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Effectiveness and Efficiency of SME Innovation Policy

(FORTHCOMING Small Business Economics)

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Abstract

This paper assesses UK innovation policy impact on a large, population weighted, sample of both service and manufacturing SMEs. By focussing on self-reported innovation the study achieves a wider coverage of the effects of SME innovation policy than possible with more traditional indicators. Propensity score matching indicates that SMEs receiving UK state support for innovation were more likely to innovate than unsupported comparable enterprises. Innovating enterprises are shown to have grown significantly faster over the years 2002-4 when other growth influences are appropriately controlled. Combining these two results and comparing the outlays on SME innovation policy with the estimated effects suggests that policy was efficient as well as effective. There is evidence that SME tax credits were expensive compared with earlier support instruments. But the overall high returns estimated suggest that, even in times of public spending cuts, persisting with SME innovation policy would be prudent.

Key words: Innovation; State Aid; SME; Policy Evaluation
JEL: L25, R38

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Effectiveness and Efficiency of SME Innovation Policy

1. Introduction

Innovation policy aims to promote the commercial exploitation of new ideas as products, processes, and organisational techniques (OECD 2003). The policy is increasingly prominent in EU and OECD countries because 'market failure' is judged to matter in this field. EU Member States are permitted to provide state aid to firms as long as it

'addresses a defined market failure, and the identified benefits outweigh the distortions to competition resulting from the aid'. (European Commission 2006).

Market failures are particularly liable to arise in the generation and utilisation of knowledge; one example occurs when those who do not invest in research and development (R&D) nonetheless gain knowledge from others' investments. As a consequence of such market failures, social returns to R&D are estimated to be high and to exceed private returns by a wide margin (Griffith et al 2001; HM Treasury et al 2004; Wieser 2005).

Typically innovation policy evaluation has focused on the R&D input, rather than on the innovations themselves, and restricted the analysis to large manufacturing firms (Jones and Williams 1998, Hall and Van Reenen 1999)- although more recently coverage has been extended to manufacturing SMEs (e.g. Hall et al 2009). Service as well as manufacturing firms employing fewer than 250 persons accounted for about one half of private sector jobs and turnover in the United Kingdom during 2007 (BERR 2008 Table 1); all types of SMEs matter for the economy. For these enterprises there is evidence that R&D surveys markedly under-report research activity and innovativeness (Kleinknecht 1987; Harris 2009)[1]. Lev (2001) noted that many innovative firms did not include any R&D expenditure figures in their reports. Instead of formal R&D, investment

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[1] Kleinknecht's study showed that according to the official R & D survey, 91% of private R & D in Dutch manufacturing firms was undertaken by large firms (with 500 and more employees). According to Kleinknecht's estimate, this percentage would fall to 82.4% (when considering only firms with 50 and more employees) , and declines even more to 77.3% when adding the R & D of firms with 10 to 49 employees not covered in the official survey.

in plant and equipment is more strongly associated with innovation by smaller businesses (Smith 2005; Skuras et al 2008)[2]. The approach adopted here to evaluating policy therefore is to consider the impact on self-reported innovation on both manufacturing and services SMEs, and how this innovation affects the economy.

The central question is whether 'reporting unit' level data in the Fourth Community Innovation Survey (CIS4) (DTI 2006) shows that British SME innovation policy in 2002-4 was effective and efficient[3]. An effective policy is simply one that gets results – achieves 'additionality'- but the costs of doing so might exceed the benefits[4]. The resources deployed with an efficient policy yield social returns greater than their alternative uses.

In their recent survey Ientile and Mairesse (2009) concluded that an innovation policy was effective; business R&D investment grew in response to a tax credit in all the cases reviewed. Their observation that a unit of taxpayer's money sometimes generated less than a unit of additional R&D does not necessarily indicate the policy was inefficient. The evaluation of this so-called 'bang for the buck' (Baghana and Mohnen 2009) need not even approximate an assessment of social efficiency, for it fails to take into account the social returns to the induced R&D. If returns to unsubsidised R&D at the margin are high (as for instance the survey of Wieser 2005 finds), then they may still be high (albeit reduced) on the tax credit that induced less than one for one R&D outlays. Links between policy spending and ultimate social returns must be established to evaluate policy efficiency, a contribution of the present paper. A second contribution is to distinguish between the impacts of traditional state support for SME innovation and of R&D tax credits. Studies such as Czarnitzki et al (2011) that estimate the impact of tax credits typically do not compare them with alternative innovation policies.

[2] If this point is accepted then the Crepon et al (1998) model using R&D as an intermediate variable, standard for larger firms, is not appropriate for SMEs.
[3] The UK CIS5 cannot be used for this purpose because the public policy questions were dropped.
[4] Following HM Treasury (2003 p52) for the definition. "The success of government intervention in terms of increasing output or employment in a given target area is usually assessed in terms of its 'additionality'. This is its net, rather than its gross, impact after making allowances for what would have happened in the absence of the intervention."

Section 2 outlines UK state aid for innovation in an international context. Then section 3 discusses the method and the data. A key methodological problem is how to establish what supported firms would have done if they had not received state aid for innovation and conversely, whether or not unsupported enterprises would have innovated had they been helped. A propensity score matching solution is outlined. No less essential to policy evaluation is estimation of the impact of innovations. The section therefore considers how the growth of the firm responds to them, the measurement of the ultimate policy output and control function and instrumental variables estimation. The final subsection of 3 discusses the CIS4 data from which these equations are estimated. In section 4 the results are reported and in the following section (5) the estimated parameters are employed to calculate a downward biased or conservative estimate of the overall impact and efficiency of SME innovation policy.

2 . Context of UK Innovation Policy

Official concern about possible uncorrected market failure in British innovation focused on Business R&D intensity, which was persistently lower in the UK than in the US, France or Germany over the decade after 1992 (DTI 2003 Table 1.1). Firms in the UK were also less likely to be innovative, according to analysis of the aggregated Community Innovation Survey 3. Moreover the proportion of innovators in manufacturing sectors that received public financial support for innovation was significantly lower in the UK than in France, Germany and Spain (Abramovsky et al 2004).

Most of the R&D discrepancy was attributable to lower British spending in a few manufacturing industries. In the UK service sector greater R&D intensity narrowed the gap, suggesting that an exclusive focus on manufacturing industry typical of most studies could be misleading. 42 percent of R&D performed in the UK was funded by UK businesses in 2005, a smaller proportion than other G7 countries and the OECD average. Perhaps because of a low British propensity to invest in innovation, the UK had a relatively high share of R&D funded from abroad, at around 19 percent in 2005 (DIUS Science and Innovation Investment Framework 2008).

That muted UK state support may be a reason for lower innovation rates was suggested by another aggregative cross-Europe CIS3 analysis. State aid was a statistically significant contributor to the fraction of innovative firms and to the proportion of innovative products in turnover (Jaumotte and Pain 2005b). For the UK, unlike France, Germany and Spain, Griffith et al (2006 Table 3) using disaggregated CIS3 found that for all sizes of firms state funding had no effect on R&D intensity.

On the other hand the problem may lie in the measurement. Certainly a caveat is that international comparisons of state aid for innovation can be problematic. The EC Competition Directorate estimates UK spending to be low and falling (Table 1). Yet British figures for R&D tax credits alone exceed the Directorate's estimates for 2005-7 (Table 2). The reason is that whereas the SME tax credit counts as state aid, the large firm tax credit support does not.[5]

Table 1 State Aid for Research & Development & Innovation (million €, average p.a.)

	2002-2004	*2005-2007*
Germany	1661	1836
France	1249	1721
Italy	759	731
United Kingdom	**771**	**543**

Source: http://ec.europa.eu/competition/state_aid/studies_reports/ws3_21.xls

Table 2 Cost of Support UK R&D tax credit (£ mill) (accruals basis)

	Average 2002/3- 2004/5	2005/6	2006/7
All R&D schemes	507	630	670
SME scheme	197	180	200

Source: http://www.hmrc.gov.uk/stats/corporate_tax/rd-accrualsbasis.pdf

To support innovation, traditionally the UK government employed grant-based schemes, such as the Small Firm Merit Awards for Research and Technology (SMART) and Support for Products Under Research (SPUR). But in 2000, they introduced as well an R&D tax

[5] Communication from Competition DG, European Commission, 20 May 2009.

credit for SMEs, extending the scheme in 2002 to include large companies. SMEs did not need to make profits to benefit from the credit; if they incurred losses SMEs could claim a cash payment from the tax authority equal to 24 percent of their eligible R&D spending (Abramovsky et al 2004).

3. Method and Data

3.1 The Innovating SME

Estimates of innovation policy impact require both measures of innovation output or outcome, and a model of the innovating firm. Possible innovation measures include patents, with three major approaches (Griliches 1990). But patent applications are only one of many means of innovation protection. Patents are rarely used in services and by small firms so that this indicator will understate innovation in these sectors (Jaumotte and Pain 2005a 25). Another method has been to identify and count 'significant' innovations (Tether et al 1997). A drawback is that there is no obvious way of comparing the relative importance of the innovations and therefore count measures of innovation output may be misleading. A number of recent studies suggest instead that the self-reported approach can explain company performance (North and Smallbone 2000: Freel 2000: Roper et al 2008; Skuras et al 2008; Hall et al 2009).

This self-reported approach, as employed by the CIS4 questionnaire to management, is probably currently the best available SME innovation measure for the UK. Innovations are here defined as products or processes that were at a minimum, new (or significantly improved) to the enterprise. The CIS definition of innovations does not require them to be profitable or accepted by the market[6]; quality enhancement or cost reduction could come at the expense of each other, change can be damaging. In principle then it is

[6]' Innovation is defined as major changes aimed at enhancing your competitive position, your performance, your know-how or your capabilities for future enhancements. These can be new or significantly improved goods, services or processes for making or providing them.' Innovation here is measured as either or both of process or product innovation, either new to the firm or to the market.

possible that innovations, as measured, impact adversely or not at all on business performance.

How SMEs innovate will depend on how they acquire and utilise knowledge, how they invest in innovation and the challenges posed by this type of investment, in contrast to others (Hall 2009). Such investment creates an intangible asset, the firm's knowledge base, from which innovations and profits may be generated. Much of this 'knowledge capital' is implicit rather than formal, dependent upon the firm's employees. So, human capital of graduates should be an important, measurable, contributor to this base. SMEs may be especially likely to abstain from intramural R&D on grounds of excessive risk and limited access to finance compared with larger firms (Rammer et al 2009).

