Industry 4.0 and Value Creation in the Future City

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Abstract

There has been growing discussion of industry 4.0 and the opportunities that it may provide for new and existing manufacturers to redistribute production and re-establish previously offshored activities. We consider the role of cities in this context and suggest that for this case there is limited evidence so far that industry 4.0 activities will provide significant economic opportunity. Any transformative impact of industry 4.0 on the geography of production is hitherto hard to discern, and ownership patterns and the dominance of platform firms in technology sectors may significantly reduce the ability of most cities to generate and retain 'new' economic value.

Keywords:

Cities

Manufacturing

Digital technology

Automation

1 Introduction

The role of robots, algorithmic problem solving, and artificial intelligence in the production and distribution of goods and services is increasingly recognised as being of deep significance, potentially transforming industries and the roles of workers, lifestyles, and the physical environment (Bailey & De Propris, 2019; Baldwin, 2019; Brynjolfsson & Mcafee, 2014; Frey & Osborne, 2017). Such structural change is of course not new, with economic development long been known to be shaped by successive waves of innovative technologies, industries and work (Perez, 2009). The current wave builds on development in digital applications and other fields such as nanotechnology and biology, and provides opportunities for manufacturers to introduce digital technologies such as 3D printing, robotics and sensors to the production process. Such developments have been discussed under the term industry 4.0[1] and offer new possibilities for existing manufacturing, as well as the potential to reshore production capacity back to a firm's home country (De Propris & Bailey, 2020; Kinkel, 2020).

Meanwhile, large digital platforms have been identified as having a significant role in the emerging wave of digital technology development (Bearson et al., 2020; Kenney & Zysman, 2016). Researchers have highlighted their monopolistic tendencies and their ability to reshape economic value creation in a broad range of markets, as well as to have implications for the nature of tasks, occupations, industries and places (Arntz et al., 2016; Autor, 2015; Berger & Frey, 2016; Feldman et al., 2020). The impact of such platforms on cities has primarily been

[1] The term industry 4.0 was initially introduced by the German Federal Government (Federal Ministry of Education and Research, 2010).

explored in relation to the sharing economy (Bearson et al., 2020), with studies examining their impact on the housing market (Garcia-López et al., 2020; Horn & Merante, 2017) and urban transportation (Hall et al., 2018). Discussion has only recently begun to consider the implications of digital technology use in production processes, where technologies such as artificial intelligence, robotics, 3D printing and Internet of Things have been increasingly integrated by manufacturers (De Propris & Bailey, 2020; OECD, 2017).

Our paper seeks to link these two areas of debate by assessing the challenges and implications for production in cities. We suggest that the adoption of industry 4.0, while providing opportunities for some manufacturers and places, presents significant challenges to the role of cities, and to their ability to generate economic value. This leads us to two contentions. Firstly, that the transition towards industry 4.0 in many cities, has so far seen only a modest upheaval of the activities of established manufacturing firms and places. Secondly, that the economic value associated with industry 4.0 has the potential to 'bypass' the city scale, with digital platforms and small-scale maker entrepreneurs benefitting. The future economic role of cities remains an open question, as existing service provision becomes more aspatial, and occupations that dominate cites are subject to automation,

We begin by considering the emergence of industry 4.0 technologies and their role in creating opportunities for localised manufacturing. The presence of digital platforms, their incursion into manufacturing and questions of localisation is then considered. This moves us to the substance of our argument, where we place economic value creation in cities in its historic context, and argue it is under increasing pressure, with harder-to-tax digital platforms and small scale urban 'makers' well placed to capture most of the benefit, and thus with implications for local incomes and city development. We conclude the paper with a discussion of how digital technologies present challenges to cities and regions that wish to

become centres for new forms of smart manufacturing, and tease out some areas for future research.

