on the economy and society.

The form of value arising from the financial sustainability frame, instead, is based on profitability measures. Therefore, the financial sustainability frame (i.e. incubators' financial models) qualifies innovation projects in terms of categories of costs, revenues, and profits, hence in monetary terms.

The findings points to the existence of a form of interaction between the financial sustainability and the public intervention frame that mainly occurs within organizational sites. This means that such type of interaction does not operate only at level of principles, i.e. addressing a market failure through public intervention on the one hand and making profits on the other hand. Rather, this tension occurs between sets of arrangements which can potentially lead to two different types of exchange: public money for (the evidence of) new jobs/new companies on the one hand, and public money for (the evidence of) profits, on the other hand. The empirical evidence suggests that the breakeven indicator is called upon in order to mediate between the construction of value as profitability and the construction of value as new jobs and new companies creation. This means that, while jobs and companies creation remains the dominant form of value, parties agree on breakeven indicator (instead of profits) as an additional form of value to be mobilised in the exchange. The role of accounting metrics here seems to be one of mediating between two types of arrangements, i.e. financial sustainability and public intervention, which emerged in the exchange of value for public money.

#### *Tensions within the public intervention frame*

While remaining within the context of the exchange of public money for value, the findings point to two types of tension deriving from controlling innovation. These are the tension between commercializing and publishing academic research, and the tension between licensing and spinning-out academic research. Compared to the tensions analysed so far, these originate *within* the frame of public intervention.

The tension between publishing and commercializing academic research is mostly visible in the context of the formula-based funding (see Chapter 5). In this case, the formula-based funding (used in HEIF, RAE 2008, and REF2014), by linking research and commercialization performances to the allocation of funding creates a number of effects. First, the 65% and 20% weights attributed by REF 2014 (70%-20% in RAE 2008) to research outcome (i.e. academic publishing) and research impact (i.e. research commercialization) embed, at governmental level, the political tension toward equating purely academic research with applied research carried out with industry, without solving it. Second, the same system of weights contributes to performing, unintendedly, localized tension (i.e. within each university) between publishing and commercializing paths.

According to a fairly recent study (PACEC-CBR 2010), there has been a significant change between 2001 and 2008 in the perception that academics have of the importance of publications for their career, paralleled by a starker change in their perception of the importance of commercialization activities for their career (see Table A-3, Appendix 3).

However, the emphasis on research commercialization has not been paralleled by a change in the criteria for academic excellence (i.e. high quality publications), with the consequence that collaborating with industry while maintaining a high level of scientific publication adds further pressure on individual academics (#29- Licensing executive).

The findings show that there exists a second tension which occurs within the public intervention frame. Such tension occurs between licensing and spinning-out the technologies arising from universities emerges in the context of the exchange of value for public funding (i.e. funds from the Higher Education Funding Bodies). The tension here is between two versions of value that arise within the same frame: value as number of spin-outs created and value as number of licenses created. How do multiple versions of value come to interact within the same frame? As showed earlier, controlling innovation is a form of action that is distributed across multiple entities. In this case REF and HEIF agencies on the one hand and local government agencies on the other hand translate the principle of public intervention into different forms of value. In short, the effects of public intervention are evidenced according to different modalities.

The findings suggest that the impact that licensing has on regional economies do not carry the same weight as the impact that the creation of new companies and new jobs has on regional economies. Although within governmental/regulatory agencies such as REF and HEIF regulatory texts, licensing and spinning-out a technology carry the same

weight (i.e. 20% and 100% respectively), within agencies such as local councils/governments and university there lies a tension between licensing and spinning-out. The source of such tension lies in the fact that while a license can go “anywhere in the world” (#21 –Licensing executive), the benefit that the regional economies can gain from new jobs and companies is more straightforward to prove – or so the argument goes. Therefore, the choice of creating spin-outs seems more appealing to local government agencies (and regional development agencies), which traditionally have had a strong public intervention remit, i.e. the development of regional and local economies by addressing market failures.

#### *Tensions between the financial sustainability frame and the quality frame*

A fourth type of interaction, evidenced in the empirics, occurs between the quality and the financial sustainability frames. Compared to the interactions considered so far this one occurs in the context of the exchange of both public and private funding for value. The quality frame is encapsulated in the percentage of tenants that has developed or is in the process of developing intellectual property (IPs). The financial sustainability frame is instead inscribed in the percentage of Contract Research Organisations (CROs) tenants.

The two targets are combined in one ratio, the IPs/CROs ratio. The ratio, negotiated and agreed at board level, inscribed the two different ways of framing incubation, that is incubation as a financially sustainable business and incubation as high quality scientific environment. The ratio contributes to mediate the tension between the two frames by creating a space where negotiation can take place. The IPs/CROs ratio ‘temporarily’ solves the tension between the two different frames by creating a space where different notions of value, i.e. value as profitability and value as intellectual properties, can be represented and negotiated.

In conclusion, the action of controlling innovation can be better understood if put in the context of exchanges of financial resources for value. As emphasized in the opening quote, it is in the context of exchange that tensions between different modes of realizing value arise. Since different versions of value inscribe different sets of arrangements, understanding the origins of value implies understanding such arrangements. The evidence discussed in this chapter suggests that accounting plays multiple roles in the negotiation of different versions of value of innovation, i.e. accounting metrics *inscribe* arrangements, accounting devices *configure* arrangements, accounting devices give

voice and *rights of experimentation* to the parties involved in an exchange, and finally accounting allows a type of exchange in which what circulates is not the underlying object (e.g. jobs, intellectual properties, new companies, etc.) but their value. Let us discuss each of these accounting roles.

First, by inscribing sets of arrangements such as those categorized in table 7.1 (public intervention, financial sustainability, investment, and innovation) accounting metrics make it possible to translate into numbers the complex arrangements between economic, managerial and accounting devices, principles, and human entities. Once inscribed into metrics, such configurations need not to be re-opened unless controversies arise.

Second, accounting provides the material basis for the economic exchange to take place by configuring the economic agencies participating in the exchange. As discussed earlier, the evidence shows that discounted cash flow device configures economic agencies within the investment frame; the input-output indicators and the management by objectives principle configure agencies within the public intervention frame; and yet the principle of financial sustainability and the financial model device configure agencies within the financial sustainability frame.

Third, accounting is not neutral to the process of realizing value, for accounting can either give or deny voice and rights of experimentation to those participating in the action. As a consequence, those entities that cannot, or are unwilling to, qualify a scientific project in terms of economic value, find themselves in a position of weakness. The lack of an inclusive mechanism for negotiating different versions of value is possibly the main cause (together with the lack of equipment for calculating value) of the rise of positions of dominance in the context of economic exchanges.

Finally, accounting metrics make it possible a type of exchange where the agent who provides the financial resources does not claim property rights on the object, but claims instead rights on the value of the object. In simpler terms, government is unlikely to claim property rights over the companies created or assisted by those university incubators that received government funding. Nevertheless, government is likely to claim that jobs have been created and technologies have been licensed as a result of public funding. In this respect, accounting metrics allow operating a separation between the property of the underlying object and the value of that object.

The chapter has so far addressed the following questions: how is the action of controlling innovation performed and with what consequences? The findings suggest

that the governance of innovation as a social and technical phenomenon is enacted in the form of *collective* and *distributed* action oriented toward *realising* the multiple values of innovation (i.e. value as job creation, value as scientific publishing, value as profitability, value as start-up creation, and value as patenting and licensing technologies) and with the ultimate effect of constructing economic markets for innovation.

However, this is one side of the coin, for the puzzle addressed in the thesis title, i.e. “controlling innovation, innovating control”, also questioned whether accounting needed to change/innovate its tools in order to control innovation. The chapter so far has showed how accounting metrics and devices play multiple roles in the action of controlling innovation, from inscribing complex nexus of arrangements into simple metrics to providing the tools for negotiating conflicts and tensions. However, to what extent are such metrics and devices ‘new’? The next section will address this question by exploring the properties of accounting tools that make them adapt rather than change to new accounting rationales (i.e. innovation).

## 7.2 Innovating control

Arguably, the types of accounting devices emerging from the analysis of the forms of economic action in the field of innovation can hardly be regarded as new to the accounting discipline and practice. Most of the accounting devices mobilized within each calculative frame, i.e. budgets, wish lists, performance indicators, and discounted cash flow technique might well be classed as traditional accounting tools. Nevertheless, a more careful analysis of how these devices interact with other (economic and non-economic) tools and with actors who deploy them, suggests that accounting tools possess intrinsic properties that make them *adapt* to new accounting rationales, such as the innovation rationale. Therefore, controlling innovation seems to be performed not by new accounting devices, but by a ‘bricolage’ of traditional accounting devices and other non-accounting tools.

While evidencing this point, the remainder of the section contributes to expanding Çalışkan and Callon’s argument according to which: “[V]aluation is no longer the effects of structures or regimes, which affect the value through (passive) intermediaries, but it is a consequence of how competent and active people engage with specific things” (Çalışkan and Callon 2009, p. 22). The thesis shows that not only is valuing innovation

performed by competent and active people who engage with accounting devices, but valuing innovation is also made possible by distinctive properties of accounting devices. To prove this point, the section will discuss how accounting *adapts* to new environments because of its *fluid* and *combinable* characters.

#### *Discounted Cash Flow as a combinable device*

As the empirical evidence discussed in Chapter 4 showed, the discounted cash flow (DCF) is a technique often used in drug discovery and development to assess the commercial value of drugs and is regarded as a reliable and standard box valuation tool. The discounted cash flow technique, which is based on the notion of time value of money, allows to move in time the cash flows generated by an investment in order to produce an estimate of the present value of said investment. In drugs valuation the potential future cash flows generated by a drug are adjusted for the probability of success, which indicates the chances that a drug is finally launched in the market after passing all the development stages and being approved by the regulator.

As Figure 4.2 in Chapter 4 showed, the drug discovery and development stages are usually rationalised in terms of a phase-gate process that proceeds from pre-clinical to clinical phases (until regulatory approval and market launch). The probability of success is one of the components of DCF formula that is linked to the drug discovery process. R&D costs estimate is another one. Both probability of success and R&D cost increase or decrease according to the stage of drug discovery in which the valuation is carried out. As a consequence, the value of a drug estimated using the DCF formula increases depending on the phase in which the drug is being evaluated. The DCF technique links with the drug discovery and development chain via the success rate and R&D cost estimates components. The effect of such interaction is the production of value inflection points, which capture the change in the value of a drug across the stages of development. Furthermore, value inflection points translate the sequence of stages of drug discovery and development into a value chain.