Effective public support intended to counteract market failures, the central concern of the present study, will further add to an enterprise's resource base and so stimulate innovation. The in-part tacit nature of knowledge implies that personal contacts, imitation and frequent interactions for SMEs are particularly necessary for knowledge transmission. Collaboration with other firms and institutions will therefore matter (Cassiman and Veugelers 2002, 2005; Roper et al. 2008); around 13 percent of UK firms in the CIS4 engaged in such arrangements (DTI 2006 25-6). In short, the 'innovative SME' model proposed here controls for the direct influence of collaboration arrangements on an enterprise's chances of innovating.

Another control in the model recognizes that enterprise resources for utilizing knowledge will include human capital. Non-human resources devoted to knowledge production, utilization and innovation comprise R&D spending and investment in plant and machinery. New firms may be more likely than other businesses to have been established to exploit an innovation, so that age or date of formation could be an influence upon the chances of innovating. Larger enterprises are usually able to draw upon more indivisible knowledge or other resources than smaller, in which case firm size will positively influence innovation, though the relationship may be more subtle than the Schumpeter hypothesis about the greater innovativeness of larger firms (Acs and Audretsch 1988; Tether et al 1997; Hall et al 2009). Membership of an enterprise group could exercise a similar effect. Technological opportunities for innovation are likely to vary between industries. Consequently sector controls are included in the model.

The estimated innovation equation assumes that I_i^* is an unobserved, or latent, variable, the chances of enterprise i innovating. An innovation is achieved (I = 1)) if $I^* \geq 0$ and not achieved (I=0) if $I^* < 0$. Both of these outcomes can be observed. So, where u_i is a disturbance term ;

Probability of innovation $[I_i=1] = Pr[I_i^* \geq 0] = \mathbf{X_1'b} + u_{i1}$

= f(state support, collaborative arrangements for innovation, firm size, human capital, R&D, investment, firm age, sector, enterprise group member, u_{i1}) …(1)

where f is a cumulative distribution function.

There is strong theoretical and empirical evidence consistent with innovation causing or permitting exporting (BIS 2010 11-12) which would be a reason for excluding foreign sales from the controls in the innovation equation (1). But the association of these variables also may include an element of innovation being driven by exporting (BIS, 2010 54-62). For this reason it could be desirable to include exporting as a control in the innovation equation in case the policy coefficient is altered by its presence.

3.2 Allocation of State Aid for Innovation

Whether traditional state aid for innovation is given to an SME depends upon management making an application and upon civil servants judging the application appropriate for the terms of the support. The allocation of aid is determined by the interaction of these two groups; even if state officials could ‘pick winners’ they cannot force state aid upon an enterprise. Even if an enterprise knows they have a good idea they cannot insist that civil servants allocate state aid to innovate it. When successful applicants exclude a high proportion of firms poor at innovating and consist of those likely anyway to innovate, there would be much less policy ‘additionality’ than at first sight appears. The disturbance term in the innovation equation (u_{i1}) would be correlated with the State aid allocation. Aid would be non-randomly assigned to SMEs. Unobserved particularly innovative managements may for lack of time perhaps have a lower propensity to seek and obtain state support for innovation, generating a negative association between u_{i1} and the independent variable of interest.

What determines an enterprise’s willingness to apply for innovation aid and the inclination of the authorities to grant it? If the likely success of the aid is a determinant then everything that influences the probability of innovation might be included in the aid allocation equation. In addition, policy has a strong regional element in the UK and therefore the location of the enterprise also influences the chances of receiving state aid. The State aid equation assumes that the latent variable S^*_i is the perceived net benefit- by the applicant and in conformity with programme conditions - of support for firm i , $\mathbf{X_2}$ are the explanatory variables and u_{i2} is a disturbance term. S = 0 if $S^*_i<0$. S = 1 if $S^*_i \geq 0$.

Probability state support $[S_i=1] = \Pr[S_i^* \geq 0] = \mathbf{X_2'b} + u_{i2}$ =

g(location, sector, foreign sales, collaborative arrangements, enterprise size, age, human capital, R*D, u_{i2}) ...(2)

where g is a cumulative distribution function.

Possibly the process differs between the R&D tax credit and other support schemes because the receipt of the tax credit is more exclusively dependent upon enterprise management and less on officials. In which case, aid equation (2) should yield different parameters for the two types of state support.

Equation 2 can control for non-random allocation of innovation support to firms in a propensity score matching exercise (Rosenbaum and Rubin 1983; Heckman et al 1997: Oh et al. 2009). If enterprises were entirely randomly assigned to the two groups, state aided establishments and others, the difference in mean innovation outcome could be attributed to the state aid. Each firm getting state aid is therefore matched where possible with a business with an identical probability (propensity score) from equation 2 that did not receive aid[7]. All firms that can be matched are 'on support'. The difference in the mean innovation chances of these two groups is then attributed to the aid.

Matching analyses are based on two key principles: the conditional independence assumption (CIA) and common support. The first principle requires that any unobservable variation in innovation chances, after adjusting for the effects of whatever variables determine the allocation of support, has the same random distribution for aided and non-aided firms. Common support, the second principle, necessitates that comparable observations are available for both groups; if size is a determinant of state aid, some big and some small firms must receive aid while some of both categories must not[8].

A test of how well the matching is undertaken is to compare the means of the characteristics determining the propensity score before and after matching. Firms with graduates in their workforces are more likely to innovate than others. Hence before matching firms receiving innovation support more probably employ graduates than unaided establishments. But after matching the chances of employing graduates should

[7] Rosenbaum and Rubin (1983) showed that matching enterprises on just the propensity score, rather than matching firms on the vector of characteristics of equation 2, was appropriate. This is because firms receiving state aid but with the same value of the propensity score as those not receiving it have the same distribution as the entire vector of regressors.

[8] Matching estimators do not rely on linear extrapolation (outside the common support region) or functional form assumptions. Nor do they require an exclusion variable or impose joint normality assumptions.

be similar between state aided and control groups – even though the matching is on the score and not on the determinants of the score[9].

3.3. Innovation and SME Growth.

Commonly models of the impact of innovation and knowledge seek to explain labour productivity (for example Belderbos 2004, Roper et al 2008). Alternatively they employ a Cobb-Douglas production function to predict output (for instance Harris et al 2009). Crepon et al (1998) use as dependent variable value added per employee, while van Leuween and Klomp (2006) and Hall et al (2009) favour turnover per employee. The present exercise instead adopts proportionate increase in turnover as the measure of innovation impact. As shown below, rise in turnover provides the closest approximation to the increase in welfare from innovation and it is also readily measurable with CIS4.

Successful innovation either lowers an SME's costs or expands their demand or both. If a firm faces a perfectly price inelastic demand then the proportionate cut in price from a successful process innovation would match the proportionate increase in welfare. Productivity increase would be a good proxy for the impact of the innovation. But profit maximisation requires that firms operate in the output range where they face a price elastic demand. Consequently a cost and price reduction expands sales and turnover, and productivity increase understates the value of the innovation. How much expansion takes place depends upon the price elasticity of demand.

An impact assessment based solely on labour productivity and a production function is especially mis-specified when a product innovation shifts the enterprise's demand function. Profit maximisation normally ensures that sales volume of the now improved products expands but, with a constant elasticity of demand and constant returns to scale, the price remains unchanged. Turnover and output (or value added) increase, but

[9] Combining the propensity score matching with a difference-in-differences estimator (Blundell and Costa Dias 2000) might improve the efficiency of estimates. Unfortunately Community Innovation Survey 4, the data source for the present exercise, does not include the observations on SME innovation in two distinct periods that would permit this approach.

measured productivity does not; only welfare or 'utility' productivity rise (see Appendix A). A conventional productivity index will markedly understate the welfare effect of such innovations.

The output increase from innovation is more closely related to the 'surplus' measures of well-being from welfare economics; consumers' surplus and profits. The relation varies with the average price elasticity of demand faced by the firm in the short run. Tellis' (1988) meta-analysis of several hundred studies concluded that the mean price elasticity faced by firms was in the region of -2.5. With constant elasticity demand functions and constant returns to scale, in this region the proportionate change in sales revenue is a downward biased measure of welfare expansion in relation to initial turnover – but considerably less biased downwards than change in productivity (Appendix A).

Turning now to the model in which the impact of innovation on enterprise growth is embedded, younger firms may possess a greater capacity for learning about their own capabilities, as well as about their markets, boosting their growth rates by this route (Pakes and Ericson 1998). Allowing for enterprise age in the enterprise growth equation therefore would help distinguish between innovation itself and other sources of growth. For the same reason, firms with greater knowledge capital should be better placed to grow. Thus human capital and membership of an enterprise group (Sutton 1997) may be expected to influence growth independently of size and innovation. For the *i*th firm then;

Growth rate $_{ti}$ =

f(Innovation, Lagged Output, Age, Human Capital, Enterprise Group Membership,u_{3i}) …(3)

Unbiassed estimates of the effect of innovation on turnover require that the disturbance term, u_{i3}, is uncorrelated with innovation. Unobserved especially innovative managements may also be less interested in, or competent at, running a large firm than other management teams; if so there would be a negative association between the output disturbance term and the innovation variable. Measuring output or turnover before and after the innovation (in 2002 and 2004 in the present study) and considering the difference for innovators and non-innovators goes some way to eliminating this problem. Unobserved management of the above type would be a common factor that was eliminated by differencing (Blundell and Costa Dias 2000). However this 'difference in differences' approach does not address the case where, say, unobserved innovative management are not very interested in, or good at, growth.

A potential solution to such bias in this instance is to instrument innovation to obtain the estimate of the impact on output growth. In practice good instruments may not be available and invalid or 'weak' instruments estimate more biased and inconsistent IV coefficients, as well as with larger standard errors, than those of OLS (Staiger and Stock 1997). Because instrumental variables estimators are less efficient than OLS, whether IV estimation is necessary should be first tested. Including the residuals from innovation equation (1) in equation (3) is such a test for potential bias in the parameter estimate of the impact of innovation on growth. It also provides a control function estimate of the parameter (Heckman and Navarro 2004)[10]. If the residuals' coefficient is not significantly different from zero the hypothesis can be rejected that the disturbance term in the growth equation is correlated with the innovation measure[11]. In these circumstances single equation estimates of the impact of innovation on growth are consistent and unbiased.