2 Industry 4.0 and the case for localised manufacturing

The potential for digitalisation to shape the role of manufacturing and territories has begun to gain interest amongst researchers and policy makers (Ciffolilli & Muscio, 2018). This has been reflected in concepts such as industry 4.0, highlighting the growing integration of digital technologies in production process and products, and the potential implications for manufacturers and regions. Such developments are recognised as part of the 'Fourth wave' of socio-technological development (Perez, 2009) including technologies such as digital devices and connectivity, nanotechnologies, and green technologies in the current wave of industry developments (Bailey & De Propris, 2019). It has been argued that these developments have the potential to not only underpin new manufacturing efficiencies, business models, products and services, but also change the nature of roles and employment within businesses (Santini & Bellandi, 2017). It is recognised, however, that the transition between waves is likely to have disruptive implications for businesses and regions, as the old gives way to new models of industrial operation and work (De Propris & Bailey, 2020; Lester & Piore, 2009), and that that such developments may be occurring more rapidly than earlier waves might suggest (Baldwin, 2019; OECD, 2017).

Large industrial businesses have for many years been active in integrating digital technologies within the production processes (Kusiak, 2018). Here research has highlighted developments in factories of the future by businesses such as Siemens, and their automation of industrial processes and use of robotics (Gupta, 2018). While robots are not new in factories, the growing interaction between physical products and digital processes points

towards a new mode of industrial operation in which automation, communication and information sharing are important characteristics This may provide opportunities for *makers*, in the form of 'artisans, tinkerers and digital era inventors' to both create and capture economic value in local places (Dougherty, 2012; Doussard et al., 2018: 651). Such makers are have been identified in contrast to the large manufacturing firm, and represent a movement towards manufacturing without a firm (Davis, 2016; Doussard et al., 2018)..

The introduction of greater options for flexibility has led to the ability for both individual makers and larger firms to offer increased customisation and personalisation of products (Rogers, 2016). It may also allow for, and indeed reward, localised and bespoke manufacturing of small-scale batches as such technologies may enable manufacturers to reduce distribution costs and increase responsiveness (Bailey & De Propris, 2019). This points towards possibilities for greater democratization of manufacturing activities and opportunities for new production jobs to be created closer to customer home markets, countering the tendency, associated with global value chains, for such jobs to move away from core manufacturing areas in the US and Europe in recent decades (Kinkel, 2020).

The role of digital technologies has also been identified in debates around the potential for reshoring of manufacturing activities back to (or near to) their former home economy (Bailey & De Propris, 2014; Kinkel, 2020) This holds the prospect for countries to re-establish manufacturing activities that had once been offshored (or relocated), and for industrial competitiveness to be developed (De Backer et al., 2016; Di Mauro et al., 2018; Gray et al., 2013; Kinkel & Maloca, 2009). Evidence, however, suggests that such strategies are most likely to succeed when there is both the availability of skilled labour and access to finance (Bailey & De Propris, 2014), the presence of support services and institutions (Bailey & De Propris, 2019) and presence of R&D intensive businesses and ecosystem (Kamp et al., 2019).

Research has pointed to the emergence of digital technologies such as robotics and their role in enabling greater productivity, thus reducing some of the former rationale for offshoring to lower (labour) cost regions (Kamp et al., 2019; Kinkel, 2020). The flexibility offered by such technologies may also provide a further driver for such reshoring, enabling manufacturers to provide greater responsiveness to customer needs (Lasi et al., 2014). Such technologies, it has also been argued, may offer opportunities for smaller scale manufacturing and the emergence of 'micro factories' (Nieuwenhuis, 2018), where it has been argued that they offer opportunities for greater economies of scale for suppliers, with lower transport costs and associated environmental benefits. Indeed the potential for such factories 'could play a key role in revitalizing local economies in many parts of the word' (Wells & Nieuwenhuis, 2004: 204).

Question marks about the potential for significant job benefits to emerge from reshoring have however been identified in the literature (Bailey & De Propris, 2014). Here the debate surrounding such developments has pointed towards the potential for significant job losses (in aggregate) as machines take over the work of mainly process-oriented occupations (Frey & Osborne, 2017). The scale and nature of such impacts, however, is much debated, with some authors arguing that initial estimates have overestimated the nature of automation on tasks (Arntz et al., 2016), and underestimated the potential gains for existing employees to be assisted by the new technologies (Autor, 2015; Mcafee & Brynjolfsson, 2017).

