

The OECD Trento Centre for Local Development

The spatial dimension of productivity

A story still to be told

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1. Introduction

1. Productivity, the efficiency of input conversion into output, is the main determinant of living standards (Easterly and Levine, 2001^[1]). More productive economies have greater ability to support and enhance well-being of their citizens via higher incomes, better infrastructure, more services and other means. The drivers of productivity, and its effects on a range of social and economic outcomes, are the focus of a voluminous, long-standing and well-developed research literature. Despite the vast scholarly attention paid to productivity, its spatial dimension is generally missing from this discourse and is yet not well understood.

2. While productivity is ultimately driven by individual decisions of workers and companies on how to use resources in the process of value generation, regional environment conducive to and offering support infrastructure for more efficient choices is important. Many, if not all, productivity determinants studied in the international literature vary considerably at the regional and local levels. An extensive body of regional science research demonstrates subnational origins of many productivity drivers. The productivity discourse, however, often fails to link the regional nature of a number of productivity determinants to aggregate productivity (growth).

3. The spatial dimensions of productivity performance are becoming more salient as the global megatrends, in particular globalisation and digitalisation, affect localities differently along the urban-rural continuum. As policy makers strive to ensure spatially-inclusive growth with no places left behind, spatially-conscious productivity research is needed to inform the design of efficient policies tailored to the needs of specific places. Such policies should help the more productive regions to enhance their standing and the lagging regions to close productivity gaps.

4. This report offers an overview of the current productivity research placing a particular emphasis on the spatial dimension. The following observations follow from this review.

5. First, in the economics literature, productivity is predominantly studied within industries/sectors and/or firms. The productivity discourse identifies a range of productivity determinants and explains the mechanisms of their effects. The studies, however, ignore the spatial dimension of productivity. As a consequence, productivity debates in mainstream economics are of limited relevance for *regional* economic growth and mostly cannot inform the efforts to reverse the increasing subnational productivity divergence.

6. Second, the spatial subnational (local, regional) dimension clearly plays a role in the ways people, firms, industries and other actors interact and function, which has both direct and indirect effects on productivity. Every productivity determinant highlighted by the economics literature has a well-defined spatial dimension. Besides, there is a set of obviously spatial productivity determinants that are mostly overlooked by the economics research but are well developed in the regional science literature.

7. The importance of productivity as an underlying factor of the socio-economic wellbeing and the obvious disconnect between the territorially bounded nature of any policy and the lack of detailed knowledge on the spatial dimension of productivity calls for

policy-relevant research on productivity-driving mechanisms within and across various spatial contexts, as well as their interactions.

8. To be most useful and precise, the research efforts to better understand productivity, its determinants and the ways to boost aggregate productivity performance while reducing interregional inequalities need to rely on better data. A census of establishment-level business microdata and the employer-employee linked data in particular appear crucial for the ability of researchers and policy makers to understand the productivity-defining processes and phenomena, as well as their interactions across space, industries, company types and other dimensions.

2. Productivity definition and measurement

9. Productivity is a measure of how much output an economic agent (firm, industry, region, etc.) produces out of a given amount of inputs. Since greater productivity is generally related to higher profits and wages, the determinants of productivity, as well as variations in its levels and/or growth rates, have been the focus of intensive scrutiny from both scholars and policy-makers. Recent slowdown of productivity growth in many OECD countries¹ coupled with raising subnational disparities has revived a broad interest in this phenomenon.

10. When it comes to empirical research, the literature adopts various ways to measure productivity depending on the specific research question, data availability and plausibility of certain assumptions about the production function. Among productivity measures, labour productivity is perhaps the most widely used followed by total factor productivity (TFP) or multifactor productivity (MFP).

11. The former approach usually relies on measures of GDP, output or value added per worker or hour worked (Syverson, 2017_[2]; Monteiro, Gouveia and Santos, 2017_[3]). Alternatively, wages² (Slobodnitsky, Drucker and Geva, 2018_[4]; Glaeser and Resseger, 2010_[5]) or per capita income (Stansel, 2005_[6]) can be used as a loose approximation for labour productivity. Obviously, labour productivity depends on the intensity of other factors use and is hardly comparable across firms, industries and locations (Syverson, 2011_[7]). The advantage of approximating productivity by the labour-related measures, however, is the ease of calculation and the ready applicability to all industries/sectors, including services.

12. A more comprehensive approach is to calculate total factor productivity or multifactor productivity, which can be done in at least three ways. The most common one is based on the regression analysis and detailed (usually plant-level) data. A measure of output (value added) is regressed on the separate input costs. The unexplained residual is believed to capture productivity. Another methodology is to calculate a ratio between output and an index number aggregating all inputs. Finally, a distance to the technological frontier can be employed as a measure of TFP performance (Capello and Lenzi, 2015_[8]).

13. A change in aggregate productivity of an industry, a region or a country generally results from productivity improvements, business churn or industry evolution and resource reallocation (Figure 2.1 Components of aggregate productivity change (growth)). The first component refers to incumbent firms or existing industries becoming more productive but staying of the same size. Productivity change via churning happens when less productive companies exit the market and more productive companies enter. At a more aggregate level, this component captures industry evolution when an economic structure of a region is altered by an addition of the more productive industries and an elimination of the less productive industries. Finally, as the more productive incumbents/existing industries grow

¹See, for example, <https://www.conference-board.org/data/economydatabase/index.cfm?id=27762>. A useful overview of the slowdown and the central explanations offered in the literature (including measurement issues) is given in Andrews, Criscuolo and Gal (2016_[15]).

² On the link between productivity and pay, see, for example, Stansbury and Summers (2017_[247]).

and the less productive incumbents/existing industries shrink, overall productivity of an economy improves.

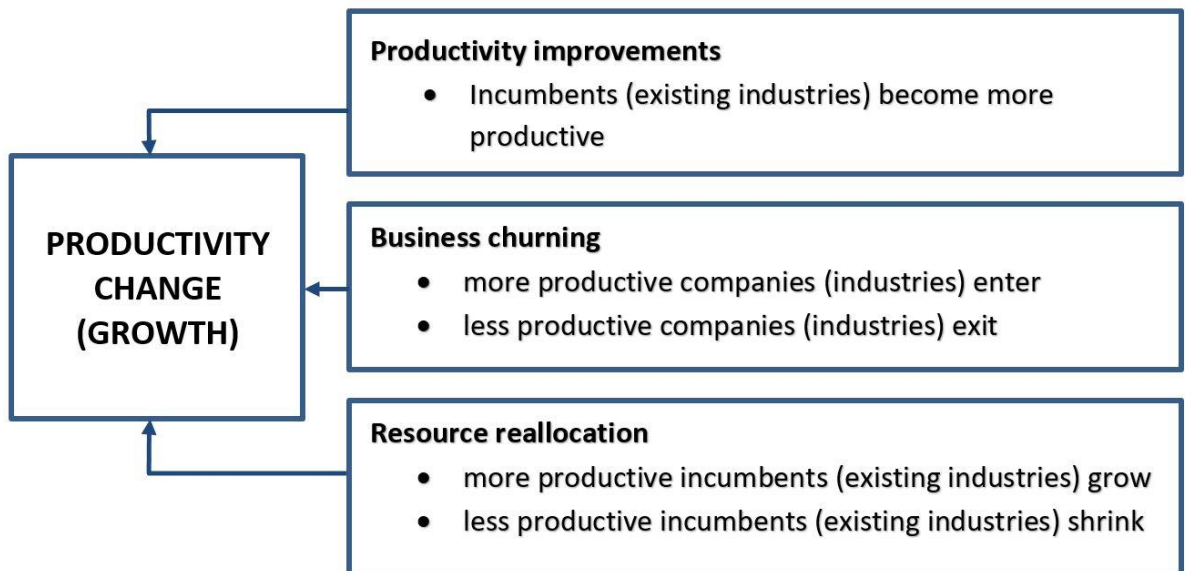


Figure 2.1 Components of aggregate productivity change (growth)

14. Separating these components is important because their relative contribution to the aggregate productivity growth can differ markedly depending on the context. Most importantly, each component is likely to respond to a distinct set of policies. Depending on the specific goals and available resources in a region, productivity-enhancing measures are more likely to succeed if designed with a clear understanding of what component of change they target and how significant this component is in driving overall productivity performance of a region.