Overall, the interaction between the DCF (i.e. an accounting device) and drug discovery and development process (a non-accounting device) through the rate of success and the R&D costs estimate is possible not only because of skilled and creative individuals who combine the two types of device. The interaction is also made possible because DCF components are combinable. Such property makes DCF formula adapt to

a context such as pharmaceutical innovation without modifying the structure of the formula.

*R&D budget, wish lists, and financial attrition as combinable devices*

The empirical evidence in Chapter 4 showed how financial attrition is an accounting categorization that is said to be often used in drug discovery and development. Financial attrition responds to the need of the organization to control underspends, which occur because of delays or failures in the delivery of the activities of R&D projects. Given the difficulty of pinpointing where such underspends would happen, the concept of financial attrition is created in order to explain those variances caused by failures and delays in carrying out drug discovery projects. Far from being new, financial attrition is linked to the practice of applying slippage allowances in capital projects planning.

Similarly to financial attrition, the concept of slippage in capital projects planning indicates that a spending will be incurred on the final delivery of the project (for projects which extend over a number of years), but will be delayed beyond the current financial year. Financial attrition seems to be the outcome of a re-labelling of the concept of slippage allowance.

Compared to the term slippage, financial attrition recalls the term drug attrition often used in drug discovery and development to indicate the rate of those drugs failing to move from one development stage to the next. Such operation of re-labelling operates at a more aesthetic level and does not change practically and conceptually the already existing slippage allowance category. In this case, the adaptation of an existing accounting categorization, i.e. slippage allowance, to the environment of drug discovery and development where the term (drug) attrition is widely used, consists more in changing the vocabulary without modifying the underlying practice.

Furthermore, financial attrition proves to be a combinable tool when used in conjunction with budgetary devices such as wish lists (see Chapter 4). The wish list device works in such a way that every time a R&D activity is cancelled or delayed, a new activity goes up in the priorities so that the gap between the total cost of the wish list and the approved budget decreases. The gap between the total cost of all the R&D activities in the wish list and the approved budget is set according to the rate of financial attrition. When financial attrition is combined with wish lists the effect is to create the appearance of a centralised control over the uncertainties of the R&D process while

granting autonomy to budget holders, who can draw wish lists and assign priorities to R&D activities.

As in the case of DCF, the cases of financial attrition and wish lists show how the interaction between devices is made possible not only by human entities (e.g. finance directors, scientists) who use their skills, creativity and past experience to combine different devices. The findings suggest that said interactions occur also because of the combinable properties of financial attrition. But what makes financial attrition a combinable tool? Let us consider the sequence of actions that leads to the total approved budget: re-labelling slippage allowances into financial attrition, calculating historical financial attrition rate, listing R&D activities required to complete a project, applying financial attrition rate to total costs of (wished-for) R&D activities. The combinability of financial attrition rate lies in the fact it summarises the whole history of slippages into a single figure (a percentage) that can be applied to future costs in order to determine the approved budget figure.

#### *Performance Indicators as fluid and combinable devices*

Performance indicators continuously adapt to notions of ‘performances’ which are contingent to the environment in which they operate. The remainder will discuss how the performance indicators mobilised within each calculative frame (see table 7.1) adapt to the innovation rationale.

The main performance indicator mobilised within the financial sustainability frame is profitability. While normally the profitability of a business is measured in terms of the amount of profits and revenues generated through time, in the early stage of drugs development process, given the absence of revenue streams, profitability is judged against the ability of the project to attract rounds of funding, the amount of such funding, the value of the potential market for the drug, or the intellectual property that the project has generated (or could potentially generate). According to de Laet and Mol (2000) a device is fluid when its boundaries are not “solid” but adapt to the environment in which it operates by including “variants” (de Laet and Mol 2000) taken from that environment. Measures of profitability in drug discovery depart from the notion of profitability as profits/revenues and experiment with other forms of profitability such as the amount of external investments raised. For early stage projects the ability of raising funds, whether public or private, is vital for the development of a drug or technology. Reliance on external public and private funding is therefore a central characteristic of



the drug discovery environment and constitutes a variant that is included in profitability performance indicators.

The performance indicators often mobilised within the public intervention frame are the input and output indicators. Input-output indicators emerge from the interaction between two types of device: an accounting device, i.e. performance indicators, and a non-accounting device, i.e. the input-output framework. The input-output categorization provides a rationale for organizing the measurement of performances. The input-output categorization organizes objects, e.g. academic research, according to a linear representation where outputs, outcomes, and impacts follow from inputs. Subsequently, performances are measured according to such linear representation. Therefore, performance indicators *combine* with other non-accounting tools such as the input-output representation of processes.

Performance indicators are combinable also in a sense of linking the same indicator to different narratives. This is evidenced by the input/output indicators used in the context of public intervention programmes such as ERDF, HEI, and REF. The findings here suggest that measures such as the number of new jobs and companies created indicate simultaneously the excellence of research, the degree of economic development brought about by a project, and innovation. The same can be said for measures such as the number of patents developed out of a project. Similarly, the number of patents is mobilized to measure the degree of inventiveness of an institution, to measure innovation, and yet to measure the quality of research. In these cases, the same performance measures become linked to different narratives (e.g. inventiveness, quality, etc.). What enables *combining* the same measure to different narratives is the ability of the measure to reduce the complexity of ERDF, HEIF, and REF arrangements to single numbers such that all the arrangements behind become black boxes and are opaque to those who stand outside such arrangements.

To conclude this section, the cases of innovation analysed in this thesis show little evidence in support of the “innovating control” hypothesis. Rather, the findings suggest that controlling innovation is not so much about innovating the devices for controlling as it is about *adapting* existing accounting concepts and devices to the innovation rationale. The evidence from the thesis suggests that accounting tools adapt to innovation rationale because of a number of properties they feature such as fluidity and combinability. Evidence of combinability is provided when accounting tools such as DCF, performance indicators, and financial attrition become linked to other accounting

and non-accounting devices (e.g. drug discovery and development chain, R&D budget and wish list, input-output framework), but still maintain their original components. Evidence of fluidity of accounting tools is provided when the same performance indicator (e.g. profitability) is measured differently depending on the environment where the indicator operates (e.g. external funds raised versus profits).

While discussing accounting properties, this section aimed to show that the interactions between the human entities and non-human entities (e.g. accounting tools) that compose a socio-technical agencement do not rely exclusively on actors' competences, creativity, and skills as Çalışkan and Callon argued (2009). Rather, the interactions between the entities of an agencement are also made possible by the fluid and combinable qualities of accounting.

The next chapter will summarise the findings and show how the thesis has contributed both theoretically and empirically to the study of innovation as a socio-technical phenomenon. The chapter will also clarify the role of critique in the context of this thesis and sketch avenues of future research.

# CONCLUSION

---

Over the past four decades, innovation has progressively taken centre stage in national economic and science policies and programmes, corporate strategies, universities' mission, and other domains of economic life. While *promoting* innovation, public and private economic agencies such as national and local governments, universities, corporations, and charities have become increasingly concerned with making innovation manageable, measurable, hence *controllable*. Evidence for this growing concern is provided by the spread of research assessment exercises that have characterised the domain of academic research in the UK from the 1980s and by the growing number of innovation and R&D statistics being collected through national and European surveys (e.g. the HE-CBI survey).

This thesis has addressed this double concern for *promoting* and *controlling* innovation by attending to the organisational and institutional domains where such concerns have been enacted and the involvement of accounting devices in such enactment. Changing government rationalities and the extensive programmes of privatizations initiated in the 1980s, also coupled with a growing attention of economic theory on issues of R&D productivity, have constructed university-business interrelations (and research commercialisation) as a laboratory where the British government has experimented with programmes for decentralising innovation, while exerting at a distance control.

In the attempt to research into the laboratory where innovation is assembled and configured as an economic actor, capable of changing not only economic landscapes but also managerial courses of action, the thesis has investigated and analysed the types of action and accounting devices that constitute innovation.

The following sections provide a summary of the main research findings and then proceed with discussing the research contribution and sketching out avenues of future research.

### *Summary of research findings*

This thesis sought to identify the multiple accounting and organisational practices that contribute to measuring, managing, and ultimately controlling innovation. The thesis has placed the analysis of how innovation is controlled through accounting within the larger issue of how economic agencies and economic action are configured, organised, distributed, and the role of accounting in these processes. While studying the interplays between accounting and innovation across three major sites of research commercialisation in the UK, namely technology transfer, technology incubation, and corporate R&D activities, a number of findings have emerged.

First, the thesis indicated that assembling, or configuring, innovation as an economic actor requires efforts that are *distributed* and *calculative*. The thesis showed that controlling innovation involves calculative action which is mainly *distributed* across accounting devices (e.g. Discounted Cash Flow, R&D budget, and input-output performance indicators), non-accounting devices, and human entities.

Second, the findings suggested there are patterns of regularity occurring in the mechanisms through which economic action within innovation is organized and distributed. These patterns, conceptualized as *calculative frames* (Beunza and Garud 2007) were the public intervention, financial sustainability, quality, and investment valuation frames. While observing calculative frames to overlap in the context of exchanges of value for money, the thesis accounted also for the tensions arising in the negotiation of different versions of value. The findings suggested that the roles of accounting were multiple, namely translating frames into different versions of value, embedding and mediating the tension between different versions of value.

Furthermore, the thesis showed that, while controlling innovation is enacted through a variety of accounting devices, the latter are not new to the accounting discipline and practice, but rather represent *adaptation* of traditional accounting tools to the innovation rationale. The thesis showed that the adaptation was made possible by accounting's fluid and combinable properties.

Overall, the thesis showed that configuring innovation as an economic actor and the actions of controlling innovation through accounting are intrinsically related. This is because to control innovation, in a sense of monitoring, assessing, budgeting for innovation, implies a process of qualifying the objects of action, e.g. a drug, a new technology, an incubation project. By qualifying these objects of innovation, hence attributing value to them, accounting devices are not neutral, but rather are involved in

translating innovation objects into goods or services that can circulate within an economy. Furthermore, by qualifying the objects of innovation, accounting makes the exchange of their value for money (e.g. public funding) possible. In short, accounting makes it possible the circulation not only of the object, but also of its value (e.g. almost like in financial derivatives).