The policy effect then is deduced from the two basic equations (1) and (3). From them can be obtained two magnitudes; the effect of support on the chances of innovation,

[10] These are generalized or Gourieroux (1987) residuals because (1) is a probit equation. Where y is the dependent variable, the residuals are:
u = [pdf(xB)/cdf(xB)]*[(1 - cdf(xB))*(y - cdf(xB)]
When y = 1, u = pdf(xB)/cdf(xB),
when y = 0, u = - pdf(xB)/(1 - cdf(xB)),
where pdf and cdf are the p.d.f. and c.d.f. of N(0,1).
[11] This a version of the Durbin-Wu-Hausman (DWH) test (Davidson and MacKinnon 1993).

and the impact of innovation on turnover/profits plus consumers' surplus (on the assumptions discussed above). The product of these two parameters gives the average impact of policy on those enterprises that received support. Multiplying by the proportion of firms that obtained state aid and their contribution to the performance measure yields the boost due to policy. Then if we know how much is spent on policy this outcome may be interpreted as the return.

3.4. Data and Model Specification

Data for the present exercise comes from the Fourth Community Innovation Survey (CIS4) and the variables are summarised in Table 3. This source is essentially a cross-section average for the period 2002-4, but with both beginning and end period observations for turnover and employment, so the results must be interpreted with this in mind. CIS4 in the UK obtained valid responses from 16,446 enterprises, yielding a response rate of 58 percent (DTI 2006). CIS data is collected at the reporting unit (i.e. establishment) level, not at the firm/enterprise or plant/local unit level[12].

Sampling weights for CIS4 were created by using the inverse sampling proportion in each stratum[13]. These weights may correct for bias introduced by different response rates across enterprise size, sector or region, in particular compensating for under-sampling of small businesses. Formally CIS4 includes enterprises as small as ten employees, although in the unweighted data set of the present analysis, ten percent employ ten or fewer.

[12] The CIS survey questionnaire refers to enterprise, but defines this as a reporting unit. '*An enterprise is defined as the smallest combination of legal units that is an organisational unit producing goods or services, which benefits from a certain autonomy in decision making, especially for the allocation of its current resources. An enterprise carries out one or more activities at one or more location.*' So the reporting unit may be a subsidiary of a larger firm, or it may be a single plant or even several plants in the same or different regions. Some enterprises operating in one region may be owned by enterprises located in another region and so classified to this other region. The smaller the unit size the more likely it is to be a single plant firm operating at a single location. The theoretically ideal unit is one with substantial operational autonomy at the location where it is recorded. In practice the unit could affect places where it controls other units without substantial autonomy. For empirical purposes much depends upon how 'a certain autonomy' is interpreted in the data.

[13] The weight assigned to each enterprise was the number in the population divided by the number of responses in that stratum. On average each respondent represents 11 enterprises in the population. In our smaller sample there is a maximum of 13367 enterprises, the median weight is 7.4 and the mean 10.4. The largest percentile has a weight of 45.7 and the smallest 1.43.

In the empirical specification of (1) human capital is measured by whether or not the enterprise employs graduates[14]. Collaboration options are those with other group enterprises, with customers, with suppliers, with competitors and with universities. Firm size is measured as the log of turnover in 2002. Enterprise 'age' is whether the firm was established after 1 January 2000. Intramural R&D spending is normalised by turnover and so is plant and machinery investment. Binary UK state policy variables distinguish R&D tax credit claimed, local/regional state support for innovation, and national/devolved state support. EU policy variables are first, whether support was received and second if so, whether the enterprise participated in 5th or 6th Framework. 14 industrial sectors are distinguished and 12 regions.

Table 3 CIS4 Descriptive Statistics (Weighted)

	Firm Size	
	Large	SME
UK state innovation aid	0.1039	0.0950
State aid exc tax credit	0.1039	0.0950
Tax credit claimed	0.0526	0.0421
EU aid	0.0232	0.0134
EU framework programme	0.0149	0.0084
Innovation	0.5272	0.3638
Collaboration *–other group*	0.1624	0.0669
suppliers	0.1859	0.1046
customers	0.1842	0.1008
competitors	0.1101	0.0582
university	0.0982	0.0454
Human capital: graduates employed	0.7671	0.5564
Percent graduates	16.296	16.912
Size: ln. turnover 2002	10.466	7.2644
Age: start after 1.1. 2000	0.0819	0.1398
Intramural R&D/Turnover	0.0156	0.0546
Plant and machinery investment/turnover	0.0367	0.0621
Turnover growth 2002-4	0.1792	0.1410
Employment growth 2002-4	0.0984	0.0543
Enterprise group member	0.6768	0.2622
Foreign sales	0.4881	0.3058

[14] The proportions of science and engineering graduates employed in the labour force and the proportion of other graduates did not prove significant explanatory variables.

Notes: Units with zero turnover are excluded. Variables are binary unless specified as ratios, logarithms, percentages or growth rates. SEs in italics. Large firms employ 250 or more,

Just under one in ten SMEs received some form of state innovation aid (Table 3). R&D tax credits were more of a minority interest, with slightly less than one half of firms that received state aid also claiming the credits. More than half of large businesses stated that they innovated in the period 2002-4, compared with little more than one third of SMEs.

SMEs more probably started recently and recorded the higher mean ratios of intramural R&D to turnover and investment. Smaller establishments were less likely to utilise graduates but those that did employed sufficient to ensure that the average proportion of graduate workers, at just under 17 percent, did not vary much between the two size categories. All forms of extra-firm collaboration for innovation were more common with large enterprises.

A comparison of mean turnover and employment growth across enterprise size indicates that, although on average SMEs' turnover rose more slowly, labour productivity grew faster. Large establishments were likely to be members of an enterprise group whereas small establishments were not (three out of four were not). Consistent with their greater probability of a more recent start, small firms were unlikely to export (not much more than a one in four chance) while almost half of large establishments did so.

The foregoing data provide the variables for isolating the impact of receipt of state aid on innovation and, indirectly, on growth. For each enterprise there are two equations of fundamental interest, determining the likelihoods of innovation and growth, and one equation, determining the chances of state support that may be necessary to ensure such support can be treated as exogenous to innovation.

4. Results

4.1 State Aid and Innovation

The first relationship, how state aid affects innovation by SMEs, is estimated by nearest neighbour propensity score matching (Leuven and Sianesi 2003; Oh et al 2009). For matching based upon weighted equations, standard errors of estimates have not been defined in the literature. The Propensity Score programme PSMatch2 authors (Leuven and Sianesi 2003) recommend looking at the balance of weighted and unweighted estimates and choosing the best balance. In addition to doing this, a pseudo-sample is created by grossing up the data with the sample weights, and the matching exercise is conducted on this much larger data set.

In practice there is little difference between results from weighted and unweighted data (Appendix B) and the standard errors for the unweighted and grossed up data are very small relative to the coefficients. Collaboration with Universities is one of the most important positive correlates of the likelihood of receiving state aid for innovation. Exporters, employers of graduates and spenders on R&D are also more likely to have innovation aid. Wales is the region where enterprises are most likely to get aid, and London the least likely.

All firms receiving aid have a counterpart in the non-aided firm population. For instance in (the typical) estimated equation (iii) of Table 4, among those not receiving innovation aid the predicted probability of receiving it (not tabulated) ranges from effectively zero to one with a mean of 0.102 and a median of 0.072. Among those granted innovation aid the predicted probability ranges from 0.01 to 1 with a mean of 0.25 and a median of 0.19. Thus the zone in which there is no 'common support' given by those not receiving aid is extremely small.

Nearest neighbour matching takes each of the SMEs receiving innovation aid and identifies the firm not accepting aid with the most similar propensity score. To ensure the quality of the matches a tolerance for comparing propensity scores is imposed. In table 4 in all but one instance (eq. iv) a 0.001 calliper is set; where the propensity score of an aid-receiving firm falls beyond this bound for a near comparator, the firm remains unmatched and is dropped from the sample. There is a trade-off between more precise matching and a smaller sample.

Table 4: State Aid for Innovation: Propensity Score Matching for SMEs

	weighted data	weighted probit			unweighted probit	
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
UK innovation policy effect	0.29	0.29	0.27	0.23	0.3	0.27
Standard error	0.006				0.02	0.02
Absolute % bias before matching	14.12	14.51	18.62	18.62	14.51	18.61
Absolute % bias after matching	4.17	3.23	2.49	3.34	2.37	2.78
State aided off support	838	64	144		59	141
Total state aided	11591	1142	1142	1142	1142	1142
Total sample	121995	10093	10093	10093	10093	10093
Specification	Restricted	restricted	Full	Full	restricted	Full
.001 caliper no replacement	Yes	yes	Yes	No	yes	Yes

Note: standard errors cannot be calculated for weighted probits. Nearest neighbour matching.

Since the present sample is quite large, the calliper approach is generally preferred. In equation (iv), without the calliper, although the mean gap between the probability score and that of the nearest neighbour is only .0006, or .06 percent, the 99th percentile gap is .012 or 1.2 percent. The cost of using the calliper is seen in the fifth row of Table 4, 'State aided, off support'. For equation (iii), 144 out of 1142 cases receiving aid must be dropped. The matching is generally good. For equation (iii) Table 4 for instance, after matching no variables are significantly different between the aid recipients and no aid recipients at the one percent level and only two variables out of 36 are significantly different at the five percent level (Appendix C)[15].

[15] In Appendix C the value of 'foreign sales' of aid recipients after matching is 0.527 and for the control group it is 0.573. This difference is significant at the 3.9 percent level. However dropping the foreign sales variable from the state innovation support equation reduces the equation fit, leads to a significant difference at

All the coefficients from the exercises reported in Table 4 are very similar. On the basis of lowest absolute percentage bias after matching, an innovation aid 'treatment effect' of 0.27 with a standard error of about .02 seems the most justifiable[16]. The lowest effect (0.23, Table 4 equation iv) is achieved with the uncallipered approach but the maximum absolute value of [propensity score –propensity score (nearest neighbour)] was as high as 0.037. Hence the calliper results are preferred; dropping some observations seemed a worthwhile price to achieve a closer match.