3. Why spatial dimension matters

3.1. Productivity and well-being of places

15. Productivity ultimately determines the living standards, as more productive companies are able to pay higher wages and taxes. The well-being of a region, then, is very closely linked to the performance of firms located within its borders. Given the growing subnational income inequalities across regions (Milanovic, 2016_[9]), the quest is to understand the determinants of productivity (Mortensen, 2003_[10]).

16. The main drivers of productivity have been changing over the last decades. The industrial landscape of many countries is being reshaped by globalisation, technological advance and other megatrends. As a result, the share of employment in manufacturing in the OECD area is decreasing while that of services is steadily increasing. The conventional wisdom of the 20th century that larger manufacturing companies pay higher wages (due to the economies of scale), the so-called “size-wage premium”, becomes of limited relevance. Instead, productivity increasingly depends on technology adoption, innovation diffusion and human capital. The long-standing “productivity-wage premium” comes to the fore, particularly for the (ever more prevalent) services (Berlingieri, Calligaris and Criscuolo, 2018_[11]).

17. Despite the recent increase in the tradability of services, the sector still remains mostly nontradable. This means that its performance, and productivity in particular, is largely linked to the local conditions. Services are more likely to depend on the size of the local market and on the presence of agglomeration economies.

18. The importance of the local conditions for productivity performance (as opposed to the national and industry-level determinants) is indirectly confirmed by the well-documented productivity dispersion across firms even within the same, narrowly defined, industries within a country (Syverson, 2011_[7]; Berlingieri, Blanchenay and Criscuolo, 2017_[12]). While national conditions and industrial characteristics explain some of the differences, much of them seem to depend on other factors such as subnational variation in endowments and assets.

19. For example, information and communication technology (ICT) adoption and innovation at a company level is often cited as a driver of divergent productivity outcomes (Sorbe et al., 2019_[13]; Gal et al., 2019_[14]). The adoption of ICT and other advanced technologies, in turn, is driven by the human capital of a firm (its absorptive capacity), exposure to foreign markets and embeddedness into global knowledge flows (e.g. being a part of a multi-national enterprise or MNE) among others (Andrews, Criscuolo and Gal, 2016_[15]). All of these factors are not uniformly distributed in space and, as will be demonstrated in this paper, have a clear-cut spatial dimension.

20. The regional inequalities in well-being are even larger if they are measured in a more holistic manner (Veneri and Murtin, 2016_[16]), i.e. by accounting for broader aspects of the economic and social environment (Coyle, 2018_[17]). For example, the OECD *Regional Well-Being* framework (OECD, 2015_[18]) integrates the traditional material conditions (income, earnings and housing) with extensive quality of life indicators (*inter alia* health, education, social connectivity, environmental quality) and future well-being resources (natural, human, economic and social capital). The UN Human Development

Index (HDI) measures life expectancy, education and income per capita, while the EU *Quality of Life Indicators* include employment, environmental and social exclusion data.

21. Another measure that captures how gains from productivity growth are distributed within society is inclusiveness. The OECD has developed the *Inclusiveness Composite Indicator* (ICI), which accounts for various types of unemployment and work intensity, material deprivation, poverty risk and educational attainment. Based on the ICI, current evidence on the spatial variation in the inclusiveness of European regions shows substantial national and regional divergence. In particular, since 2010, between-country differences account for 57% of total variation in inclusiveness, while the remaining 43% is due to within-country variation, stemming from different characteristics of local economies (OECD, 2018_[19]). Given the subnational disparities, the focus on productivity *at a regional level* is needed more than ever, as many facets of the holistic well-being and inclusiveness measures are linked to the regional (spatial) realities.

22. It follows that local and regional conditions are important for regional productivity, earnings and well-being and can explain – at least in part – the growing subnational disparities. This also means that the policy efforts devoid of an explicit spatial dimension are likely to be unable to successfully leverage local assets for more efficient outcomes tailored to the local needs. Focusing research and policy efforts on productivity from a subnational perspective can facilitate both aggregate productivity growth and a decrease in regional inequalities.

3.2. Subnational policies for balanced and inclusive growth

23. Successful policies should seek to enhance productivity, well-being and social inclusion based on a dual typology of policy design and implementation. First, a synergy between national and regional policies is necessary. Second, different types of regions (metropolitan, urban, rural) require a different policy mix.

24. Nationally designed monetary and fiscal policies ensure a stable macroeconomic environment that increases the potential of investment measures to promote productivity and also cushions the negative shocks on households in the lower half of the income distribution (Adalet McGowan and Andrews, 2015_[20]). A range of other national policies such as market regulations (Nicoletti and Scarpetta, 2003_[21]; Andrews, Criscuolo and Gal, 2016_[15]) have been shown to be important for productivity. A different set of national conditions within the policy reach, e.g. union activity, minimum wage and others can be related to the link between productivity and earnings (Berlingieri, Blanchenay and Criscuolo, 2017_[12]).

25. It is important that development policies also address the goal of a less unequal distribution of productivity benefits. One of the conditions to achieve this is a design and implementation of structural policies that are based on the local economic, social, demographic and labour market conditions. For instance, rigid employment regulations have larger detrimental effects in lagging regions with thinner labour markets and a low share of high-skilled employees (D'Costa, Garcilazo and Oliveira Martins, 2013_[22]).

26. Likewise, a range of productivity-enhancing policies called for by the mainstream productivity research, such as increased connectivity between industry and universities, labour training initiatives and more opportunities for interactions that would enhance technology and knowledge diffusion, seem to be better tackled at the subnational level with regional and local conditions in mind.