### *Research contribution*

This study contributed to advance our knowledge of accounting and innovation both empirically and theoretically.

First, this thesis contributed to conceptualising innovation by detailing the economic agencies that constitute it. Despite the growing influence that innovation has had over the past decades on domains of economic and social life (i.e. economic policy, science policy, corporate strategies, university missions, charities missions), we still do not know what types of entity (accounting, non-accounting, human, non-human) give innovation the capacity to influence the courses of action of people and organisations. This thesis contributed to opening up the black box of innovation by identifying the roles that accounting devices and principles have in providing the content and sources of action in the realm of innovation. In so contributing to studies in accounting that looked at the constitutive power of accounting, that is the power of accounting instruments and ideas to constitute domains of economic life (Hopwood and Miller 1994; Miller and Power 2013). With regard to this thesis, the findings showed that principles of accounting, management and finance such as financial sustainability, budgeting, management by objectives, and time value of money, as well as accounting devices such as financial plans, R&D budgets, performance indicators, discounted cash flow formula are not to be seen as merely neutral devices. Rather, as evidenced in table 7.1, they provide the mechanisms through which calculative action is distributed and organised within the realm of innovation.

Second, the study contributed empirically to tracing the historical and political emergence of innovation and research commercialisation in the UK. Such historical tracing did not merely function as a historical background to the material presented in the thesis. Rather, it contributed to exploring the conditions of possibilities for changes in the modalities of controlling innovation that go beyond the domain of practices within which such changes are implemented. Following the claim put forward by Burchell et al. (1980) according to which the sources of accounting change are usually

distant from the domain of practices where said changes are observed, the thesis attended to the historical and political contexts of innovation and to the contingent forces that gave rise to discourses of research commercialisation in the UK. In this respect, the thesis contributed historically to our understanding of the conditions that led to the explosion of calculative practices aimed at controlling innovation. It did so by showing that a progressive shift in the principles for governing the allocation of public funding to science (e.g. the 1971 Rothschild contractor-customer principle) together with regimes of increased accountability created the conditions for the spread of instruments of control such as research assessments (e.g. REF 2014, RAE).

Third, from an empirical point of view this study contributed to the performativity programme in social studies of science, and more specifically to the study of economic action and economic agency (Callon and Muniesa 2005; Callon 1998c), by identifying the content of action and the mechanisms through which action is organised and distributed within the arrangements of innovation. From an empirical point of view, it was found that controlling innovation involves a range of calculative actions, such as monitoring ERDF project, assessing the quality/excellence of research, assessing the commercial value of new drugs, financial modelling. It was also found that such actions are mostly collective and distributed in that, in order to be carried out, they require the collaboration among different entities. Furthermore, it was found that each form of action does not necessarily mobilise the same entities across different arrangements. For example, the action of monitoring a project funded through ERDF mobilises different entities than monitoring a R&D project within a corporate R&D unit. These findings resonate with the core objective of the performativity programme, which consists in recognizing and attending to the infinite ways of configuring calculative equipment and material devices (Çalışkan and Callon 2010). The thesis extended such literature by showing that differences in calculative equipment and frames can result into *tensions*, and do not just remain differences. In this respect, not only does accounting configure the economic agencies of innovation, but also has a role in creating, mediating, and dissolving tensions that emerge across and within sets of arrangements (see Chapter 7).

This research contributed to the study of *agencements* (Callon, 2005) also from a theoretical point of view by identifying and conceptualizing *patterns of regularity* in the mechanisms through which calculative action is distributed and organized across arrangements. As discussed in the previous chapters, the concept of *calculative frames* has been mobilised to account for such regularities. Originally developed by Beunza

and Garud (2007), the concept of calculative frames was advanced to account for the regularities in the interactions between the categories, analogies, and key metrics used by financial analysts. In line with Beunza and Garud's work, the concept of calculative frame deployed in the thesis aims to capture regularities/patterns. However, compared to Beunza and Garud, the pattern of regularity is found in the sources or mechanisms for attributing action within a set of given arrangements. In this respect, the thesis showed how financial sustainability, public intervention, investment valuation, and quality frames group different arrangements according to a distinctive mechanism that organizes action. Such mechanisms vary across frame and usually consist in stable sets of relation between accounting devices and accounting principles. This finding, that is the existence of pattern of regularities across arrangements, represents a contribution toward bridging the performativity programme (and its search for multiplicities and differences) toward the new institutional theory's concern for *isomorphism*.

Finally, this study contributed to the existing body of work in accounting which conceptualises accounting as being multiple and fluid (Andon, Baxter, and Chua 2007), combinable, immutable, and mobile (Robson 1992), by showing that it is also because of accounting properties such as *fluidity* and *combinability*, that the interactions between the entities of innovation are made possible. With regard to this, Chapter 7 has discussed how the interactions between the principle of time value of money and the drug discovery and development chain could take place because of the combinable property of discounted cash flow formula. The same can be said of the input-output framework and the combinable property of accounting instruments such as performance indicators. By showing how accounting and non-accounting devices interact and how such interactions are made possible by accounting properties, this thesis contributed to extend Çalışkan and Callon's argument (2009) according to which valuation follows from the interaction between "competent and active people" (Ibid., p. 22) and things. To be sure, the thesis extended Çalışkan and Callon's argument in that it showed the not only the qualities of individuals (i.e. competent, active, creative) matter, but also the qualities of devices are central too to the process of valuating innovation.

Overall, this research was not a comparative study for it did not compare different accounting practices and benchmark one against the other. Nor did it assess the strength and weaknesses of specific accounting tools. What this study did instead was to identify and analyse the entanglements between innovation, as a phenomenon, and the economy by attending to the role that accounting plays in economizing innovation. Where

economizing meant, in the context of this thesis, to translate the entities of innovation (e.g. technologies, incubation projects, new scientific ideas, new drugs, etc.) into *economic* entities which possess economic value(s), that is into entities that can *circulate* and be *exchanged* within the economy precisely because of that economic value(s).

What this study did not do either was to follow a specific technology (e.g. a new molecular entity, a new drug) from discovery to launch into the market. Nor did it attend to the ways in which technical and economic considerations shape a specific technology throughout the different stages of development. Differently, this study focused on the enactment of innovation as a socio-technical phenomenon and how this enactment takes place through a network of interactions between accounting devices and principles, and human entities.

#### *Research implications and the role of critique*

In terms of research implications, the type of critique advanced in this thesis is in line with the idea of “experimental critique” put forward by Muniesa (2014) and Callon (2005):

“Talking of the performativity of economics [...] also means that the role of critique is limited to clarifying differences and local asymmetries in order to raise the open question of experimentation with new forms of organization” (Callon 2005, p. 3)

In the context of this study, “clarifying differences” in the ways of valuing innovation entailed tracing their origins and consequences. As a result of this tracing, there emerged a number of unintended and sometimes paradoxical effects of calculating innovation, such as the tensions between publishing and commercialising research.

As discussed in the case of IPs/CROs<sup>12</sup> ratio and in the case of REF2014 and HEIF<sup>13</sup>, ratios and weighting mechanisms constitute calculative spaces where different calculative frames confront and compete with each other. However, ratios and formulas are hardly complete and this is because not all the entities involved in the action (of controlling innovation) are equipped with tools that enable them to translate their

---

<sup>12</sup> As discussed in Chapter 4 in the context of Incubator#1, IPs/CROs ratio refers to the percentage of Intellectual Property related tenants as opposed to the percentage of Contract Research Organisations type of tenants.

<sup>13</sup> As discussed in Chapter 5, REF2014 refers to the Research Excellence Framework 2014. While HEIF refers to the Higher Education Innovation Fund.



frames into numbers. In this respect, the thesis showed that accounting is not neutral to the process of realizing value, for accounting can either give or not voice to and rights of experimentation to those participating in the action. As a consequence, those entities that cannot, or are unwilling to, qualify a scientific project in terms of economic value, find themselves in a position of weakness. The lack of an inclusive mechanism for negotiating different versions of value is possibly the main cause (together with the lack of equipment for calculating value) of the rise of positions of dominance in the context of economic exchanges.

At the same time, creating calculative spaces (e.g. ratios and weighted average formulas) where different actors can give voice to and negotiate their interests do not necessarily sweep tensions away. The findings showed that ratios and weighted average formulas *crystallized* or *embedded* tensions into a participatory valuation process that did not, however, dissolve the tensions. Let us take, for example, REF2014 and the weights attributed to research outcome (measured in terms of publications) and research impact (measured also in terms of research commercialisation initiatives). The thesis showed that the emphasis on research commercialization has not been paralleled by a change in the criteria for academic excellence (i.e. high quality publications), with the consequence that collaborating with industry while maintaining a high level of scientific publication adds further pressure on individual academics (#29- Licensing executive).

#### *Sketches for future research*

A possible avenue for future research will be in the direction of contributing to the debate on performativity. Since the performativity programme “*starts with an ethnography of socio- technical agencements*”(Callon 2005, p. 5), this thesis contributed to tracing the socio-technical agencements of innovation, that is the arrangements of accounting and non-accounting devices, people, accounting principles, and metrics. The thesis contributed to identifying the role and effects of accounting in the process of configuring such economic agencies. While innovation has come to be seen as a central actor of national economies since the second half of 20<sup>th</sup> century, little is known on how its capacity to act and influence the courses of action of governments, corporations, universities and so on has been configured through time, and the role of accounting in such process. One of the virtues of this thesis was in that it attempted to address such gap both empirically and theoretically (e.g. calculative frames).

Nevertheless, this thesis did not address fully the debate on the performativity of economics (MacKenzie, Muniesa, and Siu 2007) , that is the idea that financial models, accounting tools and techniques “do not create the object[s] to which [they] refer *ex nihilo*” (Callon 2007, p. 327), but have to make them happen. This means that models and tools “can be made to work if their corresponding agencement can be constructed” (Hardie and MacKenzie 2007, p. 59). Therefore, future work will be in a sense of further interpreting the empirical material in order to discuss more fully in detail the issue of how accounting devices and models, and calculative frames have *performed* innovation as a socio-technical phenomenon.