Because the state aid equation specification may affect the results, a version ('restricted') (not tabulated) excluding the collaboration arrangements of the SME was compared with a version including them ('full')(Appendix B). The fuller specification is a better predictor of support and reduces the absolute bias after matching relative to the restricted specification in the weighted callipered equations (compare estimated equations (ii) and (iii) Table 4) from 3.23 to 2.49 percent. Equations (v) and (vi), the unweighted versions of equations (ii) and (iii), might suggest a preference for the larger coefficient of 0.3, for eq (v) has the lower bias. But the aim of the present exercise is to establish a conservative or downward biased estimate of the policy impact so equation (iii) (or (vi)) is preferred.

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the 5 percent (but not the one percent) level after matching between treated and control SMEs for one region and one SIC, and raises the estimate of the effect on innovation of support. For these reasons, and because the difference was not significant at the one percent level, the specification of Table 4 iii was preferred.

[16] This estimate, that receipt of UK state support for innovation raises the chances that a service or manufacturing SME will innovate by 27 percentage points, is not readily compared with other results, which generally refer to different groupings of firms, model specifications and/or policy instruments. For example, Griffith et al. (2006) find that UK national funding increases the chances of whether R&D is undertaken (by all firms) by 19 percentage points. Restricting themselves to SMEs (as in the present study but focussing on a different policy instrument) in England and Wales, Wren and Storey (2002) estimate a thirty to one ratio between the increase in turnover and the outlays on the state funded marketing initiative. For a sample of 3000 English SMEs Mole et al (2009) find significant employment expansion from intensive business support but not from other types.

As for the tax credit, the matching exercise suggests that there is no significant difference between tax credit effects (0.296) and non-tax credit innovation aid impact (0.298) using the unweighted estimates (Table 5). These are closer than the weighted estimates (which are 0.303 – equation iv- for the tax credit and 0.274 –equation iii - for other innovation aid) for which we do not have standard errors, but with the unweighted standard errors of 0.02 the difference between the effects of the two types of aid would not be significant. In the light of the greater cost of the tax credit support, as well as the supposed greater efficiency, this finding is striking; a significantly larger tax credit 'treatment effect' would be expected.

Table 5: SME Tax Credit Compared with Other State Aid for Innovation-Matching

	unweighted probit		weighted probit	
	(i)	**(ii)**	**(iii)**	**(iv)**
Tax credit policy effect	0.296			.8429-.5399 =.303
Standard error	0.03			
Nontax credit UK innovation policy		0.298	.7164-.4424 =.274	
Standard error		0.02		
Absolute % bias before matching	18.37	14.63	14.64	18.37
Absolute % bias after matching	3.15	2.65	3.14	4.67
State aided off support	18	56	59	18
Total state aided	444	1144	1144	444
Total sample	10066	10219	10219	10066
Specification	restricted	restricted	restricted	restricted
.001 caliper no replacement	yes	yes	yes	yes

It is instructive to compare single equation estimates of the impact of innovation aid with the matching exercises. The weighted probit for SMEs yields a policy impact coefficient (0.27) comparable with those of the calliper equations, weighted and unweighted, with the same full specification, and a comparable standard error of 0.024 (Equation (i) Table 6)[17]. Similarly, there is no significant difference in the coefficients on

[17] In accordance with the strategy of downwardly biasing the estimate of returns, equation (i) Table 6 includes foreign sales because the variable slightly lowers the policy coefficient compared with the specification excluding exports.

the tax credit and the non-tax credit state aid in innovation equation (ii) Table 6, although the tax credit coefficient is smaller.

Because all these estimates are obtained from cross-section rather than panel data, one interpretation of the similarity of the probit and propensity score measurement parameters is that both are upward biassed – on the grounds that the probits do not control for unobserved heterogeneity (discussed in section 3.2). In the following section the sensitivity of the policy conclusion to a halving of the parameter is therefore tested. Alternatively the similarity of the estimates could be interpreted as indicating the unimportance of such heterogeneity in this case.

TABLE 6 HERE

4.2 Innovation Impact

The second key relationship to be estimated is how innovation affects the expansion of the innovating enterprise. In the growth equations for SMEs in Table 7, equation (i) provides a test of the endogeneity of innovation to the growth of the firm. The innovation residuals in the control function just reject endogeneity at the five percent level with a two tailed test. The innovation coefficient itself is large, at 0.19, and significantly greater than zero at the one percent level (equation (i)). But with a large standard error, it is not significantly different from the OLS coefficient of 0.073 at the 95 percent level (equation (iii) Table 7). The IV estimate (equation (ii)) of the innovation coefficient is smaller than the control function estimate, at 0.1483, significant at the 2.2 percent level[18]. But even more than the control function estimate, the wide standard errors leave considerable doubt as to the true value of the coefficient. It is however worth noting that a similar specification estimated on CIS4 large firm data does not reject the null that the innovation coefficient is zero, implying that pooling firms of all sizes for these innovation impact estimates could be misleading.

[18] The higher value of the IV estimate of the innovation coefficient is consistent with (unobserved) innovative SME managements being less prone to expand their firms than others. The first stage F statistic of 80 is not consistent with weak instruments, nor is the significance of Shea's partial R^2. The Hanson J coefficient does not reject the joint null hypothesis that the instruments are valid (uncorrelated with the disturbance term) and that the excluded instruments are correctly excluded from the estimated equation.

If the innovation residual coefficient of (i) is judged statistically insignificant, IV estimation is inappropriate. Certainly this is the line to take when, as here, the objective is to establish a conservative or downward biased estimate of innovation policy impact. On these grounds the innovation coefficient of the OLS equation (iii) Table 7, 0.073, is the most reliable estimate available, with a 95 percent chance that the true value lies between 0.04 and 0.106[19].

Table 7 here

The other coefficients are of less fundamental interest, other than as controls. Whether or not they are biased by unobserved heterogeneity is therefore not critical to estimating the impact of innovation policy. Nonetheless there appears to be a consistently large positive growth effect across estimation methods from being a new firm. Other substantial impacts are associated with membership of an enterprise group and employing graduates. Surprisingly perhaps, exporting appears to make no difference to growth of turnover.

SMEs in mining and quarrying, the base case, were in a relatively fast growing sector, not different from financial intermediation and significantly greater than most manufacturing sectors. Only SMEs in electricity gas and water were likely to grow faster. The sole significant effect at the regional level was the slower growth of SMEs in the West Midlands.

5. Was Innovation Policy Efficient?

The return to the state support for innovation by SMEs depends on the boost to well-being from innovation. In section 3.3 and Appendix A it is contended that change in turnover or revenue (ΔR) is the most appropriate available indicator of change in

[19] Griffith et al. (2006) estimate 5.5 per cent higher labour productivity for firms with product innovation, less than 0.073 but the present estimate is for the effect on turnover not on labour productivity (for reasons explained at length in Appendix A). Moreover a sensitivity analysis is conducted in section 5 below. Here the coefficient is reduced by one standard error, from 0.073 to 0.058 (similar to the Griffith et al figure) and the large returns are not substantially dented. Usng CIS3 Griffith et al consider only firms with more than 20 employees and cover the full size range above this level, in contrast to the present exercise.

wellbeing, as measured by consumers' surplus and profits. This then is the return to policy. The counterfactual policy is no state support. So the number of firms (n) actually receiving aid may be denoted by the increase in state support (ΔS) from the counterfactual position (where S is a binary variable as defined in section 3.2 above).

The proportionate increase in turnover induced by innovation aid for the average firm is the proportion of SMEs aided (n/N) times the product of two parameters. They are, first from equation (1), the increase in the chances of the average firm innovating (Δ Pr(I)) as a consequence of receiving state aid for this purpose (defined as $\alpha = \Delta Pr(I)/\Delta S$)). The second, from equation (3), is the average SME's lift to turnover as a result of innovating (defined as $k = \Delta R/(\Delta I.R)$). The result of state supported innovation for the average SME is then;

$$\Delta R/R = \alpha.k.(n/N) \qquad ...(4)$$

where ΔR is the measure of induced SME profit (Π) and the consumers' surplus (CS). Aggregating over the whole economy ΔR must be evaluated in terms of value added. Relevant GDP is N.v, where v is the average SME value added and N is the number of SMEs. Average SME value added is less than average turnover. The consumers' surplus and profit measures are calculated as proportions of turnover ($\Delta R/R \leq ((\Delta CS+\Delta \Pi)/R)$) and so are multiplied by R/v to convert them to into GDP units. This allows (4) to be expanded to yield the value of the welfare gain - the product of the turnover boost to the average (non-micro) SME (ΔR) and the number of SMEs (N).

$$N.v.(R/v).(\Delta R/R) = \alpha.k.(n/N)(R/v).N.v = N.\ \Delta R \qquad ...(5)$$

UK private sector GDP 2002 was £830 billion[20]. SMEs account for about one half of British private sector output, but micro firms are not sampled by CIS. Micro firms produce approximately one half of the turnover of the SME sector (BERR 2008). Including their output contribution in the model would upward bias the calculation and

[20] Government weight 0.225 removed from £1075 billion GDP for 2002 from Meader and Tily (2008).

excluding it would impart a downward bias. The latter option is preferred here. So SME innovation policy is assumed to be working on 27.5 percent of private sector output in 2002 or (£830 billion*0.275=) £228 billion. This must equal the product of the average value added per SME (v) and the number of (non-micro) SMEs (N). The ratio R/v for the private sector SMEs was about 2.75 in 2002[21]. The proportion of SMEs aided was (n/N=9.5 percent), the total innovation impact on output (in Table 7 estimated equation.(iii)) is k=0.0733, and the innovation parameter for total innovation support (Table 4 equations (iii) or (vi)) is α=0.27.