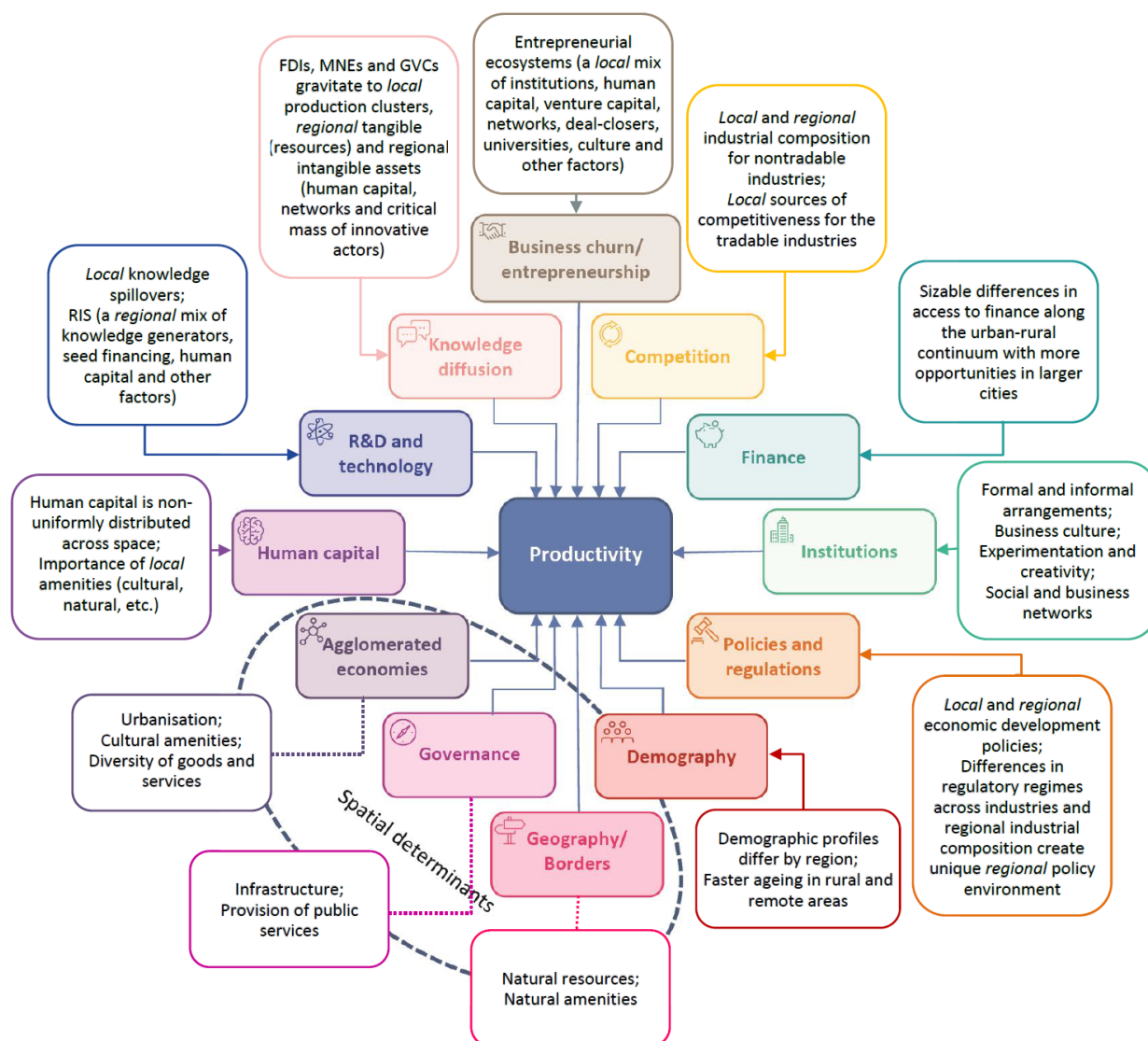
4. Bringing space into productivity discourse: Overview and synthesis

27. Regions, and space in general, have always been an obvious but untold part of the productivity story. A vast international literature demonstrates the importance of a range of factors, such as human capital, technological advance and innovation, competition and business churning, institutions and policies, for productivity of industries and sectors across countries. This literature usually does not consider the subnational dimension of the productivity drivers it studies. It also generally ignores a number of subnational phenomena that have been shown to shape productivity performance at various levels of aggregation.

28. At the same time, the regional science research tradition investigates (from a regional and local perspectives) many, if not all, productivity determinants underscored by the international productivity studies. It seeks to understand and explain a multitude of social and economic processes, explicitly modelling them as a result of regional and local dynamics. Among prominent research topics within this literature are agglomerated economies, entrepreneurship, business churn; innovation, R&D and knowledge spillovers; universities; human and social capital; networks; business dynamics and structural change among others. All of these factors, imbedded in the subnational space, are linked directly and indirectly to productivity determinants highlighted by the international productivity research.

29. Figure 5.1. A synthesis of the literature on productivity including spatial dimension presents a schematic overview of both international literature on productivity and the regional science studies that elucidate the ways, in which the “traditional” productivity drivers are shaped by regional factors. The Figure offers a comprehensive and coherent view on the role of places in determining aggregate productivity performance. While succinctly displaying main relationships highlighted in the discussion below, it does not show the complex interdependencies that exist among many determinants included in the chart.

Figure 5.1. A synthesis of the literature on productivity including spatial dimension



Source: Authors' elaboration based on the literature

30. Another way to demonstrate an importance of space for productivity is by summarising regional variation in main productivity determinants put forth by the international productivity literature, which omits the subnational dimension. Table 5.1. Regional variations in productivity determinants **Error! Reference source not found.** shows the summary statistics for selected measures taken from the OECD Stats regional database. The measures are organised around several productivity drivers shown in Figure 5.1. The reported measures are either standardised or are expressed as shares in order to capture heterogeneity that is not driven by region size.

Table 5.1. Regional variations in productivity determinants

| Productivity determinants | Measure | Obs. | Mean | Std. Deviation | Min | Max |
|---------------------------|---|------|------|----------------|------|-------|
| Business churn | Density of birth, all firm (number of births divided by 1000 population) | 154 | 7.3 | 4.2 | 2.5 | 29.9 |
| | Birth rate (in % of all firms - same sector, same size class) | 154 | 10.6 | 3.6 | 5.4 | 25.1 |
| | Churn rate (births plus deaths in % of all firms - same sector, same size class) | 128 | 19.6 | 6.1 | 11.0 | 43.9 |
| Competition | Average employment size of active enterprises (employer firms) | 187 | 12.3 | 5.6 | 3.5 | 27.9 |
| | Share of newly born establishments in the business population (in % of employer firms - same sector, same size class) | 115 | 9.5 | 2.3 | 4.4 | 18.1 |
| R&D and technology | Share of employment in high-technology manufacturing | 133 | 1.1 | 0.8 | 0.1 | 3.9 |
| | Share of employment in knowledge-intensive services | 184 | 36.5 | 10.1 | 15.6 | 61.1 |
| | PCT patent applications per million inhabitants (fractional count; by inventor and priority year) - level | 410 | 70.5 | 106.4 | 0.0 | 640.1 |
| | Share of R&D total expenditure (in % of GDP) | 183 | 1.5 | 1.1 | 0.0 | 5.7 |
| Knowledge diffusion | Share of PCT co-patent applications that are done with foreign regions (in % of co-patent applications, total count) | 386 | 53.6 | 22.1 | 4.5 | 100.0 |
| | Share of PCT co-patent applications that are done within the country (in % of co-patent applications, total count) | 318 | 14.6 | 16.1 | 0.3 | 100.0 |
| | Share of PCT co-patent applications that are done within the region (in % of co-patent applications, total count) | 338 | 43.9 | 21.7 | 4.2 | 100.0 |
| Human capital | Share of labour force with secondary education | 399 | 43.0 | 14.8 | 12.0 | 76.5 |
| | Share of labour force with tertiary education | 399 | 35.2 | 14.5 | 6.0 | 75.2 |

Note: data at the TL2 level; measures for business churn and competition are reported for year 2014 using Total economy aggregate 3 based on ISIC Rev.4 codes (Industry, construction and services excluding insurance activities of holding companies); all other variables are reported for year 2015.

Source: Aggregation from the OECD.Stat regional database.

31. Table 5.1 confirms a common observation in the regional science literature that many resources (including human capital, R&D and others) are not uniformly distributed geographically. There is a significant variation at the subnational level as evidenced by large differences between the minimum and the maximum values of the variables and the overdispersion in some cases. Although not displayed, there are also notable dissimilarities of regional industrial structures measured by employment shares across sectors. It is likely to translate into varying regional competitive and regulatory regimes, as many policies and regulations are sector-specific.

32. In sum, if determinants of productivity vary widely across space, it is not unreasonable to expect productivity to be at least partially linked to regional characteristics. This brings the spatial dimension into the productivity debate. An explicit focus on a subnational regional dimension must be an integral part of the productivity discourse, as it can provide a unifying lens to connect regional policies to regional wellbeing and to regional and aggregate productivity performance.

5. Traditional productivity drivers and their spatial dimension

33. In trying to understand and explain productivity, a vast body of literature looks at individual firms, industries or countries. Such perspective is most likely driven by the specifics of the modelling approaches that start with a representative firm/technology (Coelli et al., 2005_[23]) or a representative industry (Jorgenson and Stiroh, 2000_[24]) and by data availability for empirical analyses (industry-level productivity compilations from statistical agencies are the easiest to obtain). The productivity research that omits the spatial dimension generally consists of the studies that try to explain firm-level productivity (or its growth), industry-level productivity (or its growth) and the vast differentials in productivity levels/growth rates across firms between and within (even narrowly defined) industries.