The emerging industry 4.0 literature, while drawing attention to the digitalisation and services and its potential impacts has yet to examine the specific role of platforms in enabling these processes in the city context. It is known from the wider literature however, that large digital platforms play an important role in enabling the digital economy. Their emerging role in industry 4.0 and their spatial manifestations is considered in the next section.

3 Digital platforms, ownership and localisation

The emergence of digital platforms has been identified at the heart of the current wave of digitisation and economic development (Kenney & Zysman, 2016; Zysman & Kenney, 2018), enabling economic activities through business models established to draw economic value from customers, suppliers, and developers through the exploitation of network effects – situations in which an increase in the number of users results in a rise in average consumer benefit (Rogers, 2016; Zysman & Kenney, 2018). In this way, such business models offer the potential for businesses to start up and establish operations by levering key platform-owned digital technologies and infrastructure, and allow the emergence of asset-light business models (Rogers, 2016).

Scholars have begun to explore the role of digital platforms in urban and regional economies through the concept of smart cities (Angelidou, 2015; Kitchin & Moore-Cherry, 2020).. While development of smart cities has yet to be implemented on a significantly large scale (Kitchin et al., 2017; Shelton et al., 2014) such initiatives have been identified as seeking to serve the interests of large ICT and platform providers with respect to data extraction and its exploitation (Greenfield, 2013; Morgan & Webb, 2020). Some authors argue this provides the basis of a new form of value creation based on monetising private experiences (Zuboff, 2015, 2019).

Those writing about manufacturing and regional development have also noted the potential for manufacturers to make use of 'far away machines' (Bailey & De Propris, 2019) through the use of platform technologies such as cloud computing technologies, artificial intelligence and industry 4.0 services. Here, platform businesses such as Google, Amazon Web Services and Microsoft have been active in developing services for industry 4.0, in collaboration with established manufacturers. Such collaborations provide manufacturers with localised access

to technologies such as artificial intelligence that underpin software and robotic applications for manufacturers[2].

The emergence of digital platforms has raised concerns about the monopoly provision of important services, based on the growth of digital networked infrastructure, their globalised availability, and ability to outcompete existing business models as well as the underdeveloped nature of regulations (Feldman et al., 2020). In contrast to earlier monopolies (such as electricity networks) where ownership was spread more widely and bespoke infrastructure was required, digital monopoly provision has 'winner takes all' characteristics that enable the fast growth of platforms, and makes if difficult for competitors to provide similar services (Mcafee & Brynjolfsson, 2017; Rogers, 2016). The digital nature of such platforms enables them to service consumers and businesses from far afield, and gain financial inflows into their core headquarter regions at the expense of other places (Feldman et al., 2020). Digital monopolies can thus 'double down' on facets that have that been observed in other industry sectors to be problematic for even spatial development. In a study of the energy sector, for example, Jones & Munday (2020) argue that 'home location' of key firms is an important factor driving local economic benefits' (p. 1). This, they suggest, shapes the ability of areas to benefit from such activity, which depends on their spatial (or value-chain) proximity to centres of ownership and control. The spatial concentration of firms developing of platform services is thus notable, tending to be undertaken by businesses headquartered in Silicon Valley or the wider US West Coast (Bearson et al., 2020), where access to finance and IP have provided market and corporate control (Feldman et al., 2020). This implies that it is those regions with such headquartered functions are most likely to gain benefits from such innovative developments and suggests that (almost all) other cities and