Furthermore, future avenues of research could develop in the direction of exploring the interplay between social, technical, and economic forces in the shaping of a specific drug throughout the stages of discovery and development. This type of enquiry would entail the analysis of the interrelations between the State and the corporation in the making of a technology, and the impact of *reimbursement* (mentioned in Chapter 4) considerations into the early stage development of a technology. Another possible avenue of research could focus on open innovation and the role of accounting in constructing the idea of “openness”. Portals, forums and other platforms built to exchange open access technologies and yet unexploited intellectual properties in biotechnology and life sciences seem to be a growing phenomenon. The role of accounting in creating ‘virtual’ marketplaces where the economic value of openness is made visible seems an interesting topic for future investigation.

# APPENDICES

---

# Appendix 1

**Table A- 1: Example of interview schedule**

<p>Interviewee: Licensing Executive Life Sciences, Financial &amp; Business Services</p> <p><i>Interviewee's background, expertise and role</i></p> <ol style="list-style-type: none"><li>1. What is your background? What is your area of expertise?</li><li>2. What is your job about?</li></ol> <p><i>University approach to research commercialization</i></p> <ol style="list-style-type: none"><li>3. How do the University go about in terms of IP/research commercialization?</li><li>4. How do you go about in terms of engaging academics/scientists in IPs?</li><li>5. How important is for the University to commercialize research?</li></ol> <p><i>The invention disclosure</i></p> <ol style="list-style-type: none"><li>6. Can you explain to me the content of the invention disclosure form?</li><li>7. Has the form changed through time?</li><li>8. How important is this form for the technology transfer office? And for the University?</li><li>9. What's the difference between publishing and protecting a scientific idea with IPs?</li><li>10. How do you make sure that academics/researchers do not publish before protecting their ideas?</li></ol> <p><i>Due diligence</i></p> <ol style="list-style-type: none"><li>11. What's next after an invention is disclosed?</li><li>12. What is usually evaluated during the due diligence? And how?</li><li>13. Can you give me an example?</li></ol> <p><i>Patent application</i></p> <ol style="list-style-type: none"><li>14. What are the costs involved in patent application?</li><li>15. What are the differences between an invention disclosure and a patent application?</li><li>16. What constitutes "high quality academic endeavor" and "excellent science"? How is this evaluated?</li></ol> <p><i>Interrelations with other bodies</i></p> <ol style="list-style-type: none"><li>17. What do the University expect from Innovation service division in terms of performances?</li><li>18. How important is [other local incubator] to the University?</li><li>19. How important is the local government for the university?</li></ol> <p><i>Defining Successful Technology Transfer</i></p> <ol style="list-style-type: none"><li>20. What makes a successful license agreement?</li></ol>
---

## Appendix 2

Table A- 2: Example of invention disclosure form

### CONFIDENTIAL

#### Disclosure Form

If you believe commercially valuable IP has arisen from your research or wish to secure an IP position before approaching an industrial sponsor for funding, please contact your School Business Development Officer or XXX in the IP team.

The Disclosure form will be presented at the University of XXX Commercialisation Panel for a decision on the commercialisation strategy and funding of patent costs if applicable. It may be useful to fill out this form as far as you are able prior to a first meeting.

<b>Inteum No:</b>	<i>To be completed by TTO</i>		
<b>Title of Disclosure:</b>			
<b>Date of Disclosure to TTO:</b>			
<b>Business Development Exec:</b>			
<b>Inventor(s) &amp; School/Division:</b>			
<b>Priority Group(s). Please tick one or more boxes as appropriate</b>			
<b>Biomedical Imaging</b>	<input type="checkbox"/>	<b>Global Food Security</b>	<input type="checkbox"/>
<b>Energy</b>	<input type="checkbox"/>	<b>Science, Technology and Society</b>	<input type="checkbox"/>
<b>Advanced Manufacturing</b>	<input type="checkbox"/>	<b>Aerospace</b>	<input type="checkbox"/>
<b>Clinical Translational Research</b>	<input type="checkbox"/>	<b>International</b>	<input type="checkbox"/>
<b>Drug Discovery</b>	<input type="checkbox"/>	<b>Operations in a Digital World</b>	<input type="checkbox"/>
<b>Integrating Global Society</b>	<input type="checkbox"/>	<b>Centre for Advanced Studies</b>	<input type="checkbox"/>
<b>Other Inventor(s):</b>			
<b>University/Sponsor/Jointly Owned:</b>			
<b>Details of Project Sponsor or current Funding:</b>			
<b>Nature of IP/Patent/Know-How:</b>			
<b>Has the Invention already been disclosed outside the University?:</b>			
<b>Date of Intended Disclosure/Publication, if any:</b>			
<b>Agreements in Place:</b>			
<b>Summary of Technology:</b>			

(continued)

**CONFIDENTIAL**

Disclosure Details:

--

**COMMERCIAL PROSPECTS**

*This section to be completed if a patent is to be filed*

<b>Route to Market:</b>	<input type="checkbox"/> Licence Agreement <input type="checkbox"/> R&D and Option Agreement <input type="checkbox"/> Formation of Spin-Out Company <input type="checkbox"/> Other – Please specify -----
<b>Further Funding Opportunities:</b>	<input type="checkbox"/> Lachesis <input type="checkbox"/> Research Councils (eg BBSRC Follow-on-Fund, SBRI) <input type="checkbox"/> EPSRC, MRC etc <input type="checkbox"/> TSB <input type="checkbox"/> Other – Please specify -----
<b>Current Stage of Development (eg. concept, reduced to practice):</b>	
<b>Companies to Approach:</b>	
<b>Competitors Identified:</b>	

	Name	Signature	Date
<b>Disclosure submitted by</b>			
<b>Inventor(s)*</b>			

(continued)

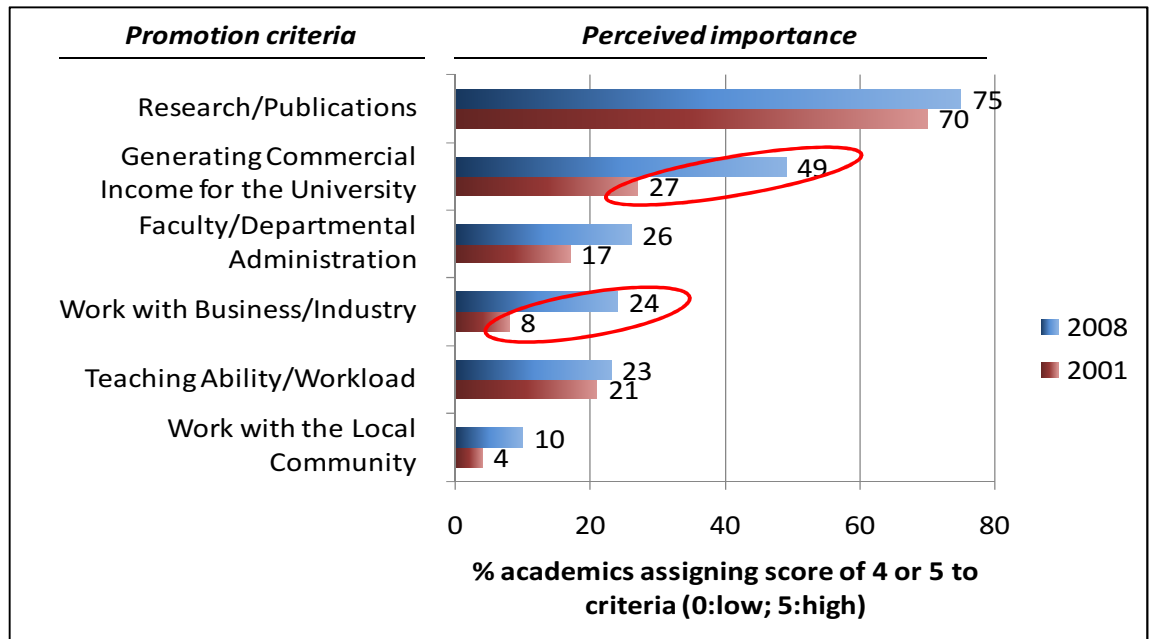
**CONFIDENTIAL**

<b>School/ Faculty agrees to cover 1/3 of costs of patent filing and maintenance</b>	<b>Yes</b>	<b>No</b>	<b>School/ Faculty authorised signatory</b>		
			<b>Name</b>	<b>Signature</b>	
<b>Agreement required with other inventor(s)</b>			<b>BDE/ Licensing Executive</b>		
			<b>Name</b>	<b>Signature</b>	

**\* We voluntarily and mutually agree that we believe the inventors listed above are joint inventors of the invention which is the subject of this disclosure.**

# Appendix 3

Table A- 3: Criteria perceived by academics to be important for academic promotion



Source: (PACEC-CBR 2010, p. 8)



## Appendix 4

**Table A- 4: Example of capitalisation table**

Misc Inputs and Outputs				
Effective Pre-Money		Share Price		
Pre-Money		Post-Money Pool		
Post-Money		Debt Discount		
Series A Cap Table				
	Investment	Shares	Ownership	
Series A Investor 1				
Series A Investor 2				
Total Series A				
Lender 1				
Lender 2				
Total Seed Debt				
Common Stock and Pre-Money Options				
Post-Money Options				
<b>Total</b>				
Summary				
	Pre-Money	Post-Money	Share Value	Exit Value
Founders				
Preferred				
All Options				

Source: adapted from <http://venturehacks.com/articles/cap-table>

# BIBLIOGRAPHY

---

- Abernethy, M.A., and P. Brownell. 1997. Management control systems in research and development organizations: The role of accounting, behavior and personnel controls. *Accounting, Organizations and Society* 22 (3–4):233-248.
- Addison, P., and H. Jones. 2008. *A Companion to Contemporary Britain: 1939-2000, Blackwell Companions to British History*: Wiley.
- Adler, P., and C.X. Chen. 2011. Combining creativity and control: Understanding individual motivation in large-scale collaborative creativity. *Accounting, Organizations and Society* 36 (2011):63-85.
- Aghion, P., and P. Howitt. 1992. A Model of Growth Through Creative Destruction. *Econometrica* 60 (2):323-351.
- Alasuutari, P. 2000. *Researching Culture: Qualitative Method and Cultural Studies*. London: Sage Publisher.
- Alvesson, M. 2010. *Interpreting Interviews*: SAGE Publications.
- Andon, P., J. Baxter, and W.F. Chua. 2007. Accounting change as relational drifting: A field study of experiments with performance measurement. *Management Accounting Research* 18 (2):273-308.
- Bache, I. 2008. *Europeanization and Multilevel Governance: Cohesion Policy in the European Union and Britain, G - Reference, Information and Interdisciplinary Subjects Series*: Rowman & Littlefield.
- Barretta, A., and C. Busco. 2011. Technologies of government in public sector's networks: In search of cooperation through management control innovations. *Management Accounting Research* 22 (4):211-219.
- Beunza, D., and R. Garud. 2007. Calculators, lemmings or frame-makers? The intermediary role of securities analysts. In *Market Devices*, edited by M. Callon, Y. Millo and F. Muniesa: Blackwell Publishing
- Brey, P. 1997. Philosophy of Technology meets Social Constructivism. *Techne': Journal of the Society for Philosophy and Technology* 2 (3&4 ): 56–79.