34. Regardless of the broad focus, the literature names a relatively narrow set of the factors and processes crucial for productivity performance. The most prominent of them are described in a greater detail below. A summary of the (mostly international) economic studies on each productivity driver is followed by a discussion of the spatial dimension, which demonstrates how productivity originates – to a varying degree – in the local and regional realities.

5.1. Innovation and technology

35. Innovation is the basic prerequisite of production activity – it makes production possible by generating needed technology (Doms and Bartelsman, 2000_[25]). A variety of economic growth models, which identify the main productivity determinants³, recognise this fact. The models focus on technological progress and innovation as the central sources of increased productivity at the firm-, industry- and national levels (Romer, 1990_[26]; Solow, 1956_[27]; Schumpeter, 1942_[28]). Innovation, in addition to increasing productivity of the innovating firms, intensifies competition, which forces incumbents to become more efficient and facilitates reallocation of resources from less efficient to more efficient businesses within the economy.

5.1.1. Business churn and competition

Traditional discourse

36. In line with the argument of creative destruction, where new innovative firms replace the less innovative incumbents (Schumpeter, 1942_[28]), innovation and technological evolution are often modelled as a process of adoption of new products and processes, which inevitably leads to the destruction of their old counterparts (Foster, Haltiwanger and Krizan, 2001_[29]). A variety of theoretical models within this tradition shows how greater business entry and exit (churn) can be productivity-enhancing. In the model by Aghion and Howitt (1990_[30]), for example, innovator firms enter the market to

³ These models, however, often focus on *aggregate* productivity (i.e. the total amount of output) growth and in some cases may not be directly applicable to explain *average* (amount of output per a unit of input) productivity growth, as, for example, is the case of savings rate in the AK models. The rate of savings and capital accumulation, another common explanation of growth, are related to average productivity indirectly e.g. via development and introduction of more efficient technologies and technological processes.

derive monopolistic rents on their innovative technology until new entrants come rendering the existing technologies obsolete and pushing existing (less productive) firms out of the market. In a related manner, average productivity can increase via business churn if only new firms can possess new vintages of capital, which are more technologically advanced and productive (Campbell, 1998_[31]). Another variation of this theoretical mechanism is when only start-ups embed new (more efficient) management styles or organisational structures (Nelson and Winter, 1982_[32]).

37. Recent empirical research confirms a central role of business churn (and of business dynamism in general) in productivity growth. For example, Foster, Haltiwanger and Krizan (2001_[29]) estimate that during the 1977-87, net entry accounted for 25% of productivity growth in the U.S. manufacturing. Asturias, Hur, Kehoe and Ruhl (2019_[33]) come to a comparable conclusion using manufacturing data for South Korea and Chile. The latter study also shows that the contribution of business churn to productivity growth is larger during the periods of economic expansion. In a more recent study covering all private sectors except farming in the U.S., Alon, Berger, Dent and Pugsley (2018_[34]) report that for 1% decline in business entry local productivity growth is reduced by 1-2%.

38. Business entry enhances productivity via several channels. Start-ups tend to bring new technologies and production processes to market driving up the overall efficiency of the economy (if start-ups are more efficient than incumbents). If new firms are indeed more efficient and market reallocates resources to such companies, overall efficiency will increase due to an expanding market share of more efficient firms. Besides, entry (and a threat of entry and exit) imposes competitive pressure that forces incumbents to become more innovative (Aghion et al., 2005_[35]) and to improve their business processes and production practices (Nickell, 1996_[36]).

39. The ability of an increase in entry to enhance productivity of incumbents is explored in Aghion et al. (2004_[37]). The authors report faster total factor productivity growth of domestic companies in industries with greater share of foreign firm employment after the reforms, which opened the UK market during the 1980. Aghion et al. (2005_[35]) explore the effect of product market competition further demonstrating that it stimulates innovation. This relationship, however, is not uniform. A threat of technologically advanced entry increases innovation in sectors close to the technological frontier (Aghion and Howitt, 2006_[38]) and suppresses innovation in the laggard sectors (Aghion et al., 2009_[39]). A positive effect is observed also in the markets with neck-to-neck competition (Aghion and Howitt, 2006_[38]).

40. A related strand of literature explores the effects of trade on productivity. The logic behind the effects is identical to the case of innovation and business entry. In order to stay competitive in international markets, firms face greater pressure to innovate and to be efficient. The same applies in domestic markets with fierce international competition from foreign exporters. Simultaneously, engagement in international trade increases the likelihood of learning, potentially boosting firm's innovative and absorptive capacities.

41. The empirical evidence testing the effects of trade on productivity performance of firms is mixed. Overall, firms engaged in international activities tend to be more productive, however, factoring out causality is a challenge because of self-selection (Bernard and Jensen, 1999_[40]; Tybout, 2001_[41]). Criscuolo, Haskel and Slaughter (2010_[42]) demonstrate that internationally engaged firms are more likely to innovate and to learn from their international counterparts. Griffith, Redding and Van Reenen (2004_[43]) show that increased imports from the frontier countries have a weakly significant positive effect on

productivity growth via technology transfer, not increased innovation. This detected effect is minor compared to the impacts of R&D and human capital. Likewise, Keller and Yeaple (2009_[44]) find positive spillovers from import activities but the results are not robust. In models estimated by Buccirossi, Cian, Duso, Pagnolo and Vitale (2013_[45]) using the data on 22 industries in 12 OECD countries, import penetration has consistently positive effect on productivity growth. On the other hand, Bernard and Jensen (1999_[40]) find that exporting manufacturers in the U.S. are not different from the non-exporters in terms of productivity and wage growth, especially in the long run.

The spatial dimension

42. The spatial dimension of business churn and competition is best understood from the Schumpeterian perspective of industry evolution. Within this tradition, business churn is a flip side of entrepreneurship. Start-ups disrupt the status quo by bringing new technologies and modes of production to the market and push less innovative incumbents to exit. Empirically, entrepreneurship is often approximated by start-up rates⁴, which are closely linked to exit rates (Dunne, Roberts and Samuelson, 1988_[46]; Geroski, 1995_[47]).

43. Entrepreneurship is a prominent topic of research across several fields (Acs and Audretsch, 2006_[48]), many of which fall under the umbrella of regional science. A great interest in entrepreneurship arguably comes from understanding that start-ups, particularly small and innovative ones, play a central role in economic performance of regions (Acs, 2006_[49]; Audretsch and Keilbach, 2004_[50]; Birch, 1987_[51]; Malecki, 1993_[52]). It comes as no surprise that a vast literature tries to explain entrepreneurial activity within a subnational perspective (Acs et al., 2009_[53]; Lee, Florida and Acs, 2004_[54]; Mueller, 2006_[55]; Qian, Acs and Stough, 2013_[56]). A set of regional determinants of entrepreneurship highlighted in the literature include regional entrepreneurial ecosystems (EEs), universities and research organisations, human capital, a culture of openness and inclusion, creativity, social networks and access to finance among others.

44. Of these determinants, the EE is the youngest and, to a degree, an all-encompassing concept. Mason and Brown (2014_[57]) underscore the importance of place-specific assets for the formation of an entrepreneurial ecosystem, which is defined as “a *set of interconnected entrepreneurial actors (both potential and existing), entrepreneurial organisations (e.g. firms, venture capitalists, business angels, banks), institutions (universities, public sector agencies, financial bodies) and entrepreneurial processes (e.g. the business birth rate, numbers of high growth firms, levels of ‘blockbuster entrepreneurship’, number of serial entrepreneurs, degree of sell-out mentality within firms and levels of entrepreneurial ambition) which formally and informally coalesce to connect, mediate and govern the performance within the local entrepreneurial environment*” (p.5).