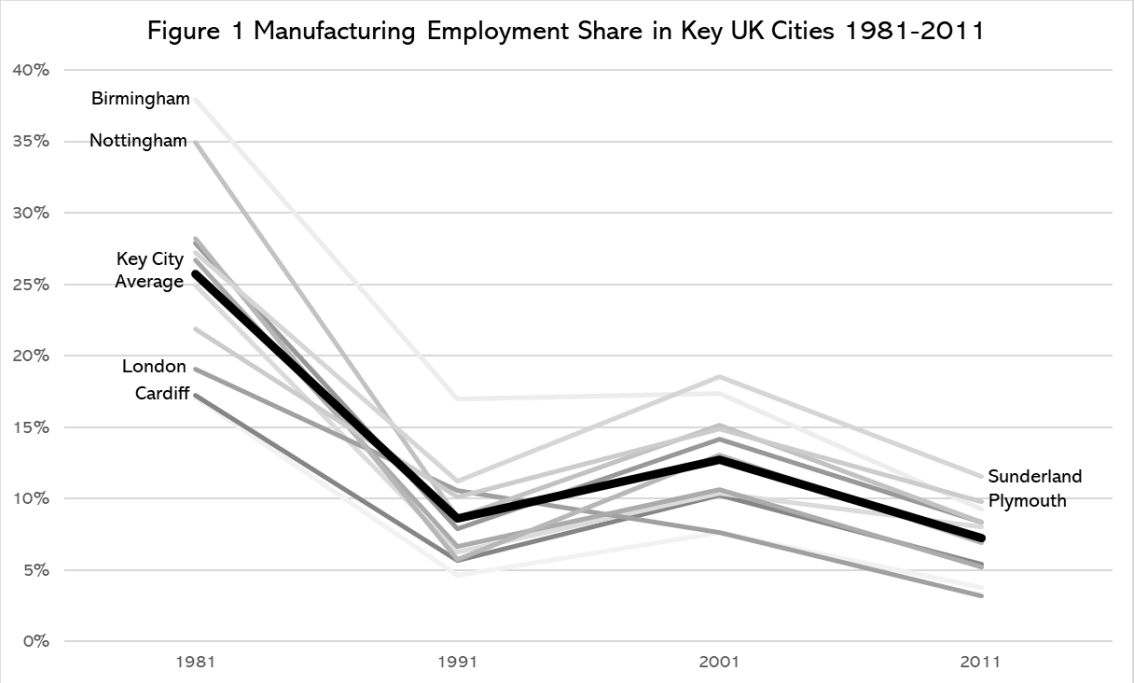
[2] See https://aws.amazon.com/blogs/iot/tag/industry-4-0/, https://www.microsoft.com/en-gb/industry/manufacturing/factory-of-the-future?activetab=pillars%3aprimaryr4 https://cloud.google.com/press-releases/2020/0709/groupe-renault-and-google-cloud

regions with branch plant (or no) manufacturing capacity may struggle to gain from the opportunities provided by industry 4.0.

4 Economic value creation in the city

Cities have long had a primary role in the organisation of complex societies, with urban innovations, social and technical, complementing continuing rural production and exploitation of natural resources to increase human welfare over time, albeit slowly (Alexander, 1954; Jacobs, 2016; Morris, 2010). The shift in production beginning in the 1960s and hastened by the deregulation of capital mobility in the 1970s and 1980s; the European Single Market; and the 'open door' policy of China in 1991 markedly changed the economic role of Western cities, and especially in the UK and US (Amin & Thrift, 1995). Over recent decades, manufacturing employment, both in total and as a share of employees fell significantly in both countries, and in their urban areas (Harris et al., 2018); see Figure 1. This is not to say of course manufacturing *disappeared* from cities: rather it refocused on firstly higher value, innovative activities where the strong research and capital-ownership base in the West still conferred advantages, and secondly, in cases where capital is a dominant cost in production and difficult to shift; for example car manufacture; (Harris et al., 2018). Large scale manufacturing employment was replaced in quantity, if not always quality, by that in services, both private and public, with of course interesting differences between cities, based for example, on their (human) comparative advantage or where they stood in national urban hierarchies (Jones, 2015; Martin et al., 2014). White-collar jobs growth was very varied in nature, including high-value private professional services (financial and legal for example); technical services (not least in ICT); and public services such as healthcare (Glaeser et al., 2001). What does *not* change for the bulk of employees in cities is the routine nature of work; what *does* change is that employment becomes polarised between reasonably well-paid white-collar service employment; and low value/low wage