- Briers, M., and W.F. Chua. 2001. The role of actor-networks and boundary objects in management accounting change: a field study of an implementation of activity-based costing. *Accounting, Organization and Society* 26:237-69.
- Broadberry, S., and M. O'Mahony. 2007. Britain's Twentieth-Century Productivity Performance in International Perspective. In *Work and Pay in 20th Century Britain*, edited by N. F. R. Crafts, I. Gazeley and A. Newell, pp. 301-329. Oxford: OUP
- BUFDG. 2014. *The Corporation Tax Treatment of UK Universities Guidance Note. Revised and agreed by HMRC June 2014*. 26 May 2015. <http://www.bufdg.ac.uk/>.
- Burchell, G., C. Clubb, A. Hopwood, J. Hughes, and J. Nahapiet. 1980. The Roles of Accounting in Organizations and Society. *Accounting, Organizations and Society* 5:5-27.
- Caglio, A., and A. Ditillo. 2008. A review and discussion of management control in inter-firm relationships: Achievements and future directions. *Accounting, Organizations and Society* 33 (7-8):865-898.
- Çalışkan, K., and M. Callon. 2009. Economization, part 1: shifting attention from the economy towards processes of economization. *Economy and Society* 38 (3):369-398.
- Çalışkan, K., and M. Callon. 2010. Economization, part 2: a research programme for the study of markets. *Economy and Society* 39 (1):1-32.
- Callon, M. 1986. Some elements of a sociology of translation: Domestication of the scallops and the fishermen of St Brieuc Bay. In *Power, Action and Belief: A New Sociology of Knowledge?*, edited by J. Law, London: Routledge and Keegan
- Callon, M. 1998a. An essay on framing and overflowing: economics externalities revised by sociology. In *The Laws of the Market*, Oxford: Blackwell
- Callon, M. 1998b. Introduction: The embeddedness of economic markets in economics. In *The Laws of the Markets*, edited by M. Callon, pp. 1-57. Oxford: Blackwell/The Sociological Review
- Callon, M. 1998c. *The Laws of the Markets*. Oxford: Blackwell/The Sociological Review.
- Callon, M. 2005. Why virtualism paves the way to political impotence. Callon replies to Miller. *Economic Sociology: European Electronic Newsletter* (2).

- Callon, M. 2007. What Does It Mean to Say That Economics Is Performative? . In *Do Economists Make Markets?: On the Performativity of Economics*, edited by D. A. MacKenzie, F. Muniesa and L. Siu: Princeton University Press
- Callon, M. 2008. Economic Markets and the Rise of Interactive Agencements: From Prosthetic Agencies to Habilitated Agencies. In *Living in a material world: economic sociology meets science and technology studies*, edited by T. J. Pinch and R. Swedberg, USA: MIT Press
- Callon, M., and B. Latour. 1981. Unscrewing the big Leviathan: how actors macro-structurereality and how sociologists help them to do so. In *Advances in social theory and methodology: Toward an integration of micro- and macro-sociologies*, edited by K. Knorr-Cetina and A. V. Cicourel, pp. 277-303. Boston, London and Henley: Routledge & Kegan Paul.
- Callon, M., and F. Muniesa. 2005. Economic Markets as Calculative Collective Devices. *Organization Studies* 26:1229-1250.
- Carruthers, B.G. 1995. Accounting, ambiguity, and the new institutionalism. *Accounting, Organizations and Society* 20 (4):313-328.
- Chancellor of the Duchy of Lancaster. 1993. *Realising Our Potential: a Strategy for Science, Engineering and Technology*. London.
- Chenhall, R.H. 2008. Accounting for the horizontal organization: A review essay. *Accounting, Organizations and Society* 33:517-550.
- Chesbrough, H. 2003. *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Boston: Harvard Business School Press.
- Chesbrough, H., W. Vanhaverbeke, and J. West. 2006. *Open Innovation: Researching a New Paradigm*: OUP Oxford.
- Christner, C.H., and T. Strömsten. 2015. Scientists, venture capitalists and the stock exchange: The mediating role of accounting in product innovation. *Management Accounting Research*.
- Clarke, A.E. 2003. Situational Analyses: Grounded Theory Mapping After the Postmodern Turn. *Symbolic Interaction* 26 (4):553-576.
- Coleman, G. 1987. Logical framework approach to the monitoring and evaluation of agricultural and rural development projects. *Project Appraisal* 2 (4):251-259.

- Collier, R. 2009. Drug development cost estimates hard to swallow. *CMAJ : Canadian Medical Association Journal* 180 (3):279-280.
- Colyvas, J.A. 2007. From divergent meanings to common practices: The early institutionalization of technology transfer in the life sciences at Stanford University. *Research Policy* 36 (4):456-476.
- Colyvas, J.A., and W.W. Powell. 2006. Roads to Institutionalization: the remaking of boundaries between public and private science. *Research in Organizational Behavior* 27:305-353.
- Connor, S. 1984. Whitehall wrangle holds up patent freedom. *New Scientist*, 29 November 1984, 72.
- Coyle, D. 1999. The Saturday Profile: Ed Balls, Treasury Adviser - Chancellor's Golden Boy. *The Independent*.
- Crafts, N. 1996. 'Post-neoclassical endogenous growth theory': what are its policy implications? *Oxford Review of Economic Policy* 12 (2):30-47.
- Crotty, M. 2003. *The Foundations of Social Research: Meaning and Perspective in the Research Process*. London: Sage Publications.
- Czarniawska, B. 1997. *Narrating the Organization: Dramas of Institutional Identity*. U.S.A.: University of Chicago Press.
- Czarniawska, B. 1997. *Narrating the Organization: Dramas of Institutional Identity, New Practices of Inquiry*: University of Chicago Press.
- Czarniawska, B. 2004. *Narratives in Social Science Research, Introducing Qualitative Methods series*: SAGE Publications.
- Czarniawska-Joerges, B., and G. Sevón. 1996. *Translating Organizational Change, De Gruyter studies in organization*: Walter de Gruyter.
- Dahlander, L., and D.M. Gann. 2010. How open is innovation? *Research Policy* 39 (6):699-709.
- Davila, A. 2010. Thoughts on the structure of management systems to encourage creativity and innovation. In *Performance Measurement and Management Control: Innovative Concepts and Practices*, edited by M. Epstein, M. J. and A. Davila, Bingley: Emerald
- Davila, A., and A. Ditillo. 2013. *Convergent Creativity and Management Control Systems: Managing Stylistic Innovation in Fashion Companies*. Working Paper.

- Davila, A., G. Foster, and D. Oyon. 2009. Accounting and Control, Entrepreneurship and Innovation: Venturing into New Research Opportunities. *European Accounting Review* 18 (2):281-311.
- Davila, T. 2000. An empirical study on the drivers of management control systems' design in new product development. *Accounting, Organizations and Society* 25 (4-5):383-409.
- de Laet, M., and A. Mol. 2000. The Zimbabwe Bush Pump: Mechanics of a Fluid Technology. *Social Studies of Science* 30 (2):225-263.
- Dee, N.J., F. Livesey, D. Gill, and T. Minshall. 2011. *Incubation for Growth. A review of the impact of business incubation on new ventures with high growth potential* NESTA.
- Denzin, N.K., and Y.S. Lincoln, eds. 1998. *Strategies of Qualitative Inquiry*. USA: Sage.
- Department for Communities and Local Government. 2008. Technical Note of Combined Indicators for RDA Single Budget and ERDF Programme 20017-2013. In *ERDF Manual*,
- Department for Communities and Local Government. 2011. *Output Definitions for ERDF Programmes 2007-2013*.
- Department for Communities and Local Government. 2012. *The National ERDF Handbook*. edited by European Union.
- Department for Communities and Local Government, and European Union. 2012. *ERDF Full Application Indicators, Funding, and Costs Annex*.
- Department of Trade and Industry. 1998. *Our Competitive Future: Building the Knowledge Driven Economy : the Government's Competitiveness White Paper : Analysis and Background*: Department of Trade and Industry.
- Department of Trade and Industry. 2006. *Evaluating the impact of England's Regional Development Agencies: Developing a Methodology and Evaluation Framework*.
- DiMaggio, P.J., and W.W. Powell. 1983. The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields. *American Sociological Review* 48 (2):147-160.
- DiMaggio, P.J., and W.W. Powell. 1991. Introduction. In *The New Institutionalism in Organizational Analysis*, edited by W. W. Powell and P. J. DiMaggio, pp. 1-38. Chicago: University of Chicago Press