45. Although the literature is ambiguous regarding a clear delineation of the causes and consequences within entrepreneurial ecosystems due to the complex nature of interdependencies, EEs are believed to be the hotbeds of productive, high-quality or high-growth entrepreneurship (Stam, 2015_[58]; Acs et al., 2017_[59]; Alvedalen and Boschma,

⁴ Other common approximations are a share of firms under certain age (usually 3 or 5 years), share of self-employed and (less common) a share of firms below certain size.

2017_[60]; Mason and Brown, 2014_[57]) and are linked to greater productivity and more innovative outputs within their boundaries (Acs et al., 2017_[59]).

46. The distinctive feature of the EE approach is its focus on the links among various types of actors (such as individuals, organisations and institutions) constituting an ecosystem instead of an isolated focus on actors themselves (Alvedalen and Boschma, 2017_[60]). Because of the spatial nature of many interactions at the core of an EE, as well as the predominantly geographical organisation of an entrepreneurship support system, entrepreneurial ecosystems are geographically bounded. Despite being clearly a spatial phenomenon, EEs are not limited to specific geographical scales – they can be found in places of various sizes from a neighbourhood to a city to a region (Mason and Brown, 2014_[57]; Qian, Acs and Stough, 2013_[56]). Entrepreneurial ecosystems can be industry-specific or include many industries (Mason and Brown, 2014_[57]).

47. In a sense, entrepreneurial ecosystems are a precondition for the success of (much older in terms of academic and policy interest) concepts such as industrial clusters, innovation systems and knowledge economy (Isenberg, 2011_[61]). EEs tend to possess unique dynamism (Mack and Mayer, 2016_[62]) that leads to synergies stemming from and reinforcing diversity, (related) diversification, resilience and adaptation (Alvedalen and Boschma, 2017_[60]). As a result, entrepreneurial ecosystems are able to nurture high-growth firms, which are central to productivity growth, increased innovation and internationalisation of their host (regional) economies (OECD, 2013_[63]).

48. Another prominent business dynamics determinant is a presence of universities or research centres, which are often linked to increased local firm formation, particularly in knowledge-intensive and high-tech industries (Baptista and Mendonça, 2010_[64]; Kirchoff et al., 2007_[65]). Many universities task their technology transfer offices with promoting business formation based on the in-house research. Alternatively, graduates, and sometimes employees, may choose to start a business based on an idea they were exposed to during their studies or work. In this sense, university-industry relationships can help overcome the “knowledge filter” helping research ideas to be transformed into new businesses entry (Mueller, 2006_[66]). The literature, however, points to the crucial importance of the local support infrastructure for the rates of university spin-offs and business formation in general. Usually a presence of an university is an important but not sufficient condition for sprouting a vibrant entrepreneurial culture (Di Gregorio and Shane, 2003_[67]; Feldman, 2001_[68]), much in line with the entrepreneurial ecosystems argument.

49. Human capital available regionally is an intensively studied explanation of regional economic dynamism and is an integral part of the EE perspective (Spigel, 2017_[69]). Human capital is crucial for the success of entrepreneurial ecosystems and high-growth firms within them, as well as for the regional entrepreneurship in general. The importance of educational attainment (perhaps the most common measure of human capital) for local and regional entrepreneurship is determined by several factors. Besides providing skilled labour force to be employed by new ventures, higher levels of education in an area increase regional absorptive capacity. This can facilitate knowledge-spillover entrepreneurship, i.e. a process of utilising entrepreneurial opportunities generated by locally produced knowledge, which usually requires the ability to understand and apply this knowledge (Qian, Acs and Stough, 2013_[56]).

50. The notion of human capital here is not limited to the skills of graduates (or educational attainment of the population). It also includes the accumulated managerial experience (including managing failed ventures) and developed networks that allow

leveraging local resources and connecting to global pipelines efficiently. Vibrant entrepreneurial ecosystems are characterised by the process of entrepreneurial recycling (Mason and Brown, 2014_[57]; Mason and Harrison, 2006_[70]) where successful (cash-out) entrepreneurs reinvest their resources in local entrepreneurial activity. For example, Amaral, Baptista and Lima (2011_[71]) show (using data for Portugal) that for younger entrepreneurs (under 30 years old) having a top managerial experience in a previously closed enterprise decreases time to the next entrepreneurial entry.

51. Empirical literature also demonstrates that a culture of openness and inclusion often plays an important role in stimulating both entrepreneurship and entrepreneurial recycling. For example, Qian et al. (2013_[56]) find that tolerance (measured by the share of households with reported homosexual unmarried partner and by the share of bohemian population) is positively linked to the rate of business start-ups in the U.S. metropolitan areas. The estimated effects are larger for the high-technology start-up activity in particular. In a related manner, Sobel, Dutta and Roy (2010_[72]) show that entrepreneurship is positively related to ethnolinguistic fragmentation in the U.S. states. For German regions, Audretsch, Dohse and Niebuhr (2010_[73]) report a positive effect of cultural diversity on technology-oriented start-ups.

52. A local culture of accepting business failure is another example of openness that stimulates business churn within a regional perspective. In a study of a start-up community in Boulder, Colorado (USA), Feld (2012_[74]) argues that its success is partially based on a lack of stigma related to changing employers or to business failure. Failed entrepreneurs are absorbed by the business community as advisors or become serial entrepreneurs. Likewise, Isenberg (2011_[61]) argues that quick experimentation in business ideas (with quick start-ups and exits if a project does not generate expected value) is vital to the vibrancy of entrepreneurial community – the cultures that encourage quick exits enjoy higher rates of entrepreneurial activity.

53. Experimentation is intrinsically related to creativity, another important aspect of local culture that may stimulate entrepreneurship and business churn. Florida (2003_[75]) argues that there are three types of creativity – technological (innovation), economic (entrepreneurship) and artistic or cultural creativity. These three types reinforce each other. For a region to succeed in entrepreneurship, conditions must be created for thriving technological and cultural creativity. While highly influential, the Florida's approach was widely criticised for the fuzziness of the main concepts and an overly casual treatment of the cause-and-effect relationships (Markusen, 2006_[76]; Peck, 2005_[77]; Asheim and Hansen, 2009_[78]). The empirical evidence testing Florida's propositions is mixed. The extant research suggests that the direct and large effects of creativity and of creative class on regional economic performance are unlikely (Krätke, 2010_[79]; Boschma and Fritsch, 2009_[80]; Rausch and Negrey, 2006_[81]) but creativity might play an auxiliary role enhancing the contribution (or facilitating geographical concentration) of other factors (Audretsch and Belitski, 2013_[82]). For example, cultural industries and occupations can facilitate innovation and greater customer satisfaction via supplying content and designs to the technology sectors and the economy of experience (Cooke and de Propris, 2011_[83]).

54. Finally, a sociological and management traditions study extensively social networks. Although this approach is not directly related to a region and focuses instead on entrepreneurial opportunities and available resources as a function of embeddedness in various types of social connections (Stuart and Sorenson, 2005_[84]), the latter tend to have a clear spatial dimension. As a result, networks partially determine local business

opportunities (business ideas that can be utilised by start-ups) and resources to establish a firm based on these ideas. In terms of business start-ups, the role of networks often comes via facilitating access to financing (Jenssen and Koenig, 2002_[85]; Stuart, Hoang and Hybels, 1999_[86]).

55. Unlike business entry, which often is a regional phenomenon regardless of industry or sector, the regional dimensions of competition are clearly industry-dependent. Here local conditions (including the local number and market strength of competitors) would be relevant mostly for non-tradable industries. For the tradable industries, on the other hand, the local determinants of competitiveness are of great importance. In words of Michael Porter (1998, p. 78_[87]) “the enduring competitive advantages in a global economy lie increasingly in local things – knowledge, relationships, motivations”.