personal service employment (of various types), catering largely to outside and local markets respectively see (Andress & Lohmann, 2008; Sassen, 2016). The 'export base' for the UK and US, and the cities within them that comprise the majority of their GDP, then narrowed to focus more on financial services, tourism and other income relating to the ownership of foreign-employed assets – including returns to innovation and, related to this, global brands. These inflows have however not been sufficient for either country as a whole to maintain trade balance with the rest of the world (Reinbold & Wen, 2018).



Source: ONS Censuses of Population. Note city average is unweighted

Even where cities – and especially capital cities – have performed better than national economies in terms of overall economic growth, there is some debate as how far this relates to inflation in assets (rather than productivity gains), especially in property (Toporowski, 2009). This points to the other functions of cities that have become increasingly important in

their economic mix – as leisure, consumption and residential spaces – and with much of this dependent on urban returns from financial systems that are arguably too big to be efficient drivers of national economic growth (Law & Singh, 2014)[3]. Investment in the UK for example (as mediated by various City and city-based financial institutions) is focussed on urban and peri-urban property development of various types to a far greater extent than in much of continental Europe, and with questions as to how far this might explain the UK 'productivity puzzle' – and indeed as to how far the scale of property provision marches actual social need (this orientation towards tertiary and rentier activities an may be important when considering the future scale and opportunity for manufacturing in urban areas).

Even in activities wherein cities retain an unmistakeable value-creating advantage – the symbiotic twins of higher education and publicly funded research – we see the precarious nature of the city's economic role. Research is enabled not just through the attraction of research grants and contracts, but also through its subsidisation by surpluses (financial and staff time) from inexpensive and low-time demand business, law and arts teaching, both within and between university departments. Whilst HE students have in the past seen significant wage-premia returns on their education, especially in business and professional subjects, the picture is far more nuanced for current, let alone future, students, with significant expansion in the supply of graduates combined with a potentially technology-related reduced demand for human labour (at most levels) in the large partnerships and other 'blue chip' firms that are their expected destination (Frey & Osborne, 2017). Notably, the global pandemic of 2020 revealed the extent to which Universities – and by extension key parts of city economies – relied on not just student fees but their spending on accommodation and hospitality[4]. Importantly for our later argument, apart from London, universities do not,

[3] And see https://www.theguardian.com/news/2018/oct/05/the-finance-curse-how-the-outsized-power-of-the-city-of-london-makes-britain-poorer for the wider argument.
[4] See for example https://www.ft.com/content/1bbf4bdc-c80b-4220-ba23-34d1cbce813d

typically educate the bulk of students to respond to local economic needs, and outside of the South East, post-graduation inter-regional spatial mobility is high. This again may have implications for the role of cities in an urban manufacturing renaissance (Cardak et al., 2017; Zhan et al., 2020).

In summary then the modern large city is largely post-industrial, at least in the sense of mass industry. Typically, foreign revenue earnings depend on a small number of specialised services, varying between places but typically including higher education, research and innovation, professional (especially financial) services and the earnings of headquartered firms from assets employed abroad. Cities themselves provide important consumption, healthcare, and retail and logistical intermediation spaces. The ability of cities to create economic value from this mix of activities is, however, likely to come under significant pressure as the changed nature of globalised production mixes with digital technological incursion into production, distribution, intermediation and consumption. Whether cities can become new homes for ‘re-shored’ industry 4.0 activity, and in doing so provide high-value future employment at scale will relate to the ownership of relevant IP, technologies and digital platforms, is examined in the next section.

5 What Prospects for the Industry 4.0 City?

i. What is the size of the opportunity?