Using equation (5), where ΔR is welfare improvement (= increase in consumers' surplus plus profit), the return to state aid in terms of GDP is

= (relevant GDP). (R/v).(Δ R/ΔI. R).(Δ Pr(I)/ΔS).(n/N)

=228*2.75*0.0733*0.27*0.095

=£1180 million in each year in 2002 prices

This must be compared with the approximately £ 320 million p.a. cost of SME innovation policy 2002-4 to obtain the return[22]. Then the downward biased benefit estimate implies more than a 250 percent return on the £320 million outlay. Reducing the state aid coefficient (α) by one standard error (0.02) lowers the return to £1090 million, making little difference. Cutting it in half, halves the money valued return, which is still an excellent 84 percent. Lowering the growth impact of innovation (k) by one standard error (0.015) cuts the benefit to £930 million, again not significantly denting the massive return. Combining this reduced k with a halving of α yields a return of 46 percent; there is plenty of scope for downward revisions of parameter estimates while leaving high policy returns. It should also be remembered that among other large downward biases to the welfare estimates are that benefits to micro firms are not considered, nor are

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[21] Calculated from BIS Table 1 2002 and 2007 Enterprise and Small Businesses. http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/whatwedo/enterprise/enterprisesmes/index.html

[22] Abramovsky et al (2004)'s named support programme totals (using the earlier years, where there are two) amount to £156 million per annum. Multiply by 0.8 (because in January 2004, there were 899 Knowledge Transfer Partnerships, roughly 80% of which involved SMEs; about 2,400 firms, mostly SMEs, and about 200 research base institutions were involved in 75 LINK programmes since the launch of LINK in 1986,) to get an approximation to the SME allocation. Add in SME R&D tax credits of about £0.2 billion p.a. to reach approximately £ 320 million p.a. as the cost of SME innovation policy 2002-4.

spillovers, and that the output impact of an innovation may well continue after the three year period considered[23].

According to the SME equation much of the return to innovation could apparently be earned without the expensive tax credit[24]. Tax credits had a smaller take up than other innovation policies (4.2 percent of SMEs compared with 9.5 percent, Table 3). Table 5, (propensity score matching) and Table 6 (the weighted innovation equation) suggest that the tax credit impact on innovation was unlikely to have been significantly stronger than other innovation policy instruments, despite the greater expense. Perhaps the spread of information about the tax credit in due course would raise innovation rates, but presumably at additional public cost.

6. Conclusion

Three basic equations have been proposed to link innovation support, innovation outcomes and SME growth. By focussing on self-reported innovation the approach ensures a wider coverage of innovative SMEs that respond to policy than included in most studies. The large (around 10,000 observations) representative UK SME sample includes both services and manufacturing businesses, although micro firms are largely excluded.

In view of the inevitable uncertainties in evaluating SME innovation policy, the method has been to aim for a downward biased or conservative estimate of impact. The study addresses the policy counterfactual of how an enterprise would have performed if it had not received innovation support, when actually it did, with propensity score matching. The matching exercises generated broadly similar estimates of the impact of UK state aid upon innovation, the first key parameter, to those from conventional single equation approaches.

[23] The profits and consumers' surplus performance measure are ratios with turnovers as denominators so the same turnover to value added ratio is needed to calculate the impact in these terms.
[24] Unless tax credits triggered innovations that were disproportionately productive.

To justify the use of the turnover SME performance variable, the paper discussed how policy benefits could best be defined and measured, a theme generally left implicit in the literature. UK SME performance and innovation equations show that self-reported innovation significantly predicts differences in enterprise turnover growth. Estimates of the second key parameter, the effect of innovations on growth, indicate strong and significant boosts to SME revenue. There is no significant difference between the effects on SMEs of R&D tax credits and other state aid for innovation. Since the much smaller take up implies that the tax credit is an expensive instrument, the findings are consistent with Baghana and Mohnen's (2009) assessment of considerable deadweight losses from such credits.

Comparing the calculated payoffs with the outlays implies that the returns to British innovation policy 2002-4 were nonetheless very substantial. Because no attempt is made to calculate spillover benefits between enterprises, the gains for micro enterprises or the persistence of induced innovation effects beyond the three year window, the estimates of policy impact will be downward biased for these reasons. The bias reinforces the conclusion that SME innovation policy is efficient as well as effective. Also, the finding supplements the consensus view of high social returns to R&D by extending it to include other forms of innovation effort, as far as SMEs are concerned. A reason the estimated returns are so large is that, unlike the conventional productivity approach, the performance measure here does take into account demand shifting by innovation and measures welfare effects more appropriately. Also the greater coverage of firms without formal R&D recorded markedly expands the number of SMEs assessed as responding to state innovation aid. These very high returns found suggest that, even in times of public spending cuts, persisting with SME innovation policy would be prudent.

References

Abramovsky, L., Harrison, R. and Simpson, H. (2004), "Increasing innovative activity in the UK? Where now for government support for innovation and technology transfer?", *IFS Briefing Note* no.53

Acs, Z., and Audretsch, D., (1988). Innovation in large and small firms: an empirical analysis. *American Economic Review* 78, 678–690.

Baghana, R. and Mohnen, P.(2009) Effectiveness of R&D tax incentives in small and large enterprises in Quebec*, Small Business Economics* 33:91–107

Belderbos, R., Carree, M., and Lokshin, B. (2004) Cooperative R&D and Firm Performance, *Research Policy*, December v. 33, iss. 10, pp. 1477-92

BERR (2008) SME Statistics for the UK and Regions 2007, http://stats.berr.gov.uk/ed/sme/smestats2007.xls#'UK Private Sector'!A1

BIS (2010) *Internationalisation of Innovative and High Growth SMEs*, BIS Economics Paper No.5 March, Department for Business Innovation and Skills.

Blundell, R., and Costa Dias, M. (2000). Evaluation methods for non-experimental data. *Fiscal Studies* 21: 427-468.

Cassiman B. and Veugelers R (2002), R&D Cooperation and Spillovers: Some Empirical Evidence from Belgium, *American Economic Review*, 92, 4, pp. 1169-1184.

Cassiman B. and Veugelers R (2005), R&D Cooperation between Firms and Universities, Some Empirical Evidence from Belgian Manufacturing, *International Journal of Industrial Organization*, 23, pp. 355-379.

Crepon, B., Duguet, E. and Mairesse, J. (1998) Research, Innovation, and Productivity: An Econometric Analysis at the Firm Level. *Economics of Innovation and NewTechnology* , 7(2), 115–158.)

Czarnitzki, D., Hanel, P., and Rosa, J. (2011). Evaluating the impact of R&D tax credit on innovation: A microeconometric study on Canadian firms. *Research Policy*, 40, 2, 217-229.

Davenport, T. H. and Prusak, L.(1998) *Working knowledge: how organizations manage what they know.* Boston, Ma: Harvard Business School Press

Department for Innovation Universities and Skills (2008) *Persistence and change in UK innovation 2002-2006*, http://www.dius.gov.uk

DTI (2006) *Innovation in the UK: Indicators and Insights* DTI occasional paper no. 6 July

DTI Innovation Report (2003) *Competing in the global economy: the innovation challenge ,* December, http://www.berr.gov.uk/files/file12093.pdf

Freel M S (2000) Do Small Innovating Firms Outperform Non-Innovators? *Small Business Economics* 14 195–210

Gourieroux C, Monfort A, Renault E and Trognon A l (1987) Generalised Residuals, *Journal of Econometrics*. 34, iss. 1/2, pp. 5-32

Griffith, R , Redding S and Van Reenen J (2001) Measuring the Cost-Effectiveness of an R&D Tax Credit for the UK, *Fiscal Studies* vol. 22, no. 3, pp. 375–399

Griffith R, Huergo, E, Mairesse, J and Peters, B (2006) Innovation and Productivity Across Four European Countries, *Oxford Review of Economic Policy* 22 4 483-498
Griliches, Z. (1990). Patent statistics as economic indicators: a survey. *Journal of Economic Literature*. vol. 28. December. pp. 1661-1707.
H M Treasury (2003) *The Green Book: Appraisal and Evaluation in Central Government,* London TSO, http://www.hm-treasury.gov.uk/d/green_book_complete.pdf
Hall, B. (2009) The Financing of Innovative Firms, *EIB Papers* 14, 2, 8-29
Hall, B. and Van Reenen, J. (1999), 'How effective are fiscal incentives for R&D? A review of the evidence', *Research Policy*, vol. 29, pp. 449–69
Hall, B. Lotti, F. and Mairesse, J. (2009) Innovation and Productivity in SMEs: Empirical Evidence for Italy, *Small Business Economics* 33, 1, pp. 13-33
Harris R (2008*) An Empirical Study of the Respective Contributions of Exporting and Foreign Direct Investment to UK R&D*, UK Trade and Industry, November
Harris R I D and Robinson C (2001) *Final Report: Research Project on DTI Industrial Support Policies,* DTI Ref: SEC Research 01 ITT No. SEC01
Harris, R., Cher Li ,Q. and Trainor M (2009) Is a higher rate of R&D tax credit a panacea for low levels of R&D in disadvantaged regions? *Research Policy* 38 192–20
Heckman, J. J. (1979). Sample Selection Bias as a Specification Error. E*conometrica* 47(1) 153-161
Heckman, J.J. and Navarro, S., (2004). Using matching, instrumental variables, and control functions to estimate economic choice models. *Review of Economics and Statistics* 86 (1) 30-57.
Heckman, J.J., Ichimura, H. and Todd, P. (1997) Matching as an econometric evaluation estimator: evidence from evaluating a job training program, *Review of Economic Studies* 64 4 605 -654
HM Treasury, DTI and DfES, (2004) *Science and Innovation Investment Framework 2004–2014*, July
Howells, J., (2005) Innovation and regional economic development: a matter of perspective. *Research Policy* 34, 1220–1234.
Ientile D and Mairesse J (2009) A policy to boost R&D: Does the R&D tax credit work? *EIB Papers* 14, 1, 145-168
Jaumotte F and Pain N (2005a) Innovation in the Business Sector, *OECD Economics Department Working Papers no. 459*
Jaumotte F and Pain N (2005b) From innovation development to implementation: evidence from the community innovation survey*, OECD Economics Department Working Papers no. 458*
Jones C and Williams, J. (1998), 'Measuring the social return to R&D', *Quarterly Journal of Economics*, vol. 113, pp. 1119–36.
Kleinknecht A (1987) 'Measuring R&D in Small Firms: How Much are we Missing?', *Journal of Industrial Economics*, 36, 253-256.
Leuven, E. and Sianesi, B. (2003). 'PSMATCH2: Stata module to perform full Mahalanobis and propensity score matching, common support graphing, and covariate imbalance testing' http://ideas.repec.org/c/boc/bocode/ s432001.html.