5.1.2. R&D and technological advances

Traditional discourse

56. The defining role of the R&D and technological innovations in productivity growth has been long recognised (Griliches, 1979_[88]; Griffith, Redding and Reenen, 2004_[43]; Keller, 2000_[89]; Geroski, 1995_[47]). The advent and the penetration of the information and communication technologies (ICT) have reinforced the general understanding that technological progress is a major driver of productivity growth (Jorgenson, Ho and Stiroh, 2008_[90]). The ongoing rapid development of new technologies, which lead to automation and digitalisation of economic activity, suggests that the role of the R&D as a productivity determinant is likely to grow in the future.

57. There are several ways technology contributes to productivity growth. First, knowledge-intensive industries are on average more productive and their expansion contributes sizably to productivity. For example in the U.S., productivity growth in manufacturing is predominantly accounted for by the computer and electronic product manufacturing industry (Houseman, Bartik and Sturgeon, 2015_[91]). Devices, equipment, technologies and electronic applications produced by the knowledge-intensive industries increase efficiency and profitability of companies utilising them. The surge in productivity in the late 1990s was mostly attributed to the penetration of the ICT technologies (Jorgenson, Ho and Stiroh, 2008_[90]).

58. Research and development naturally increase innovation but they also contribute to a greater absorptive capacity of firms and industries allowing them to benefit more from innovative activities of other economic actors (Geroski, Machin and Reenen, 2006_[92]; Griffith, Redding and Reenen, 2004_[43]). Related to the absorptive capacity argument, the knowledge spillovers literature demonstrates how companies, industries and countries not directly involved in the development of specific technologies can nevertheless benefit from them.

59. Existing empirical studies consistently find that the R&D investments by firms explain a large part of differences in productivity (Hall, Mairesse and Mohnen, 2010_[93]), although the estimates of the R&D investment elasticity of productivity (and returns to R&D in general) vary widely (Griliches and Séneca, 2000_[94]; Mairesse and Sassenou, 1991_[95]). Despite the differences in the magnitude of the estimated effects, the literature is in agreement that the positive effects of the R&D and innovation are larger for high-tech firms and in high-tech or knowledge-intensive sectors (see, for example, Hall and Mairesse (1995_[96]); Tsai and Wang, (2004_[97]) and Verspagen, (1995_[98])). A recent study by Kancs

and Siliverstovs (2016_[99]) concludes that the firm-level productivity increases as a result of R&D investments; this effect is greater for more knowledge-intensive firms and in more knowledge-intensive sectors. When productivity *growth* is concerned, the same study finds that the relationship is non-linear and a critical mass of knowledge needs to be accumulated before the positive effects of the R&D are observable in the data.

60. A more recent – and still relatively scant – strand of research investigates the productivity effects of automation and digitalisation, which only now are becoming prevalent. The general consensus so far is that these processes are linked to increased productivity, although the causation is not clearly established (Graetz and Michaels, 2018_[100]; Koch, Manuylov and Smolka, 2019_[101]; Sorbe et al., 2019_[13]).

61. Several international studies report a positive effect of robotisation on industrial productivity. Using data on 17 developed countries, Graetz and Michaels (2018_[102]) estimate that the use of robots has boosted labour productivity growth by 0.36% annually over the 1993-2007 period. The authors also report increased TFP and reduced output prices as a result of automation. Likewise, Kromann and co-authors (Kromann et al., 2016_[103]) find that one standard deviation increase in the robot-intensity index is associated with more than 5% increase in total factor productivity in nine countries during 2004-2007. Similarly, a positive association between the robot adoption and productivity of manufacturing firms is documented by Dauth et al. (2018_[104]) for Germany and by Kromann and Sørensen (2019_[105]) for Denmark.

62. Although the existing empirical evidence on the productivity effects of automation is predominantly based on the analysis of how industrial robots influence manufacturing firms, automation is likely to affect sectors beyond manufacturing. The recent wave of developments in prediction algorithms, image recognition and machine translation entails potential gains in productivity for various sectors (Agrawal, Gans and Goldfarb, 2019_[106]; Varian, 2018_[107]).

63. When it comes to the effects of digitalization on productivity, several cross country firm-level studies report positive effects. Gal et al. (2019_[14]) provide evidence that adoption of digital technologies in an industry is linked to firm-level gains in productivity. The authors document the positive effects of such technologies as cloud computing, customer relationship management, enterprise resource planning systems and access to high-speed broadband internet. Similarly, Bailin Rivares et al. (2019_[108]) find that expansion of online platforms is associated with higher productivity of service firms.

64. The identification of the effect of digitalization on firm-level productivity is, however, complicated by various confounding factors such as self-selection into technology adoption. Furthermore, complementarities between digital technologies and organizational capital of firms can potentially explain why some studies find no effect (Gal et al., 2019_[14]). For instance, access to broadband was found to have no effect on within-firm productivity in the UK (DeStefano, Kneller and Timmis, 2018_[109]) and in a selection of European countries (Bartelsman, van Leeuwen and Polder, 2017_[110]). Likewise, Acemoglu et al. (2014_[111]) find no association between IT-intensity and productivity in manufacturing.

The spatial dimension

65. The technology adoption and the R&D intensity clearly differ by industry. Enterprises comprising an industry, however, are located in space. The regional research

has convincingly shown that geographical proximity is important for knowledge exchange, cross-fertilisation of ideas and the R&D intensity, which often happens in (spatially bounded) knowledge hubs. Such hubs can be industry-specific, but most often they consist of companies, which belong to a range of (related) industries and sectors⁵. The co-location (even at a micro-level) can define knowledge intensity and productivity performance (Andersson, Larsson and Wernberg, 2019_[112]), although the literature suggests that various types of proximity (e.g. related and unrelated) can be conducive to enhanced innovation and productivity depending on the specific conditions (Boschma and Frenken, 2011_[113]; Castaldi, Frenken and Los, 2015_[114]).

66. Like innovation in general, the R&D and technological progress have a well-defined spatial dimension that emerges via multiple channels. They include the presence of research universities, R&D labs and a concentration of R&D-intensive industries; abundance of highly educated human capital; presence of research support infrastructure and mechanisms, e.g. seed financing, venture capital, formal and informal networks and others. These elements, when well-connected and functioning in a synergy, can form a regional innovative system (RIS) that promotes and enhances the R&D and innovation within its borders.⁶

67. Besides promoting business formation directly, universities and research labs considerably contribute to the knowledge-intensity of their host regions and innovativeness of the firms located therein. The literature shows that the mechanisms of firm learning from universities are manifold and complex (Cohen, Nelson and Walsh, 2002_[115]; Laursen and Salter, 2004_[116]). There is also some evidence that proximity to universities tends to help innovative efforts by small and medium enterprises (SMEs), those that usually would lack capacity to perform their own research (Acs, Audretsch and Feldman, 2006_[117])⁷ but it is crucial for firms to possess sufficient levels of absorptive capacity (Laursen and Salter, 2004_[116]). Research-intensive universities can bring global knowledge flows to their host regions by absorbing cutting-edge international research and sharing its pieces relevant for businesses in proximity, which normally would not be able to benefit from global knowledge creation independently (Fritsch and Schwirten, 1999_[118]).

68. Highly successful research universities often serve as the focal point for a regional innovation system development. The RIS approach emphasises the role of local factors and of their system-like interactions in the innovative behaviour of and knowledge production by firms (Mason and Brown, 2014_[57]). While connections to the global knowledge pipelines are important for knowledge creation within the RIS, the innovative activities of firms can be perceived as a locally driven process deeply influenced by local networks and resources, including tacit and context-specific knowledge (Asheim and Isaksen, 2002_[119]).

⁵ A more comprehensive view suggests that several types of proximity are crucial for learning and information exchange: cognitive, organizational, social, institutional and geographical (Boschma, 2005_[246]). While acknowledging that these types are likely to work in tandem and could be difficult to clearly disentangle in terms of effects on innovation, we predominantly focus on the geographical proximity, since it is most relevant to our discussion.