Before considering the extent to which cities might benefit from becoming sites of industry 4.0 manufacturing, it is worth considering the overall size of the national opportunity. So far, relevant shifts in productive behaviours and locations, and consequent employment are partially evident at best. For example, whilst business R&D[5] has increased in the UK since 2010 by around 37% in real terms (and up 0.2 percentage points of GDP), R&D in manufacturing has significantly underperformed overall business R&D growth – up a nominal 43% over the same period compared to over 100% for services and 240% for miscellaneous business services (albeit these latter two from a much lower base). Meanwhile, since 2010 London has significantly outperformed the manufacturing heartlands of the Midlands (East and West) in intramural R&D - with the North West actually seeing a nominal decline (Office for National Statistics, 2020a). Total employment in manufacturing also grew more slowly between 2015-19 than for the whole economy (2% compared to 5%), with the best performing British regions being London and the South East (at 7% and 10% growth respectively). If manufacturing re-shoring driven by industry 4.0 is yet happening it is not evident in the aggregate – and especially not in the regions which were home to formerly strong manufactory cities (Office for National Statistics, 2020b). More narratively, whilst we might look in expectation at future productive upheaval that is industry 4.0-consequent, there is also limited evidence so far. A study of Scottish manufacturers finds that whilst ambition in this area is high, the large majority of firms have not engaged with their staff on industry 4.0 issues and have no relevant strategy, resources or training plans (Scottish Enterprise, 2020). Given the painfully long transition to the (now) position as an EU 'third country', and all the

[5] We use business R&D as a proxy for industry 4.0 readiness/activity in cities. Other measures, such as patents are problematic at this spatial scale.

value-chain disruption and opportunity this was likely to bring, one might fairly ask 'if not now, when?'

The promise of industry 4.0 upheaval, in terms of re-locating the activities of established firms at least, seems so far modest. In the original home of industry 4.0, Germany, VAG is building its new fully electric ID models at a converted Golf plant in Zwickau, which has been making cars for a century[6]. Volume EV production is taking place largely in existing plants (e.g. Nissan Sunderland; Jaguar's e-Pace alongside Mercedes and Toyotas in Magna Steyr, Graz) and even where plants and entrants have forged a position – e.g. Tesla in Fremont and Shanghai - it is notable that the geography of production is driven far more by prosaic factors like access to skills, labour and key inputs (here batteries) than by industry 4.0 production upheaval. Indeed, the EV example is one of new technology being more standardised, 'modular' and less complex than the old, reducing the opportunity for bespokeness in key attributes (like differing powerplants). The Volkswagen ID3 is less choice-rich in terms of engine, gearbox, trim, colour and accessories than a BMW Mini. Meanwhile core components themselves – batteries, infotainment – are more (or more obviously) provided to multiple brands by a small set of multinationals (LG, Google), reinforcing ever more the need for scale and efficient production over bespokeness[7]. The most important example of new and greener consumer technology is thus being delivered in existing plants, through existing (or, as with Tesla, even more geographically concentrated) distribution channels, and with limited opportunity for individualisation. Where then are the counter-examples of industry 4.0 that upends global production and has it fall in very different ways to the benefit of places like the UK? The fact we are still waiting, decades

[6] https://electrek.co/2019/11/04/vw-id3-production-electric-car-converts-factory/
[7] https://www.polestar.com/uk/polestar-2/google-polestar/

later, for the growth of micro-factories[8] is not encouraging (Okazaki et al., 2005; Wells & Nieuwenhuis, 2004).