Lev, B. (2001) *Intangibles: management, measurement, and reporting*, Washington, D.C.: Brookings Institution Press.
Lotti, F., Santarelli, E. and Vivarelli, M. (2009) Defending Gibrat's Law as a long-run regularity. *Small Business Economics* 32:31–44
Maddala G S (1983) *Limited dependent and qualitative variables in econometrics.* Cambridge: Cambridge University Press
Meader R. and Tily G. (2008) 'Overview of UK National Accounts and Balance of Payments: Blue Book and Pink Book 2008' *Economic and Labour Market Review* 2 10 33-43
Mole, K., Hart, M. and Roper, S. Assessing the Effectiveness of Business Support Services in England, *International Small Business Journal*, 27, October 2009, 557–83.
Monjon**,** S and Waelbroeck, P (2003) Assessing Spillovers from Universities to Firms: Evidence from French Firm-Level Data*, International Journal of Industrial Organization*, November v. 21, iss. 9, pp. 1255-70
North D. and Smallbone D. (2000) The innovativeness and growth of rural SMEs during the 1990s, *Regional Studies* 34, 145–157.
OECD (2003), *Tax Incentives for Research and Development: Trends and Issues*, Paris.
Oh, I., Lee J-D., Heshmati, A. and Choi, G.-G. (2009) Evaluation of credit guarantee policy using propensity score matching, *Small Business Economics* (2009) 33:335–351
Pakes, A., and Ericson, R. (1998). Empirical implications of alternative models of firm dynamics. *Journal of Economic Theory*, 79, 1–45.
Rammer C., Czarnitzki D., and Spielkamp, A. (2009) Innovation success of non-R&D-performers: substituting technology by management in SMEs. *Small Business Economics* 33: 35–58
Roper, S., Du, J and Love J H., (2008) Modelling the Innovation Value Chain, *Research Policy*, 37, 6-7, July 961-977
Rosenbaum, P. and Rubin, D. (1983), The central role of the propensity score in observational studies for causal effects. *Biometrica* 70,. 41-50.
Skuras, D., Tsegenidi, K. and Tsekouras, K. (2008) Product innovation and the decision to invest in fixed capital assets: Evidence from an SME survey in six European Union member states. *Research Policy* 37 1778–1789
Smith K (2005) 'Measuring Innovation' in Fagerberg J Mowery DC and Nelson RR eds *Oxford Handbook of Innovation* , Oxford University Press
Staiger, D. and J. Stock, (1997) Instrumental Variables Regression with Weak Instruments, *Econometrica*, 65(3):557-586.
Sutton, J. (1997). Gibrat's legacy. *Journal of Economic Literature*, 35, 40–59.
Tellis G J (1988) The Price Elasticity of Selective Demand: A Meta-Analysis of Econometric Models of Sales, *Journal of Marketing Research* 25 331-341
Tether B S, Smith I J and Thwaites, A.T. (1997) 'Smaller enterprises and innovation in the UK: the SPRU Innovations Database revisited' *Research Policy* 2 19-32
Wieser, R., (2005). Research and development productivity and spillovers: empirical evidence at the firm level. *Journal of Economic Surveys* 19, 4, 587–621.
Wren C and Storey D J (2002) Evaluating the Effect of Soft Business Support upon Small Firm Performance *Oxford Economic Papers* 54 334-355

Table 6. SME Innovation Probits (Weighted)

	(i) dF/dx	SME robust S.E.	(ii) dF/dx	SME robust S.E.
UK state aid	0.2679	0.0238		
tax credit			0.1872	0.0516
other UK state aid			0.2291	0.0288
graduates	0.1608	0.0139	0.1813	0.0133
foreign sales	0.1366	0.0160		
investment/turnover	0.0106	0.0096	0.0117	0.0092
R&D/turnover	0.4106	0.2120	0.3228	0.1538
collaboration – other group	0.1051	0.0414	0.0872	0.0395
suppliers	0.2278	0.0395	0.2356	0.0395
customers	0.1735	0.0432	0.1557	0.0419
competitors	-0.0657	0.0399	-0.0885	0.0366
university	0.0209	0.0430	0.0335	0.0415
EU aid			0.1065	0.1030
framework programme			-0.1884	0.0790
start after 01/01/2000	0.0586	0.0207	0.0571	0.0202
log turnover	0.0092	0.0051	0.0158	0.0050
mfr of food, clothing, wood, paper	0.1759	0.0565	0.1948	0.0553
mfr of fuels, chemicals, plastic	0.1691	0.0554	0.2093	0.0540
mfr of electrical and optical	0.2613	0.0580	0.3038	0.0555
mfr of transport equipments	0.1494	0.0671	0.1930	0.0651
mfr not elsewhere classfied	0.2390	0.0598	0.2695	0.0581
electricity, gas & water supply	-0.1010	0.1044	-0.0980	0.1029
construction	-0.0523	0.0518	-0.0853	0.0478
wholesale trade (incl cars & bikes)	0.1656	0.0582	0.1319	0.0564
retail trade (excl cars & bikes)	0.0288	0.0562	0.0072	0.0535
hotels & restaurants	-0.0202	0.0581	-0.0262	0.0559
transport, storage & communication	0.0804	0.0562	0.0943	0.0552
financial intermediation	0.1484	0.0618	0.1487	0.0607
real estate, renting & business	0.1712	0.0538	0.1736	0.0526
observed probability	0.3588		0.3504	
predicted probability (at x-bar)	0.3605		0.3477	
number of observations	10338		10547	
Wald Chi2	1241.67		1187.7	
log pseudolikelihood	-5539.30		-5690.09	
pseudo R2	0.1791		0.1671	

Table 7 **SME (Weighted) Growth of Turnover 2002-2004**

	(i) Control Function		**(ii) Instrumental Variable estimate**		**(iii) OLS**	
	coeff	**robust t**	**coeff**	**robust z**	**coeff**	**robust t**
Innovation	0.1908	3.040	0.1483	2.290	0.0733	4.380
Gourieroux generalised residuals	-0.0714	-1.910				
start after 01/01/2000	0.1717	6.620	0.1740	6.760	0.1741	6.570
enterprise group member	0.1270	4.850	0.1255	4.780	0.1300	5.060
graduate	0.1135	5.260	0.1209	5.580	0.1442	6.750
foreign sales	-0.0081	-0.420	-0.0005	-0.030	0.0210	1.090
log turnover	-0.1587	-8.350	-0.1584	-8.350	-0.1653	-8.370
mfr of food, clothing, wood, paper	-0.1345	-2.880	-0.1282	-2.710	-0.1212	-2.630
mfr of fuels, chemicals, plastic	-0.1513	-3.240	-0.1445	-3.060	-0.1388	-2.990
mfr of electrical and optical	-0.1957	-3.610	-0.1838	-3.360	-0.1708	-3.280
mfr of transport equipments	-0.0450	-0.880	-0.0390	-0.750	-0.0318	-0.620
mfr not elsewhere classfied	-0.1580	-3.050	-0.1488	-2.840	-0.1394	-2.750
electricity, gas & water supply	0.4244	1.950	0.4203	1.920	0.4171	1.920
construction	-0.0628	-1.320	-0.0636	-1.330	-0.0681	-1.420
wholesale trade (incl cars & bikes)	-0.0262	-0.550	-0.0204	-0.420	0.0139	0.280
retail trade (excl cars & bikes)	-0.2070	-4.020	-0.2053	-3.950	-0.2090	-4.020
hotels & restaurants	-0.2509	-4.300	-0.2509	-4.280	-0.2585	-4.390
transport, storage & communication	-0.0845	-1.670	-0.0814	-1.590	-0.0778	-1.530
financial intermediation	-0.0121	-0.210	-0.0060	-0.100	0.0049	0.080
real estate, renting & business	-0.1927	-3.800	-0.1848	-3.600	-0.1784	-3.580
N E England	-0.0445	-1.160	-0.0445	-1.160	-0.0476	-1.250
N W England	-0.0143	-0.370	-0.0137	-0.350	-0.0201	-0.520
Yorks &Humber	-0.0121	-0.320	-0.0105	-0.280	0.0075	0.170
E Midlands	-0.0170	-0.450	-0.0198	-0.520	-0.0192	-0.510
W Midlands	-0.0899	-2.420	-0.0900	-2.430	-0.0969	-2.610
E England	-0.0610	-1.660	-0.0623	-1.690	-0.0680	-1.850
S E England	-0.0203	-0.570	-0.0216	-0.600	-0.0315	-0.880
S W England	-0.0749	-1.770	-0.0759	-1.790	-0.0813	-1.930
Wales	0.0229	0.560	0.0251	0.610	0.0193	0.480
Scotland	-0.0020	-0.050	0.0009	0.020	-0.0030	-0.080
N Ireland	-0.0114	-0.320	-0.0115	-0.320	-0.0173	-0.480
constant	1.2867	8.160	1.2886	8.170	1.3444	8.280
number of observations	10296		10296		10429	
R^2	0.1461		0.1427		0.1471	

Note: eq (ii) the instrumented variable is innovation.. Excluded instruments: uk innovation aid, collaboration variables, R&D and investment. Partial R-squared of excluded instruments: 0.0885, Test of excluded instruments: F(8, 10258) = 89.70, Prob > F = 0.0000,

First stage F(37, 10258) = 80.79

Anderson canon. corr. LR statistic (identification/IV relevance test): 953.984, Chi-sq(8) P-val = 0.0000; Hansen J statistic (overidentification test of all instruments): 5.428, Chi-sq(7) P-val = 0.6079; Anderson-Rubin test of joint significance of endogenous regressors B1 in main equation, Ho:B1=0, F(8,10258)= 3.22 , P-val=0.0012, NB: Anderson-Rubin stat heteroskedasticity-robust,

For large firms only: Anderson-Rubin test of joint significance of endogenous regressors B1 in main equation, Ho:B1=0, F(8,2371)= 0.59 P-val=0.7848

Appendix A. The value of innovation

This appendix examines the relationship between the immediate consequences for profits, consumers' surplus and turnover or revenue of two types of innovation by a firm with constant marginal costs facing a constant elasticity of demand function. The purpose is first to show that with this plausible model some conventional measures of innovation impact substantially underestimate the welfare gains. The second purpose is to demonstrate that the proportionate increase in turnover is generally a good (close or downward biased) proxy for welfare (consumers' surplus plus profits) increase. This allows the return to innovation policy spending to be calculated in section 5 above.