- DiMasi, J.A., R.W. Hansen, and H.G. Grabowski. 2003. The price of innovation: new estimates of drug development costs *Journal of Health Economics* 22.
- DiMasi, J.A., R.W. Hansen, and H.G. Grabowski. 2005a. Extraordinary claims require extraordinary evidence. *Journal of Health Economics* 24 (5):1034-1044.
- DiMasi, J.A., R.W. Hansen, and H.G. Grabowski. 2005b. Setting the record straight on setting the record straight: Response to the Light and Warburton rejoinder. *Journal of Health Economics* 24 (5):1049-1053.
- DiMasi, J.A., R.W. Hansen, H.G. Grabowski, and L. Lasagna. 1991. Cost of innovation in the pharmaceutical industry. *Journal of Health Economics* 10 (2):107-142.
- DIUS and BERR. 2008. *Innovation Nation, Cm (Series) (Great Britain. Parliament):* Stationery Office.
- Djelic, M.-L. 2006. Marketization: From intellectual agenda to global policy-making. In *Transnational Governance: Institutional Dynamics of Regulation*, edited by M.-L. Djelic and K. Sahlin-Andersson, pp. 53-73 Cambridge University Press
- Djelic, M.-L., and K. Sahlin-Andersson. 2006. *Transnational Governance: Institutional Dynamics of Regulation: Cambridge University Press.*
- Douglas, F.L., V.K. Narayanan, L. Mitchell, and R.E. Litan. 2010. The case for entrepreneurship in R&D in the pharmaceutical industry. *Nature Reviews Drug Discovery* 10 (September):683-689.
- Drews, J. 2000. Drug Discovery: a Historical Perspective. *Science* 287.
- Drori, G.S., J.W. Meyer, and H. Hwang. 2006. *Globalization and Organization: World Society and Organizational Change: World Society and Organizational Change: OUP Oxford.*
- Drori, G.S., J.W. Meyer, F.O. Ramirez, and E. Schofer, eds. 2003. *Science in the Modern World Polity. Institutionalization and Globalization.* Stanford, California: Stanford University Press.
- Drucker, P. 1993. *Post-capitalist society.* London: Butterworth Heinemann.
- Dyer, J., H. Gregersen, and C. Christensen. 2013. *The Innovator's DNA: Mastering the Five Skills of Disruptive Innovators: Perseus Books Group.*
- Edvinsson, L., and M. Malone. 1997. *Intellectual Capital, Realising Your Company's True Value by Finding its Hidden Brainpower.* New York: Harper Business.

- EFPIA. 2015. *The Pharmaceutical Industry in Figures*. Belgium: European Federation of Pharmaceutical Industries and Associations.
- Ergas, H. 1987. Does Technology Policy Matter? In *Technology and Global Industry*, edited by B. R. Guile and H. Brooks, Washington DC: National Academy Press
- Ernst & Young. 2014. *Adapting and evolving: Global venture capital insights and trends 2014*.
- Espeland, W.N., and M.L. Stevens. 2008. A Sociology of Quantification. *European Journal of Sociology / Archives Européennes de Sociologie* 49 (03):401-436.
- Etzkowitz, H., and L. Leydesdorff. 1995. The Triple Helix: University-Industry-Government Relations: A Laboratory for Knowledge-Based Economic Development. *EASST Review* 14:14-19.
- European Commission. 2015. *Guidance Document on Monitoring and Evaluation. European Cohesion Fund and European Regional Development Fund. Concepts and Recommendations*. Belgium.
- Evenson, R.E. 1993. Patents, R&D, and invention potential: International evidence. *American Economic Review* 83 (2):463.
- Fagerberg, J. 1994. Technology and International Differences in Growth Rates. *Journal of Economic Literature* 32 (3):1147-1175.
- Fincham, R., and R. Roslender. 2003. *The Management of Intellectual Capital and its Implications for Business Reporting*. The Institute of Chartered Accountants of Scotland.
- Floud, R., and P. Johnson. 2004. *The Cambridge Economic History of Modern Britain, History of Britain after 1450*: Cambridge University Press.
- Fourcade, M. 2011. Cents and Sensibility: Economic Valuation and the Nature of "Nature". *American Journal of Sociology* 116 (6):1721-77.
- Freeman, C. 1982. *The Economics of Industrial Innovation*. 2nd Edition ed. London: Frances Pinter.
- Freeman, C. 1991. Networks of innovators: A synthesis of research issues. *Research Policy* 20 (5):499-514.
- Geertz, C. 1973. Thick Description: Toward an Interpretive Theory of Culture. In *The interpretation of cultures: selected essays.*, pp. 3-30. New York: Basic Books



- Georghiou, L. 2001. The United Kingdom national system of research, technology and innovation. In *Research and Innovation Policies in the New Global Economy: An International Comparative Analysis*, edited by P. Laredo and P. Mustar, pp. pp. 253-296. Edward Elgar Publishing Limited
- Gibbons, M., C. Limoges, H. Nowotny, S. Schwartzman, P. Scott, and M. Trow. 1994. *The new production of knowledge: The dynamics of science and research in contemporary societies*. London: Sage.
- Gioia, D.A., and K. Chittipeddi. 1991. Sensemaking and sensegiving in strategic change initiation. *Strategic Management Journal* 12 (6):433-448.
- Godin, B. 2007. *National Innovation System: the System Approach in Historical Perspective*. In *Project on the History and Sociology of STI Statistics*. Montreal, Canada.
- Granovetter, M. 1985. Economic Action and Social Structure: The Problem of Embeddedness. *American Journal of Sociology* 91 (3):481-510.
- Granstrand, O. 2000. The shift towards intellectual capitalism - the role of infocom technologies. *Research policy* 29.
- Grossman, G.M., and E. Helpman. 1994. Endogenous Innovation in the Theory of Growth. *The Journal of Economic Perspectives* 8 (1):23-44.
- Gröjer, J.-E., and U. Johanson. 1991. *Human Resource Costing and Accounting*. Stockholm: Joint Industrial Safety Council.
- Hackett, S., and D. Dilts. 2004. A Systematic Review of Business Incubation Research. *The Journal of Technology Transfer* 29 (1):55-82.
- Hall, B.H., and N. Rosenberg. 2010. *Handbook of the Economics of Innovation, Handbook of development economics series*: North Holland.
- Hardie, I., and D. MacKenzie. 2007. Assembling an economic actor: the agencement of a Hedge Fund. *The Sociological Review* 55 (1):57-80.
- Hartwell, R.M. 1990. Was There an Industrial Revolution? *Social Science History* 14 (4):567-576.
- Hatakenaka, S. 2004. *University-Industry Partnerships in MIT, Cambridge, and Tokyo: Storytelling Across Boundaries, RoutledgeFalmer Studies in Higher Education*: Taylor & Francis.
- HC Deb. 12 February 1991. *British Technology Group Bill*.
- HEFCE. 2005a. *RAE 2008 guidance on submissions*. RAE 3/2005.

- HEFCE. 2005b. *Related companies: guidance for higher education institutions. Produced for the UK funding bodies by RSM Robson Rhodes*
- HEFCE. 2011. *Higher Education Innovation Funding: 2011-2012 to 2014-2015. Policy, final allocations, and request for institutional strategy.*
- HEFCE. 2012. *REF 01/2012: Panel criteria and working methods.*
- HEFCE. 2013. *Higher Education - Business and Community Interaction Survey 2011-2012.*
- HEFCE and DIUS. 2008. *Higher Education Innovation Fund round 4: Invitation and guidance for institutional strategies.*
- HEFCE and OST. 2005. *Higher Education Innovation Fund round 3 Invitation and guidance for institutional plans and competitive bids*
- Helpman, E. 1998. *General Purpose Technologies and Economic Growth*: MIT Press.
- Herter-Sprie, G.S., A.L. Kung, and K.-K. Wong. 2013. New cast for a new era: preclinical cancer drug development revisited. *The Journal of Clinical Investigation* 123 (9):3639-3645.
- HM Treasury. 2000. *Productivity in the UK: The Evidence and the Government's Approach*. London.
- Holstein, J.A., and J.F. Gubrium. 2013. *Handbook of Constructionist Research*: Guilford Publications.
- Hopwood, A.G. 1983. On trying to study accounting in the contexts in which it operates. *Accounting, Organizations and Society* 8 (2-3):287-305.
- Hopwood, A.G. 1987. The archeology of accounting systems. *Accounting, Organizations and Society* 12 (3):207-234.
- Hopwood, A.G. 1996. Looking across rather than up and down: On the need to explore the lateral processing of information. *Accounting, Organizations and Society* 21 (6):589-590.
- Hopwood, A.G., and P. Miller, eds. 1994. *Accounting as a Social and Institutional Practice, Cambridge Studies in Management*: Cambridge University Press.
- House of Commons. 24 January 2007. *Debate on Innovation Policy*.
1998. *Regional Development Agencies Bill*. 1997/98, 100.
- House of Commons. 2002. *Regional Development Agencies (RDAs) Great Britain*.

- House of Commons. 2009. *Putting Science and Engineering at the Heart of Government Policy: Oral and written evidence*, HC (Series) Great Britain Parliament: Stationery Office.
- House of Commons. 2012. *European Regional Development Fund: Second Report of Session 2012-13, Vol. 1: Report, Together with Formal Minutes, Oral and Written Evidence*, HC (Series) (Great Britain. Parliament. House of Commons): Stationery Office.
- House of Commons Business and Enterprise Committee. 2009. *Regional Development Agencies and the Local Democracy, Economic Development and Construction Bill: Report, Together with Formal Minutes, Fourth report of session 2008-09*: Stationery Office.
- House of Commons Science and Technology Committee. 2002. *The Research Assessment Exercise: Second Report of Session 2001-2002*.
- House of Commons Science and Technology Committee. 2011. *Technology Innovation Centres. Second Report of Session 2010-2011*. London: The Stationary Office Limited.
- House of Commons Science and Technology Committee. 2012. *Written evidence submitted by The Higher Education Funding Council for England*.
- House of Commons Science and Technology Committee. 2013. *Bridging the Valley of Death: Improving the Commercialisation of Research, Eighth Report of Session 2012-13, Report, Together with Formal Minutes, Oral and Written Evidence*, House of Commons Series: Stationery Office.
- House of Commons Trade and Industry Committee. 2003. *UK Biotechnology Industry Twelfth Report of Session 2002-03* London.
- House of Commons Trade and Industry Committee. 2005. *Progress Towards the Knowledge Driven Economy: Eighth Report of Session 2004-05, Report, Together with Formal Minutes, Oral and Written Evidence*, HC (Great Britain. Parliament. House of Commons): Stationery Office Limited.
- House of Commons: Science and Technology Committee. 2013. *Bridging the Valley of Death: Improving the Commercialisation of Research, Eighth Report of Session 2012-13, Report, Together with Formal Minutes, Oral and Written Evidence*, House of Commons Series: Stationery Office.