ii. How far will local agents/cities benefit from any relocalisation

We thus have limited evidence of existing key firms undertaking industry 4.0 restructuring in ways which benefit places hitherto lacking key industry players (Chiarvesio & Romanello, 2018; Dachs et al., 2019). Evidence from the Basque Country suggests, however, that there may be some possibility of digital technologies *preventing* offshoring (and to a lesser extent supporting reshoring (Kamp et al., 2019). The context for such research is of course a region with a strong extant manufacturing base. For many other regions, the same possibilities may not exist. Elsewhere, we see that a number of industry 4.0 relevant technologies are delivered by a small number of 'platforms' which are clustered on the west coast of the USA, but which add (or capture) value via monopolistic processes and in ways that are almost aspatial. Feldman et al. (2020) make salient points around the tendencies of this concentration to inhibit economic development in most places through, for example, the inhibition of technological diffusion. Whilst these firms are more typically embedded in services sectors, their incursion into manufacturing[2], the Internet of Things (Kshetri, 2017) and smart-city management (Goodman et al., 2020; Greenfield, 2013; Townsend, 2013) raises the question of where, exactly local agents will find space to create value in a landscape where knowledge creation already seems, measured at least by patent data, to be concentrating into the very largest places (Mulligan, 2020). The city may well be left with value generated by locally resident labour involved in industry 4.0 activities in either established or start-up firms, but the prospect of sufficiently large numbers being employed in such activities at sufficient levels of income to comprise an important part of a city development path seems fairly

[8] With one or two notable examples; for example https://riversimple.com/

remote, especially with 'local' value creation and capture (and hence income) squeezed by the platform monopolists on whose dominant infrastructures, protocols and customer reach both established and new firms will rely. We might take an illustrative example here from the creative industry. Technology has democratised and decentralised music-making in a way unimaginable twenty years ago. 'Studio quality', award-winning and globally impactful records are made by artists, on their own or in collaboration, in their own homes on standard laptops (and especially so during 2020). This shift has been accompanied by far lower costs of production and (streaming) distribution (Doussard et al., 2018), but little or none of this has been captured spatially close to where the creatives are resident. Rather it is global platforms via Appstores (Apple, Google) and new entrants (Spotify, Tidal, SoundCloud) that have benefitted, to the detriment of both established production centres like London and Los Angeles, the supporting cast of now less-necessary session musicians, and indeed the artists themselves (Hesmondhalgh et al., 2019; Vonderau, 2017)[9]. The spatial scale of production has retreated from the global, enabled by a handful of key digital technology intermediary firms, but careered straight past the city-scale to rest with small scale maker entrepreneurs (World Economic Forum & GEM Global, 2016). This retreat to the individual (or micro-collaborative) scale for production, is as much a risk for the city in industry 4.0 manufacturing sectors. Here data from a survey of 137 makers in three US (Doussard et al., 2018) suggests that significant barriers are faced in scaling up to larger scale manufacturing, not least in terms of finance for manufacturing capacity. Indeed, even if a creative, locally-attuned and individualised approach to production does emerge at scale, might this not be by individualised or virtually collaborative makers: creatives and engineers working in bedrooms and sheds (Dougherty, 2012; World Economic Forum & GEM Global, 2016), enabled by Office 365, Slack and Virtual Reality (Anderson, 2012; Fiorentino, 2018), and by

[9] Notably, record companies remain important gatekeepers and beneficiaries.

server farms, 3D printer farms and drone-delivery to customers both far than near. Concerns about the productivity of makers and wider home-based businesses generally may further dampen down the potential benefits to cities (Dougherty, 2012; Shane, 2009). Thus the 'big win' for cities might be even more Airbnb and hipster coffee shops (Rath & Gelmers, 2016; Zervas et al., 2017), rather than 3D printing hubs and tech hubs.

The 2020 COVID pandemic has of course made the preponderance of this outcome more likely, if indeed production should decentralise at all. Where then is the city in this picture? And indeed what is the future for cities as creators and capturers of value in an increasingly weightless world, where agglomerative costs are increasingly evident, and one where perhaps smaller towns provide a better balance between productivity, wellbeing, social interaction and safety?

6 Conclusion

This paper has taken a nuanced and critical approach to the role and opportunity for cities in the industry 4.0. We recognise the important juncture that cities face; we contend that the roles they have played in human society have changed substantively only a handful of times to get to where they are today; as nexuses for service delivery, distribution and consumption, and for the production of knowledge and public services. Another change is upon them, driven by the rapid incursion of digital technology, and with this made both more impactful and urgently pressing by the COVID pandemic. Widespread use of AI and algorithmic approaches may rapidly make uncompetitive large numbers of white-collar workers on whose wages cities rely, and whose demands (and those of their employing firms) have largely shaped current cityscapes.