Product Innovation

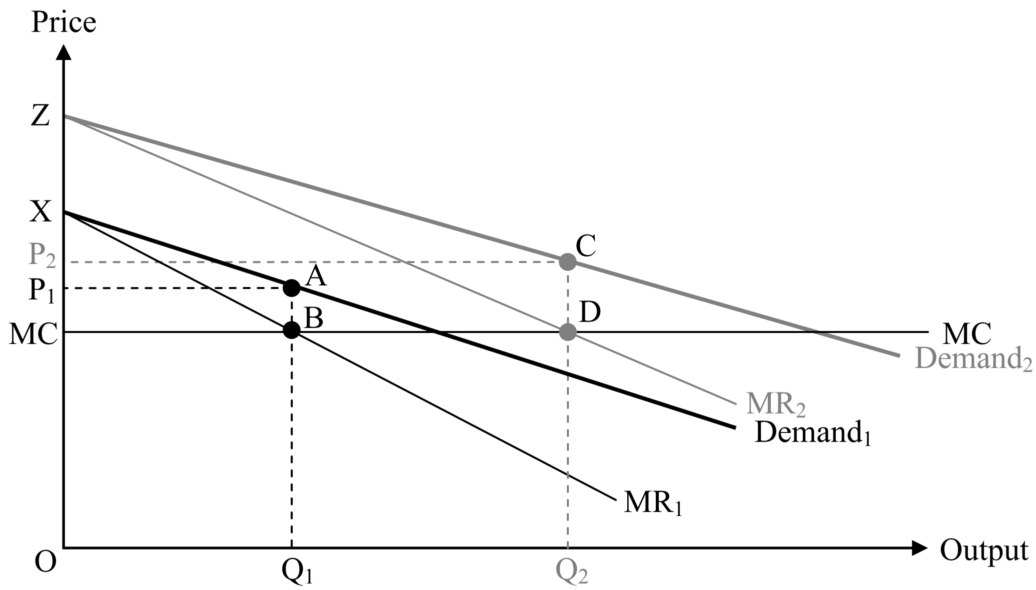
To fix concepts first a diagrammatic presentation with linear demand is given. Product innovation shifts the demand function faced by the firm from Demand 1 to Demand 2 with marginal revenues MR_1 and MR_2 and constant marginal costs MC. In figure A1 willingness to pay increases as a result of the new product from XAQ_1O to ZCQ_2O. Additional resources of Q_1Q_2DB are utilised ('displaced') by the enterprise[25]. So the net social benefit from the innovation is the change in consumers' surplus ZCP_2 –XAP_1 plus the change in the firm's profit P_2CDMC – P_1ABMC. The change in the firm's revenue or turnover is the sum of the profit increase and the cost rise or displacement. In the long run, when there are no effective entry barriers, this profit may be eliminated as competition shifts back the demand curve.

In figure A1, strictly Q_1 is a different entity from Q_2, transformed by the product innovation. The market would have been willing to pay at the margin more for the new product at volume Q_1 than for the old product. This greater willingness to pay is represented by the upward shift in the demand curve at Q_1. However in models without an explicit demand function, this will not be identified. What will be observed are equilibria P1, Q1 and P2, Q2 and these, after due allowance for the extra resources absorbed, will provide the estimated productivity impact of the innovation. Inspection of figure A1 as drawn suggests some productivity increase, more revenue in relation to costs, would be estimated. But in the constant elasticity case considered

[25] Displacement measures the extent to which the benefits of a project are offset by reductions of output or employment elsewhere (H M Treasury 2003 p.53).

below there is no equilibrium price increase and therefore measured productivity (the ratio of revenue to costs) does not change at all, even though welfare has risen substantially. Hence productivity and production function estimates of innovation without enterprise demand functions are likely markedly to under-estimate returns to innovation.

Figure A1. Product Innovation for a firm with market power



Assuming for the innovating firm a constant elasticity demand function, where P is price and Q output volume, $Q=aP^b$. From which turnover or revenue is, $R=PQ= Q^{(1/b)+1} a^{-1/b}$

And marginal revenue $MR = \partial R/\partial Q= a^{-1/b}((1/b)+1)Q^{1/b}$

The profit maximisation first order condition is

$MR=((1/b)+1)(Q/a)^{1/b} =MC =((1/b)+1)P$

$MR_2/MR_1=MC_2/MC_1=(a_1Q_2/a_2Q_1)^{1/b} =1$

In this case with no change in marginal costs the proportionate shift in MR or the demand function is the same as the proportionate increase in Q;

$a_2/a_1 = Q_2/ Q_1$

where the shift in MR is given by the change in a, $a_2>a_1$.

And $P_2/P_1 = MC_2 /MC_1$

With no change in marginal cost by assumption, price is unaltered.

The proportionate revenue change is therefore the same as the volume change.

Similarly for profits:

$\Pi = P.Q\text{-}Q.MC = Q(P\text{-}MC) = -(1/b)Q.P$

$\Pi_2 / \Pi_1 = Q_2 / Q_1$

$\Pi_1/R_1 = -(1/b)Q_1.P_1 / P_1Q_1 = -1/b$

The profit to turnover ratio falls as the elasticity b increases.

With price held constant at P_1 say, the difference in consumers' surplus (CS) is

$$\Delta CS = \int_0^{Q_2} P(a_2^{-1/b}, Q)\, dQ - \int_0^{Q_1} P(a_1^{-1/b}, Q) dQ$$

Consumers' surplus increase in relation to revenue is;

$$\frac{\Delta CS}{R_1} = \frac{b}{(b+1)}\left\{\left[\frac{Q_2}{Q_1}\right]^{\frac{(b+1)}{b}}\left[\frac{a_1}{a_2}\right]^{\frac{1}{b}} - 1\right\} = \frac{b}{(b+1)}\left\{\left[\frac{R_2}{R_1}\right] - 1\right\}$$

The total welfare increase includes profits as well as consumers' surplus, and this tends to raise the welfare increase above the turnover or revenue expansion proxy but by less as the elasticity rises (in absolute value). When b=-2.5, an increase in turnover of 10 percent is associated with an rise in the ratio of consumers' surplus to revenue of 16.66 percent[26]. Adding the increase in profits;

$\Delta\Pi/R_1 = -1/b\ [(R_2/R_1) - 1]$

amounting to 4 percent, the welfare change reaches 20.6 percent. For all plausible elasticities, turnover increase from product innovation understates the rise in welfare.

Process Innovation

In Figure A2 a process innovation shifts the cost function from MC_1 to MC_2. Turnover increases from P_1EQ_1O to P_2FQ_2O. The increase in consumers' surplus is P_1EFP_2 and in profits P_2FDMC_2 - P_1EBMC_1. 'Displacement' could be negative, resource use could be lower, if $MC_1BCMC_2 > CDQ_2 Q_1$.

Assuming a constant elasticity demand function $Q=aP^b$, $R=PQ= Q^{(1/b)+1} a^{-1/b}$

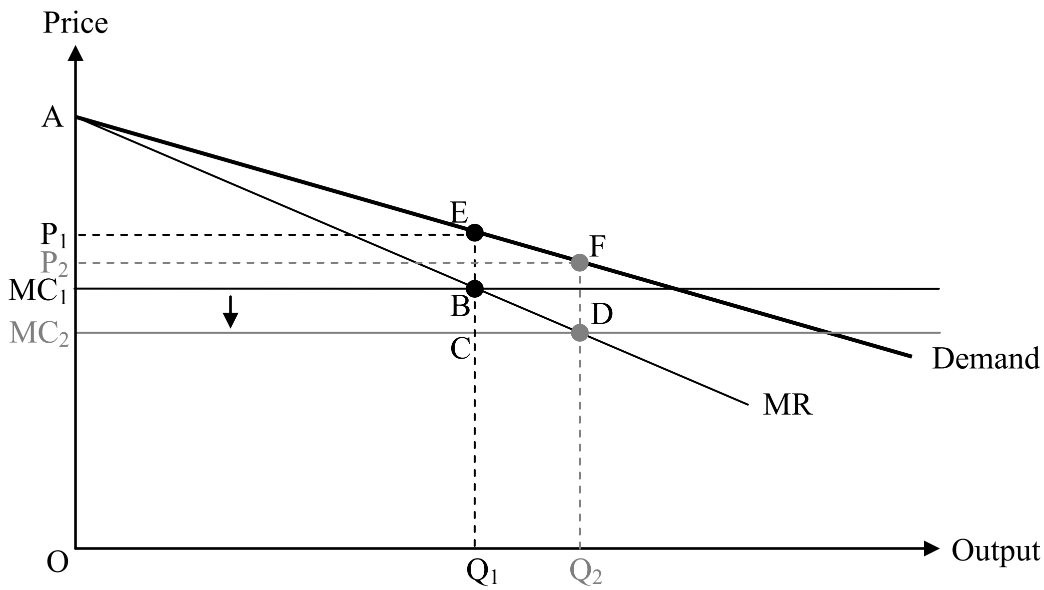
and MR $= \partial R/\partial Q = a^{-1/b}((1/b)+1)Q^{1/b}$.

The profit maximisation first order condition is $MR_2/MR_1 = MC_2/MC_1 = (Q_2/Q_1)^{1/b}$.

A process innovation that lowers average and marginal costs by MC_2/MC_1 will increase profit maximising output by $(MC_2/MC_1)^b$ and (as can be seen by substituting into the demand function) reduce profit maximising prices by the same fall in the marginal cost ratio.

[26] Tellis (1988) in a meta-analysis of several hundred price elasticity studies found a mean price elasticity of -1.76 which he raised to about -2.5 to take into account method-induced biases.

Figure A2. Process Innovation for a Firm with Market Power



Since $P = (Q/a)^{1/b}$

$P_2/P_1=MC_2/MC_1$

So $R_2/R_1=P_2Q_2/P_1Q_1 = (MC_2/MC_1)^{1+b}$

With an elasticity of b=-2.5 turnover increases by more than the marginal costs fall, but with an elasticity of b=-1.5, turnover increases by less.

The profit (Π) identity is

$\Pi = P.Q-Q.MC= Q(P-MC)$

And

$MR=((1/b)+1)(Q/a)^{1/b} =MC =((1/b)+1)P$

So $\Pi = - (1/b)Q.P$

$\Pi_2/ \Pi_1 = R_2/R_1$

And Π_1/R_1

$= -1/b$

Profit increases proportionately with turnover.