- Howitt, P. 2002. Peter Howitt on Schumpeterian Growth Theory. *Economic Dynamics Newsletter* (2).
- Huckman, R.S., and E.P. Strick. 2005. GlaxoSmithKline: Reorganizing Drug Discovery *Harvard Business Review* May:1-21.
- Håkansson, H., K. Kraus, and J. Lind, eds. 2010. *Accounting in Networks*. New York: Routledge.
- Håkansson, H., and J. Lind. 2004. Accounting and network coordination. *Accounting, Organizations and Society* 29 (2004):51-72.
- Intellectual Property Office. 2015. *Patent Cooperation Treaty (PCT) for Private Applicants*.
- Johanson, U., M. Mårtensson, and M. Skoog. 2001. Mobilizing change through the management control of intangibles. *Accounting Organizations and Society* 26 (7/8):715-733.
- Jump, P. 2013. Evolution of the REF. *Time Higher Education*, 17 October 2013.
- Kaplan, R.S., and D.P. Norton. 1992. The Balanced Scorecard—measures that drive performance. *Harvard Bus. Rev.* 70 (1):71-79.
- Keegan, K. 2009. *Biotechnology Valuation: An Introductory Guide, The Wiley Finance Series*: Wiley.
- Keegan, K.D. 2008. Early-stage Valuation. In *Biotechnology Valuation*, pp. 161-173. John Wiley & Sons Ltd
- Kitson, M., and F. Wilkinson. 2007. The economics of New Labour: policy and performance. *Cambridge Journal of Economics* 31 (6):805-816.
- Kola, I., and J. Landis. 2004. Can the pharmaceutical industry reduce attrition rates? *Nat Rev Drug Discov* 3 (8):711-716.
- Krugman, P. 2013. "The New Growth Fizzle", *The Conscience of a Liberal, The New York Times Blogs*, August 18, 2013.
- Krücken, G., and F. Meier. 2006. Turning the University into an Organizational Actor. In *Globalization and Organization: World Society and Organizational Change*, edited by G. S. Drori, J. W. Meyer and H. Hwang, pp. 1-322. Oxford University Press
- Lambert, R. 2003. *Lambert Review of Business-University Collaboration - Final Report*: Her Majesty's Treasury.

- Larsen, H.T., J. Mouritsen, and P.N.D. Bukh. 1999. Intellectual Capital Statements and Knowledge Management: measuring, reporting and acting. *Australian Accounting Review* 9:15-26.
- Latour, B. 1987. *Science in Action: How to Follow Scientists and Engineers Through Society*: Harvard University Press.
- Latour, B. 2005. *Reassembling the Social: An Introduction to Actor-Network-Theory*: Oxford University Press.
- Latour, B., and S. Woolgar. 1979. *Laboratory Life: The Construction of Scientific Facts, Princeton paperbacks : science, sociology*: Princeton University Press.
- Law, J., and A. Mol. 1995. Notes on materiality and sociality. *The Sociological Review* 43 (2):274-294.
- Lawson, T. 2006. The nature of heterodox economics. *Cambridge Journal of Economics* 30 (4):483-505.
- Lepore, J. 2014. The Disruption Machine. What the gospel of innovation gets wrong. *The New Yorker, Annals of Enterprise*.
- Lev, B. 2001. *Intangibles: Management, Measurement, and Reporting*: Brookings Institution Press.
- Lev, B., and P. Zarowin. 1999. The boundaries of financial reporting and how to extend them. *Journal of Accounting Research* 37 (2):353-385.
- León, P. 2001. *Four Pillars of Financial Sustainability*. USA.
- Light, D.W., and R. Warburton. 2011. Demythologizing the high costs of pharmaceutical research. *BioSocieties* 6 (1).
- Light, D.W., and R.N. Warburton. 2005a. Extraordinary claims require extraordinary evidence. *Journal of Health Economics* 24.
- Light, D.W., and R.N. Warburton. 2005b. Setting the record straight in the reply by DiMasi, Hansen and Grabowski. *Journal of Health Economics* 24 (5):1045-1048.
- Lombardino, J.G., and J.A. Lowe. 2004. The role of the medicinal chemist in drug discovery -then and now. *Nature Reviews* 3 (October 2004):853-862.
- Lord Rothschild. 1971. *A framework for Government Research and Development*. Cabinet Office.
- Lord Sainsbury. 2007. *The Race to the Top. A Review of Government's Science and Innovation Policies*. London: Crown.

- Lowe, A. 2000. The construction of a network at Health Waikato: The "towards clinical budgeting" project. *Accounting, Auditing & Accountability Journal* 13 (1):84-114.
- Lundvall, B.Å. 1992. *National Systems of Innovation: Toward a Theory of Innovation and Interactive Learning*, Anthem Other Canon Economics Series: Pinter.
- Lundvall, B.Å. 2010. *National Systems of Innovation: Toward a Theory of Innovation and Interactive Learning*, Anthem Other Canon Economics Series: Anthem Press.
- MacKenzie, D.A., F. Muniesa, and L. Siu. 2007. *Do Economists Make Markets?: On the Performativity of Economics*: Princeton University Press.
- Marques, L., J.A. Ribeiro, and R.W. Scapens. 2011. The use of management control mechanisms by public organizations with a network coordination role: A case study in the port industry. *Management Accounting Research* 22 (4):269-291.
- Mead, G.H., and C.W. Morris. 1934. *Mind, Self, and Society: From the Standpoint of a Social Behaviorist, 1//a*: University of Chicago Press.
- Merleau-Ponty, M. 1967. *Phenomenology of Perception, International library of philosophy and scientific method*: Routledge & Kegan Paul.
- Meyer, J.W., and R.L. Jepperson. 2000. The 'Actors' of Modern Society: The Cultural Construction of Social Agency. *Sociological Theory* 18 (1):100-120.
- Miller, D. 2002. Turning Callon the right way up. *Economy and Society* 31 (2):218-233.
- Miller, P., and T. O'Leary. 1994. The factory as laboratory. In *Accounting and Science. Natural Inquiry and Commercial Reason*, edited by M. Power, Cambridge: Cambridge University Press
- Miller, P., and T. O'Leary. 2007. Mediating instruments and making markets. Capital budgeting, science and the economy. *Accounting, Organizations and Society* 32:701-734.
- Miller, P., and T. O'Leary. 1987. Accounting and the Construction of the Governable Person. *Accounting, Organizations and Society* 12 (3):235-265.
- Miller, P., and M. Power. 2013. Accounting, Organizing, and Economizing: Connecting Accounting Research and Organization Theory. *The Academy of Management Annals* 7 (1):557-605.
- Ministry of Reconstruction. 1918. *Report of the Machinery of Government Committee under the chairmanship of Viscount Haldane of Cloan* London.

- Mouritsen, J. 1998. Driving growth: Economic Value Added versus Intellectual Capital. *Management Accounting Research* 9 (4):461-482.
- Mouritsen, J. 2006. Problematizing intellectual capital research: ostensive versus performative IC. *Accounting, Auditing & Accountability* 19 (6):820-841.
- Mouritsen, J., H.T. Larsen, and P.N. Bukh. 2001a. Intellectual capital and the 'capable' firm: narrating, visualizing and numbering for managing knowledge. *Accounting, Organization and Society* 26 (7-8):735-762.
- Mouritsen, J., H.T. Larsen, and P.N. Bukh. 2001b. Valuing the future: intellectual capital supplements at Skandia. *Accounting, Auditing, and Accountability Journal* 14:399-422.
- Mouritsen, J., and S. Thrane. 2006. Accounting, network complementarities and the development of inter-organisational relations. *Accounting, Organizations and Society* 31:241-275.
- Muniesa, F. 2014. *The Provoked Economy: Economic Reality and the Performative Turn*, CRESC: Taylor & Francis.
- Mårtensson, M. 2009. Recounting counting and accounting: From political arithmetic to measuring intangibles and back. *Critical Perspectives on Accounting* 20 (2009):835-846.
- National Audit Office. 2001. *Measuring the Performance of Government Departments: Report by the Comptroller and Auditor General*. Stationary Office.
- National Audit Office. 2002. *Delivering the Commercialisation of Public Sector Science: Report by the Comptroller and Auditor General*. London.
- Nee, V. 2005. The New Institutionalisms in Economics and Sociology. In *The Handbook of Economic Sociology*, edited by N. J. Smelser and R. Swedberg, pp. 49-74. Princeton University Press
- Nelson, R.R. 1993. *National Innovation Systems : A Comparative Analysis*: Oxford University Press, USA.
- Nelson, R.R. 1994. The Co-evolution of Technology, Industrial Structure, and Supporting Institutions. *Industrial and Corporate Change* 3 (1):47-63.
- Nelson, R.R., and S.G. Winter. 1982. *An Evolutionary Theory of Economic Change*, Belknap Press: Belknap Press of Harvard University Press.

- Nelson, R.R., and S.G. Winter. 2009. *An Evolutionary Theory of Economic Change*: Harvard University Press.
- NESTA. 2008. *Measuring Innovation*. London.
- Neu, D., J. Everett, A.S. Rahaman, and D. Martinez. 2012. Accounting and networks of corruption. *Accounting, Organizations and Society* DOI: 10.1016/j.aos.2012.01.003.
- O'Neill, M., and M.M. Hopkins. 2012. *A Biotech Manager's Handbook: A Practical Guide*, Woodhead Publishing Series in Biomedicine: Elsevier Science.
- OECD. 1963. *The Measurement of Scientific and Technological Activities: Proposed Standard Practice for Surveys on Research and Experimental Development*. Frascati Manual.
- OECD. 1997. *Oslo manual : proposed guidelines for collecting and interpreting technological innovation data*. [2nd ed.]. ed. Organisation for Economic Co-operation and Development :: Paris, France.
- Office of Project Appraisal Training. 2011. Indicators for ERDF Programmes 2007-2013 In *ERDF Users Manual*,
- Office of Technology Assessment. 1993. *Pharmaceutical R&D costs, risks, and rewards*: DIANE Publishing.
- Oliver, A.L. 2004. On the duality of competition and collaboration: network-based knowledge relations in the biotechnology industry. *Scandinavian Journal of Management* 20 (1-2):151-171.
- PACEC. 2009. *Evaluation of the effectiveness and role of HEFCE/OSI third stream funding*. Report to HEFCE.
- PACEC-CBR. 2010. *Synergies and Trade-offs Between Research, Teaching, and Knowledge Exchange*. A Report to HEFCE.
- Padgett, J.F., and W.W. Powell. 2012. *The Emergence of Organizations and Markets*: Princeton University Press.
- Pammolli, F., L. Magazzini, and M. Riccaboni. 2011. The productivity crisis in pharmaceutical R&D. *Nature Reviews Drug Discovery* 10 (June):428-438.
- Paul, S.M., D.S. Mytelka, C.T. Dunwiddie, C.C. Persinger, B.H. Munos, S.R. Lindborg, and A.L. Schacht. 2010. How to improve R&D productivity: the pharmaceutical industry's grand challenge *Nature Reviews Drug Discovery* 9 (March):202-214.
- PhRMA. 2008. *Profile 2008 Pharmaceutical Industry*. Washington DC: Pharmaceutical Research and Manufacturers of America.