There are fundamental questions about the relationship between industry 4.0 and cities that at this stage are difficult to answer. In part the relationship and economic significance will be

driven by the size of the overall opportunity for nations and cities that are currently not home to significant industry 4.0 relevant manufacturing or logistics activity. We argue that so far, industry 4.0 has not seen (or at least these authors have not found) any significant restructuring of global production approaches or value chains that provides significant hope for potential new city-entrants. Even in cutting edge sectors like EVs and electronics, investments in new geographies are along the existing big-factory-Fordist model, characterised by the (rather depressing) dance of investment grants and subsidies, rather than by any white-heat of innovative new approaches, and clusters – see for example Tesla in Berlin, or the unsavoury tale of Foxconn in Wisconsin[10]. It seems appropriate to ask what upcoming technological or operational shift will change this and bring to fruition, at scale, the potential that has been talked about for some time (Okazaki et al., 2005; Wells & Nieuwenhuis, 2004).

Even if the geographic location and production and design of goods does change significantly, the question as to how far most cities, and by extension, global regions are able to take advantage remains a complex one. We have noted in this paper that the radical re-invention of services design, development and delivery has progressed in ways which have advantaged global platform firms at the expense of most places, and at the expense of 'bespokeness' and local creators. We would wonder firstly; if this process might be replicated for physical products – for creators see makers; and secondly (and relatedly), whether established platform firms in service segments are best placed to take market share, value-added and key intermediary roles in industry 4.0 spaces. We have already seen physical spaces in cities and the regulations that govern them change under pressure from the platform economy model that is moving into physical goods and non-digital sectors: think not just

[10] https://www.theverge.com/21507966/foxconn-empty-factories-wisconsin-jobs-loophole-trump

Amazon Go here, but, for example, Lyft, Lime and Uber, which challenge local public and private transport operators, and where a considerable proportion of customer revenue leaves the city (Alemi et al., 2018; Flores & Rayle, 2017; Schaller, 2018). The question for proponents of industry 4.0 and reshoring as a place-based economic opportunity is then: why would you expect decentralised manufacturing-as-a-service to be any different (Hasan & Starly, 2020)?

The question of how cities respond to this potentially challenging environment is for another paper. It is worth however noting that the modern (British) city is not in many senses the sort of innovation ecosystem that drives value creation – at least in terms of large urban players (Gomes et al., 2018). Moreover, in Britain the high mobility of graduates, together with the standardised nature of most undergraduate (and more arguably postgraduate) programmes means there is little opportunity to build such bespoke ecosystems around the most qualified residents. The extent to which cities and city-regions (especially in post-industrial settings; Sunley et al. (2019)) can restructure to become complementary, differentiated and value-generating ecosystems across the UK is uncertain given the nature of the Westminster approach to devolution. But if we are to argue that our cities are to be important players in the design and delivery of distinctive, local, and high-value industry 4.0 products, then the cities themselves must become all these things.

This paper is necessarily speculative, given that we have not yet seen the widespread geographic restructuring of production that industry 4.0 is purported to enable. We would suggest that the lack of any substantive growth in manufacturing employment in the eight years since the original industry 4.0 report to the German government might suggest that impacts might, for the UK at least, be modest or slow. More substantively, our ex ante assessment suggests that if UK cities are to benefit from industry 4.0 developments in reshoring, and in enabling new entrepreneurial activity, then policy and industrial strategy at

city, city-region and UK scale[11] needs to be nuanced and context aware. There is currently a need for research to better link the industry 4.0 concept to wider debates about how far cities can genuinely nurture (and embody) the kind of entrepreneurial ecosystems: Those that can lever proximity to create significant, embedded and bespoke economic value in ways that can complement, or even compete with, the remote-controlled digital platforms that increasingly shape both city futures and socio-economic outcomes.

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