The change in consumers' surplus (CS) as a proportion of initial revenue (R_1) consequent upon the innovation-induced price fall from P_1 to P_2 is

$(\int_{P1}^{P2} Q(P)dP)/R_1 = \Delta CS/R_1=(1/(b+1))(1- (P_2/ P_1)^{b+1})$

The proportionate fall in marginal costs from the process innovation is the same as the proportionate decline in price. When b=-2.5 a 10 percent fall in prices and marginal costs raises the ratio of consumers surplus to revenue by 11.3 percent. $(P_2/ P_1)^{b+1}$ can be written in terms of revenue by substituting in the demand function, as $(Q_2P_2)/Q_1P_1 = R_2/R_1$.

So the relationship of this revenue or turnover to the consumers' surplus measure is

$\Delta CS/R_1 = 1/(b+1)[1- (R_2/R_1)]$.

Revenue change overstates the gain in CS/R from process innovation by 50 percent with an elasticity of -2.5 but total welfare change includes the additional profit as well;

$\Delta\Pi/R_1 = [(R_2/R_1) – 1](\Pi/R_1) = -(1/b)[(R_2/R_1) – 1]$

When b=-2.5 a 15 percent increase in revenue from a process innovation (representing a 10 percent increase in CS/R) is associated with a 6 percent rise in the profit to pre-innovation revenue. Adding the two welfare components and using Tellis's (1988) estimate of mean price elasticity then shows turnover increase from this type of innovation as well is less than the total welfare increase.

Appendix B. State Aid Equations

Probability of SMEs Receiving Innovation Aid (Probit)				
	weighted		unweighted	
	dF/dx	robust z	dF/dx	robust z
foreign sales	0.0637	8.24	0.0574	8.52
log employment	0.0115	2.31	0.0139	3.34
log turnover	-0.0094	-2.61	-0.0132	-4.31
R&D/turnover	0.0624	2.67	0.0422	2.04
investment/turnover	-0.0218	-1.31	-0.0099	-0.85
Graduates	0.0388	5.34	0.054	8.43
start after 01/01/2000	0.0135	1.36	0.0117	1.35
collaboration – other group	-0.0138	-1.03	-0.0193	-1.58
Suppliers	0.0315	1.81	0.0338	2.17
Customers	0.0427	2.43	0.0555	3.36
Competitors	-0.0072	-0.51	-0.0013	-0.1
University	0.16	7.37	0.1613	8.79
N W England	-0.0324	-2.96	-0.0347	-3
Yorks &Humber	-0.0169	-1.32	-0.0359	-3.04
E Midlands	-0.0411	-3.97	-0.0516	-4.64
W Midlands	-0.0338	-3.04	-0.0431	-3.87
E England	-0.0479	-4.84	-0.052	-4.8
London	-0.0536	-4.81	-0.0663	-6.2
S E England	-0.04	-3.72	-0.0497	-4.58
S W England	-0.0338	-3.04	-0.0491	-4.35
Wales	0.0375	2.59	0.044	2.93
Scotland	0.0001	0	-0.0073	-0.56
N Ireland	0.0019	0.15	0.0062	0.49
mfr of food, clothing, wood, paper	0.0192	0.74	0.0306	1.07
mfr of fuels, chemicals, plastic	0.0415	1.52	0.0566	1.9
mfr of electrical and optical	0.0602	1.89	0.0725	2.15
mfr of transport equipments	0.0122	0.43	0.0237	0.74
mfr not elsewhere classfied	0.0326	1.09	0.044	1.36
electricity, gas & water supply	-0.0496	-1.15	-0.0499	-0.85
Construction	-0.0017	-0.07	-0.0094	-0.36
wholesale trade (incl cars & bikes)	-0.0164	-0.67	-0.0264	-1.07
retail trade (excl cars & bikes)	-0.0131	-0.55	-0.0304	-1.26
hotels & restaurants	-0.0226	-0.89	-0.023	-0.87
transport, storage & communication	0.0059	0.23	0.0066	0.24
financial intermediation	-0.0419	-1.88	-0.0523	-2.23
real estate, renting & business	0.0347	1.37	0.0342	1.25
number of observations	10093		10093	

Wald Chi2(36)	627.16	906.37
log pseudolikelihood	-2632.84	-2998.93
pseudo R2	0.1670	0.1584
observed probability	0.0946	0.1131
predicted probability (at x-bar)	0.0690	0.0836

Appendix C.
Matching of aid recipients and non – recipients by characteristics
Weighted probit, calliper.001, no replacement - eq.(iii) Table 4.

Variable	Sample	Treated	Control	%bias	|bias|	t	p>|t|
------------	-----------	--------	--------	---------	---------	---------	-------
Foreign Sales	Unmatched	0.5683	0.30544	54.9		18	0
	Matched	0.52705	0.57315	-9.6	82.5	-2.07	0.039
Graduate	Unmatched	0.80298	0.571	51.7		15.22	0
	Matched	0.77756	0.76152	3.6	93.1	0.85	0.395
Emp1oyment	Unmatched	3.6101	3.3999	21.4		6.81	0
	Matched	3.5948	3.5773	1.8	91.7	0.4	0.687
Turnover	Unmatched	7.6384	7.557	5.8		1.81	0.071
	Matched	7.6579	7.6992	-2.9	49.2	-0.67	0.501
R&D/Turnover	Unmatched	0.26035	0.011	11		7.25	0
	Matched	0.04916	0.02985	0.8	92.3	1.26	0.208
Investment/Turnover	Unmatched	0.07151	0.04407	3.9		1.17	0.24
	Matched	0.05093	0.02482	3.7	4.8	2.38	0.018
Start after 1 1 2000	Unmatched	0.1366	0.12513	3.4		1.1	0.272
	Matched	0.12625	0.12525	0.3	91.3	0.07	0.946
Enterprise group collaboration	Unmatched	0.16112	0.05821	33.4		12.95	0
	Matched	0.13527	0.13427	0.3	99	0.07	0.948
Supplier collaboration	Unmatched	0.26357	0.0877	47.5		18.36	0
	Matched	0.20541	0.21543	-2.7	94.3	-0.55	0.583
Customer collaboration	Unmatched	0.26795	0.08144	50.7		19.95	0
	Matched	0.20441	0.20741	-0.8	98.4	-0.17	0.868
Competitor collaboration	Unmatched	0.15061	0.04904	34.4		13.68	0
	Matched	0.12325	0.12725	-1.4	96.1	-0.27	0.787
University collaboration	Unmatched	0.1979	0.03016	54.7		25.47	0

	Matched	0.10321	0.11222	-2.9	94.6	-0.65	0.516
Region dum_2	Unmatched	0.08581	0.08893	-1.1		-0.35	0.727
	Matched	0.08216	0.08317	-0.4	67.8	-0.08	0.935
dum_3	Unmatched	0.07443	0.08156	-2.7		-0.83	0.405
	Matched	0.07415	0.08918	-5.6	-111	-1.23	0.22
dum_4	Unmatched	0.05954	0.08625	-10.3		-3.08	0.002
	Matched	0.06513	0.07014	-1.9	81.2	-0.45	0.656
dum_5	Unmatched	0.07793	0.08781	-3.6		-1.12	0.264
	Matched	0.08016	0.08016	0	100	0	1
dum_6	Unmatched	0.0648	0.08926	-9.2		-2.77	0.006
	Matched	0.06814	0.05511	4.9	46.8	1.21	0.226
dum_7	Unmatched	0.03853	0.08245	-18.5		-5.23	0
	Matched	0.03808	0.0521	-5.9	68.1	-1.51	0.131
dum_8	Unmatched	0.07093	0.09921	-10.1		-3.06	0.002
	Matched	0.06914	0.07214	-1.1	89.4	-0.26	0.793
dum_9	Unmatched	0.06217	0.08602	-9.1		-2.75	0.006
	Matched	0.06313	0.06613	-1.1	87.4	-0.27	0.785
dum_10	Unmatched	0.13485	0.06446	23.7		8.67	0
	Matched	0.13427	0.10721	9.1	61.6	1.86	0.064
dum_11	Unmatched	0.09895	0.07541	8.3		2.79	0.005
	Matched	0.0982	0.0982	0	100	0	1
dum_12	Unmatched	0.14186	0.09686	13.9		4.74	0
	Matched	0.14028	0.13727	0.9	93.3	0.19	0.846
Sic dum_2	Unmatched	0.10158	0.09116	3.5		1.14	0.252
	Matched	0.10621	0.10922	-1	71.1	-0.22	0.829
Sic dum_3	Unmatched	0.20578	0.12311	22.4		7.78	0
	Matched	0.20842	0.19739	3	86.7	0.61	0.541
Sic dum_4	Unmatched	0.08932	0.03821	21		7.96	0
	Matched	0.08417	0.08517	-0.4	98	-0.08	0.936

Sic dum_5	Unmatched	0.03065	0.02257	5		1.7	0.089
	Matched	0.03006	0.02906	0.6	87.6	0.13	0.895
Sic dum_6	Unmatched	0.04991	0.03642	6.6		2.25	0.025
	Matched	0.0511	0.04609	2.5	62.9	0.52	0.603
Sic dum_7	Unmatched	0.00088	0.0029	-4.7		-1.25	0.211
	Matched	0.001	0.002	-2.3	50.6	-0.58	0.564
Sic dum_8	Unmatched	0.05166	0.10747	-20.7		-5.9	0
	Matched	0.05711	0.07114	-5.2	74.9	-1.28	0.201
Sic dum_9	Unmatched	0.0324	0.07016	-17.2		-4.85	0
	Matched	0.03607	0.03808	-0.9	94.7	-0.24	0.813
Sic dum_10	Unmatched	0.0359	0.09563	-24.3		-6.69	0
	Matched	0.04108	0.03808	1.2	95	0.34	0.731
Sic dum_11	Unmatched	0.02627	0.05161	-13.1		-3.75	0
	Matched	0.03006	0.02405	3.1	76.3	0.83	0.408
Sic dum_12	Unmatched	0.05779	0.08792	-11.6		-3.45	0.001
	Matched	0.06513	0.06613	-0.4	96.7	-0.09	0.928
Sic dum_13	Unmatched	0.01226	0.04268	-18.7		-4.99	0
	Matched	0.01403	0.01202	1.2	93.4	0.39	0.693
Sic dum_14	Unmatched	0.29422	0.21506	18.2		6.05	0
	Matched	0.26253	0.26954	-1.6	91.1	-0.35	0.723