⁶ Since networks and human capital are discussed in other subsections, this subsection focuses on the role of universities (and other research-intensive entities) and on regional innovation systems.

⁷ For opposing evidence suggesting that the effects are larger for big firms and start-ups, see Cohen, Nelson and Walsh (2002_[115]).

69. The spatial dimension appears to be important for the patterns of penetration/adoption and the productivity effects of more recent technological advances such as automation, robotisation and digitisation. Although the literature is still scant, it has already been argued that, for example, expertise in artificial intelligence (AI) tends to concentrate in space with clusters expanding around the existing IT hubs and major research departments (Goldfarb and Trefler, 2018_[120]; Klinger, Mateos-Garcia and Stathoulopoulos, 2018_[121]). The availability of talent appears to be essential to the location decisions of the AI research units.

70. The recent advances in the AI research broaden the range of tasks that can be automated, although some tasks are more prone to automation than others. As tasks and jobs embodying these tasks are unevenly distributed in space, so is the risk of automation. The estimates of the share of jobs at risk of automation across the OECD regions vary widely (OECD, 2018_[19]), implying sizable regional differences in the potential gains in productivity.

71. Besides the spatial variation in tasks that can be automated, the degree of regional exposure to automation is likely to be influenced by the existing industrial structures. For instance, Dauth et al. (2018_[104]) report that the penetration of industrial robots in German labour markets is linked to the size of the manufacturing sector.

72. Apart from the existing industrial structure, the spatial variation in productivity gains from automation and digitalization is likely to further increase. There is growing evidence that the propensity to adopt automation and digitalisation technologies is related to firm characteristics, most importantly to firm size. For instance, in the case of automation, it has been shown that larger and more productive firms are more likely to adopt robots (Koch, Manuylov and Smolka, 2019_[101]), to benefit from network externalities (Goldfarb and Trefler, 2018_[120]) and to get better access to data (Cockburn, Henderson and Stern, 2018_[122]). Likewise, larger firms are more likely to adopt such digital technologies as cloud computing (OECD, 2017_[123]). At the same time, larger firms and more productive firms tend to concentrate in larger cities (Behrens, Duranton and Robert-Nicoud, 2014_[124]; Combes et al., 2012_[125]).

5.2. Knowledge diffusion

Traditional discourse

73. After an innovation has generated a technology needed for the production activity, the diffusion and adoption of the technology determines productivity of each establishment, which, in turn, defines aggregate productivity of an industry or a country (Doms and Bartelsman, 2000_[25]). Knowledge diffusion, therefore, is a central productivity-defining mechanism together with innovation. The technology and knowledge diffusion are becoming increasingly important in a globalised world where multinational enterprises (MNEs), foreign direct investments (FDIs) and global value chains (GVCs) emerge as the leading channels of knowledge sharing across regions and nations⁸.

74. MNEs are generally expected to be productivity leaders as it takes a superior technology, management and other firm-specific resources to stay competitive in foreign

⁸ Knowledge diffusion via engagement in international trade is also briefly discussed in Section 5.1.1.

markets (Criscuolo and Martin, 2009_[126]). Multinationals usually enter foreign markets via greenfield investments (where new companies are set up to operate in a country different from the location of headquarters) and via mergers and acquisitions (M&A) with local firms. The latter channel is substantially more common and may account for 80-90% of the FDI flows (Navaretti, Venables and Barry, 2006_[127]; Stiebale and Reize, 2011_[128]).

75. As in the case of international engagement, the non-random process of firm selection for M&A and the self-selection of the headquarters into engaging in international activities complicates causal inference. Several studies seek to identify the impact of foreign ownership on productivity while properly accounting for endogeneity and other possible threats to validity of the estimates. The results tend to differ depending on the country and the industrial setting.

76. For example, Arnold and Javorcik (2009_[129]) report strong and lasting productivity-enhancing effects of foreign acquisitions on plant performance in Indonesia, which happen via restructuring, increased investments and other channels. In a group of advanced European countries, on the other hand, the effects are modest, are detectable with a multi-year delay and only if the majority stake is acquired (Fons-Rosen et al., 2013_[130]). Divergent findings come also from the UK. A study by Bloom, Sadun and Van Reenen (2012_[131]) finds that companies acquired by MNEs from the U.S. tend to exhibit better productivity performance. This effect is driven by a more efficient utilisation of information technology (IT) and by superior personnel management practices. In contrast, Criscuolo and Martin (2009_[126]) argue that the productivity advantage of the U.S.-owned manufacturing companies in the UK is the result of acquisitions of already highly productive companies. Almeida (2007_[132]) comes to a somewhat comparable conclusion in the analysis of employer-employee matched data on Portuguese firms. The author reports negligible effects of foreign acquisitions on human capital and wages of the target companies and concludes that foreign investors choose domestic firms that are already very similar to the foreign firms.

77. One way for the international engagement to affect productivity is by the greater innovation of participating firms. Criscuolo, Haskel and Slaughter (2010_[42]) look at the performance of the UK enterprises that are a part of MNEs (both British-based and foreign) or are engaged in the export activities. The authors contrast these companies with the performance of purely domestic firms. The findings suggest systematic differences in the knowledge production and innovative activities of the two types of companies with the former employing more R&D staff, enjoying more inter-company learning and being more likely to patent and to introduce innovations. The differences in innovative outputs, however, are mostly explained by the variation in the amount of inputs, whilst global engagement accounts for a very small fraction of variation in the innovative performance. Guadalupe, Kuzmina and Thomas (2012_[133]) examine innovative behaviour of 2,800 Spanish manufacturing firms and find that foreign ownership makes companies more likely to innovate. This leads to productivity improvements via both better technologies and a more efficient organisation of production. In contrast, Stiebale and Reize (2011_[128]) estimate the effects of the cross-border M&As on innovative performance of target small and medium enterprises (SMEs) in Germany. After controlling for selection and endogeneity, the researchers find that foreign acquisitions tend to suppress innovative activities and the average R&D expenditures.

78. Besides affecting the performance of the target firms, FDI and MNEs can increase productivity of domestic firms in the same or related industries via spillovers. An analysis

of productivity gains among 1,300 U.S. manufacturing firms by Keller and Yeaple (2009_[44]) reveals that FDIs have strong technological spillovers and are able to increase productivity of domestic companies, particularly in the high-tech industries. The positive effects are also stronger for small and less productive firms.

79. Finally, as production becomes increasingly fragmented across national borders, the role of GVCs as a channel of knowledge diffusion becomes more salient. MNEs play an important role in proliferation and shaping of global value chains, which grow in complexity and can be based on multiple integration mechanisms, from forward and backward linkages to outsourcing (Criscuolo and Timmis, 2017_[134]).

80. Although the literature is still scarce, it is clear that the GVC engagement can affect productivity in many ways. For the firms participating in GVCs, efficiency can be improved via integration in international trade, specialisation, offshoring, knowledge sharing and scaling up. There are also substantial spillovers for enterprises not directly involved in GVCs. The spillovers happen via knowledge diffusion within supply chains (mostly backward linkages (Havranek and Irsova, 2011_[135])), hiring employees from firms participating in GVCs and other channels. At a regional level, the R&D offshoring was shown to increase productivity growth in European regions (Castellani and Pieri, 2013_[136]).

81. The FDIs, MNEs and GVCs are by definition international⁹. When making location decisions, MNEs consider a host of national factors such as regulatory and legal frameworks, labour market regulations, protection of property rights and contract enforcement among others. There is evidence, however, that the preferences of MNEs for the national aspects are highly heterogeneous and depend to a large degree on a sector and business function (Ascani, Crescenzi and Iammarino, 2016_[137]).