- Pisano, G.P. 2006. Can Science Be a Business? Lessons from Biotech. *Harvard Business Review* October.
- Pitman, M.A., and J.A. Maxwell. 1992. Qualitative approaches to evaluation: Models and methods. In *The handbook of qualitative research in education*, edited by M. D. LeCompte, W. L. Millroy and J. Preissle, New York: Academic Press
- Potter, J., and M. Mulkey. 1985. Scientists Interview Talk: Interviews as a Technique for Revealing Participants' Interpretative Practices. In *The Research interview, uses and approaches*, edited by M. Brenner, J. Brown and D. V. Canter: Academic Press
- Powell, W.W. 1987. Hybrid Organizational Arrangements: New Form or Transitional Development? *California Management Review* 30 (1):67.
- Powell, W.W. 1990. Neither Market nor Hierarchy: Networks Forms of Organization. *Research in Organizational Behavior* 12.
- Powell, W.W., and J.A. Colyvas. 2008. Microfoundations of Institutional Theory. In *The SAGE Handbook of Organizational Analysis*, edited by R. Greenwood, C. Oliver, K. Sahlin and R. Suddaby, UK: SAGE
- Powell, W.W., and P.J. DiMaggio. 1991. *The New Institutionalism in Organizational Analysis*: The University of Chicago Press.
- Powell, W.W., K.W. Koput, and L. Smith-Doerr. 1996a. Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology. *Administrative Science Quarterly* 41(1):116-145
- Powell, W.W., K.W. Koput, and L. Smith-Doerr. 1996b. Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology. *Administrative Science Quarterly* 41 (1):116-145
- Powell, W.W., D.R. White, K.W. Koput, and J. Owen-Smith. 2005. Network Dynamics and Field Evolution: The Growth of Interorganizational Collaboration in the Life Sciences. *American Journal of Sociology* 110 (4):1132-1205.
- Power, M. 1996. *Accounting and Science: Natural Inquiry and Commercial Reason*, Cambridge Studies in Management: Cambridge University Press.
- PricewaterhouseCoopers. 2008. *Impact of RDA spending National report*. Department of Business, Enterprise, and Regulatory Reform.
- PricewaterhouseCoopers. 2010. *Biotech reinvented: Where do you go from here?*

- Pritchard, J.F., M. Jurima-Romet, M.L.J. Reimer, E. Mortimer, B. Rolfe, and M.N. Cayen. 2003. Making Better Drugs: Decision Gates in Non-Clinical Drug Development. *Nature Reviews Drug Discovery* July.
- Ramirez, F.O. 2006. The rationalization of universities. In *Transnational Governance: Institutional Dynamics of Regulation*, edited by M. Djelic and K. Sahlin-Andersson: Cambridge University Press
- Reed, I. 2008. Maximal Interpretation in Clifford Geertz and the Strong Program in Cultural Sociology: Towards a New Epistemology. *Cultural sociology* 2 (2):187-200.
- Reed, I.A. 2011. *Interpretation and social knowledge: On the use of theory in the human sciences*. United States of America: The University of Chicago Press.
- Regional Policy Commission. 1996. *Renewing the Regions: Strategies for Regional Economic Development*. Sheffield: PAVIC Publications.
- Revellino, S., and J. Mouritsen. 2009. The Multiplicity of Controls and the Making of Innovation. *European Accounting Review* 18 (2):341-369.
- Revellino, S., and J. Mouritsen. 2015. Accounting as an engine: The performativity of calculative practices and the dynamics of innovation. *Management Accounting Research*.
- Richardson, A.J., and E. Kilfoyle. 2009. Accounting in markets, hierarchies and networks: The role of accounting in the transnational governance of postal transactions. *Accounting, Organizations and Society* 34:939-956.
- Robson, K. 1991. On the arenas of accounting change: The process of translation. *Accounting, Organizations and Society* 16 (5-6):547-570.
- Robson, K. 1992. Accounting numbers as "inscription": Action at a distance and the development of accounting. *Accounting, Organizations and Society* 17 (7):685-708.
- Robson, K. 1993a. Accounting policy making and "interests": accounting for research and development. *Critical Perspectives on Accounting* (3):1-27.
- Robson, K. 1993b. Governing Science and economic growth at a distance: accounting representation and the management of research and development. *Economy and Society* 22 (4):461-481.
- Robson, K. 1994. Connecting Science to the economic: Accounting calculation and the visibility of research and development. *Science in Context* 7 (3):497-514.

- Rockness, H.O., and M.D. Shields. 1984. Organizational control systems in research and development. *Accounting, Organizations and Society* 9 (2):165-177.
- Romer, P. 1998. Bank of America Roundtable on the Soft Revolution: Achieving Growth by Managing Intangibles. *Journal of Applied Corporate Finance* 11 (2):8-27.
- Romer, P.M. 1994. The Origins of Endogenous Growth. *The Journal of Economic Perspectives* 8 (1):3-22.
- Rose, N., and P. Miller. 1992. Political Power beyond the State: Problematics of Government. *The British Journal of Sociology* 43 (2):173-205.
- Roslender, R. 2015. Accountancy. In *Routledge Handbook of Interpretive Political Science*, edited by M. Bevir and R. A. W. Rhodes: Taylor & Francis
- Roslender, R., and R. Fincham. 2001. Thinking critically about intellectual capital accounting. *Accounting, Auditing & Accountability Journal* 14 (4):383-398.
- Rossmann, G.B., and S.F. Rallis. 2003. *Learning in the Field: An Introduction to Qualitative Research*: Sage Publications.
- Sahlin-Andersson, K., and L. Engwall. 2002. *The Expansion of Management Knowledge: Carriers, Flows, and Sources*, Stanford Business Books: Stanford Business Books.
- Sandford, M. 2013. *The abolition of regional government*. House of Commons Library.
- Scannell, J.W., A. Blanckley, H. Boldon, and B. Warrington. 2012. Diagnosing the decline in pharmaceutical R&D efficiency *Nature Reviews Drug Discovery* 11 (March):191-200.
- Segerstrom, P.S. 1998. Endogenous Growth Without Scale Effects. *American Economic Review* 88 (5):1290-1310.
- Simons, R. 1995. *Levers of Control: How Managers Use Innovative Control Systems to Drive Strategic Renewal*. Boston MA: Harvard Business School Press
- Snowdon, B. 2002. *Conversations on Growth, Stability and Trade: An Historical Perspective*: Edward Elgar Publishing, Incorporated.
- Solow, R.M. 1956. A Contribution to the Theory of Economic Growth. *The Quarterly Journal of Economics* 70 (1):65-94.
- Stewart, J.J., P.N. Allison, and R.S. Johnson. 2001. Putting a price on biotechnology. *Nat Biotech* 19 (9):813-817.
- Stewart, T.A. 1997. *Intellectual Capital: The New Wealth of Organizations*, A Currency book: Doubleday / Currency.

- Stichweh, R. 1994. Differentiation of Science and Politics: Science Policy in the 19th and 20th Century. Paper read at Euroscientia Conferences. Science and Power: the Historical Foundations of Research Policies in Europe, at Firenze.
- Sveiby, K.E. 1997. *The new organizational wealth: managing and measuring knowledge-based assets*. San Francisco: Berrett-Koehler.
- Svennebring, A.M., and J.E.S. Wikberg. 2013. Net present value approaches for drug discovery. *SpringerPlus* 2:140.
- Swedberg, R. 2012. Theorizing in sociology and social science: turning to the context of discovery. *Theory and Society* 41:1-40.
- Tomkins, C. 2001. Interdependencies, trust and information in relationships, alliances and networks. *Accounting, Organizations and Society* 26:161-191.
- Trott, P., and D.A.P. Hartmann. 2009. Why 'Open Innovation' is Old Wine in New Bottles. *International Journal of Innovation Management* 13 (4):715-736.
- van der Meer-Kooistra, J., and M.Z. Siebren. 2001. Reporting on intellectual capital. *Accounting, Auditing & Accountability Journal* 14 (4):456-476.
- Weick, K.E. 1995. *Sensemaking in Organizations, Foundations for Organizational Science*: SAGE Publications.
- Welsh Government. 2013. *ERDF Indicators Definitions*.
- Wiggins, S., and D. Shields. 1995. Clarifying the 'logical framework' as a tool for planning and managing development projects. *Project Appraisal* 10 (1):2-12.
- Williamson, O.E. 1975. *Markets and Hierarchies: Analysis and antitrust implications*. New York: Free Press.
- Willmott, H., A. Puxty, K. Robson, and A. Lowe. 1992. Regulation of Accountancy and Accountants: A Comparative Analysis of Accounting for Research and Development in Four Advanced Capitalist Countries. *Accounting, Auditing & Accountability Journal* 5 (2):32-56.
- Wilson, T. 2012. *A Review of Business-University Collaboration*. London: Department for Business, Innovation and Skills.
- WIPO. 2014. *WIPO Intellectual Property Handbook*. Geneva: World Intellectual Property Organization.
- Wolcott, H.F. 1994. *Transforming Qualitative Data: Description, Analysis, and Interpretation*. Thousand Oaks: Sage Publications.