The spatial dimension

82. At the subnational level, the local dynamics is important for knowledge diffusion across both regions and firms. For example, the literature documents a growing importance of local assets for the location choices of MNEs (Crescenzi, Pietrobelli and Rabellotti, 2016_[138]; Iammarino and McCann, 2013_[139]). This is particularly true for the high value added activities within the GVCs, which centre around regional production clusters (Criscuolo and Timmis, 2017_[134]) and for the high-tech MNEs, which are attracted to the local expertise and knowledge (Crescenzi, Pietrobelli and Rabellotti, 2014_[140]).

83. As a result, the inter-regional knowledge diffusion within the global pipelines, of which MNEs and GVCs are the central conduits, is increasingly seen via the global-local perspective. This perspective blends the patterns of knowledge diffusion and regional development as an interrelated and simultaneous process (Crescenzi and Iammarino, 2017_[141]). MNEs break a complex productive process of value creation into a multitude of stages and components (ranging from functions to specific transactions). The components are placed across the globe where they can be carried out most efficiently. The location selection takes into account the ability of GVC and MNEs to tap into local and regional intangible assets and knowledge bases relevant to each specific function or transaction.

84. The intangible assets specific to a region are embedded in its human capital, local networks and a critical mass of innovation actors (Kramer et al., 2011_[142]) and can become

⁹ FDIs tend to connect neighbouring countries, making them predominantly a cross-border phenomenon, rather than a truly global one (Crescenzi and Iammarino, 2017_[141]).

central sources of competitive advantages for the MNEs (Cantwell and Iammarino, 2005_[143]; Molero and Garcia, 2008_[144]). Attracted by regional characteristics, MNEs can spread international expertise and best practices to local economy, although there are also concerns over knowledge sourcing by MNEs, which can undermine local knowledge bases (De Propriis and Driffield, 2005_[145]).

85. The empirical research documents the increased productivity of domestic firms in the regions of FDI for a number of sectors but highlights that these effects are unlikely to travel past regional borders (Girma and Wakelin, 2007_[146]; Higoacuten and Vasilakos, 2011_[147]). At the regional level, the concentration of multinationals in the US commuting zones appears to increase value added, wages (for higher-paid workers) and employment (Setzler and Tintelnot, 2019_[148]) but an appropriate level of pre-existing absorptive capacity is needed for a region to be able to benefit from the FDI (De Propriis and Driffield, 2005_[145]).

86. For the knowledge-intensive operations of the MNEs, regions with a solid knowledge and research base are more attractive. Local knowledge hubs, often centered around local universities, may play a pivotal role in attracting the R&D-related operations of the MNEs and high value added activities within the GVCs (Broström, Mckelvey and Sandström, 2009_[149]). The evidence on the link between FDI and local innovation output of their host regions suggests that there can be both positive and negative spillovers depending on the FDI types (Ascani and Morrison, 2019_[150]).

87. Universities often facilitate the inter-firm knowledge diffusion as well, in particular when active technology transfer offices (TTOs) are in place. As universities increasingly take up the role of the local economic growth engines, their TTOs are engaged in a range of activities from licencing out university-generated technologies to launching innovation parks and other incubators for business. The economic effects of such activities appear to be sizable. For the U.S., a recent report estimates that the contribution to the GDP of the non-profit inventions coming from universities and research centres ranged from 148 billion to 591 billion, in 2009 U.S. dollars, over the 1996-2015 period (Pressman et al., 2017_[151]).

88. Overall, the diffusion of knowledge happens via multiple channels, such as labour mobility, interactions with suppliers, clients and competitors, licencing, tapping into the “local buzz”, observing actions of others as well as participation in various networks. Again, many of these channels are localised. For example, specific suppliers can concentrate in spatially bounded clusters, high-skilled labour is likely to gravitate to areas with certain level of amenities, and decisions to locate in new markets are often driven by the presence of other MNEs in the area.

5.3. Human capital

Traditional discourse

89. Examining the effects of technology, knowledge and innovation on productivity performance of firms, industries and nations tells only a part of the story. Human capital, an important ingredient of any production function, is equally important. The role of human capital (in a broad sense) in determining productivity differentials comes via at least three

channels. First, managerial ability¹⁰ is strongly correlated with performance, as managers are the ones deciding how resources are being combined in a productive process (Syverson, 2011). Next, in line with the traditional growth theories, labour can be treated as a regular input (Mankiw, Romer & Weil, 1992). Greater levels of human capital are likely to contribute to (labour) productivity directly, as more educated and more skilled labour force should be able to produce more per hour. Finally, in the spirit of endogenous growth theories, the quality of human capital is crucial for technological progress, as it determines the efficiency of utilisation of other resources, most importantly, of advanced technologies.

90. The evidence on productivity-enhancing impacts of managerial practices and talent is described in Syverson (2011_[7]) who notes that the differences in business performance were attributed to the managerial ability more than a hundred years ago (Walker, 1887_[152]). Besides being able to control and streamline the day-to-day operations, managers are often responsible for the choice of technology and the use of various resources in the production process of a firm. The interdependence in the ways inputs determine productivity (Doms and Bartelsman, 2000_[25]) makes managerial decisions, such as allocation of resources within a company, its structure and others, even more consequential for productivity performance. Bloom, Sadun and Van Reenen (2016_[153]) provide supporting evidence. Using data on 34 countries, the authors find that differences in management practices can explain around 30% of variation in productivity between countries as well as within countries across firms.

91. Within the human capital – growth nexus, Benhabib and Spiegel (1994_[154]) model the influence of human capital on growth via its ability to facilitate national innovation and diffusion of technologies, as suggested by the endogenous growth theories. In this specification, the human capital is found to stimulate growth. Additional evidence suggests that higher levels of human capital have greater effect on growth via innovation closer to the technological frontier (Vandenbussche, Aghion and Meghir, 2006_[155]).

92. More recent studies investigate the relationship between human capital and innovation at the firm- and industry levels. In the analysis of German SMEs, Stiebale and Reize (2011_[128]) find that companies with higher levels of human capital measured by a share of employees with a university degree are more likely to innovate and to engage in the R&D. Griffith, Redding and Van Reenen (2004_[43]) report that human capital is positively related to the rates of innovation and technology transfer in a panel of industries in the OECD countries.

The spatial dimension

93. The spatial link between the quality of human capital and productivity growth mostly comes from a great heterogeneity in the quality of human capital across (subnational) space. The uneven spatial distribution of the human capital calls for empirical analyses of its effects on productivity at a regional level.

94. For instance, in a study of the European regions, Marrocu, Paci and Usai (2013_[156]) find a strong positive effect of human capital on productivity growth, which is larger than such effect of technological capital. In a related paper, Dettori, Marrocu and Paci (2011_[157])

¹⁰ We take the liberty of counting managerial or entrepreneurial ability within the broad category of human capital for the sake of easier exposition. It, of course, can (and for many purposes should) be treated separately. This would change the structure of the paper but the discussion will remain the same.

demonstrate that the positive impact of human capital on total factor productivity growth in the European regions is the largest compared to the effects of social and technological capital.

95. There is a long-standing unresolved debate whether jobs follow people or people follow jobs. The answer is likely to depend on a specific technology employed by the industry, supply and demand conditions in the labour market and other factors. For the high value added activities and the R&D in particular, which are at the heart of productivity growth, it appears that the highly skilled workers are more likely to be able to choose where they want to live and work (Brown and Scott, 2012_[158]; Graves and Linneman, 1979_[159]; Rappaport, 2009_[160]).

By and large, highly educated population tends to increasingly concentrate in urban areas (Shapiro, 2006_[161]). This is the result of the local educational efforts (Moretti, 2004_[162]) and in-migration of graduates (Brown and Scott, 2012_[158]). Empirical literature offers plentiful and conflicting accounts as to what are the primary drivers of highly educated workers' migration choices – jobs or amenities (Brown and Scott, 2012_[158]; Partridge and Rickman, 2003_[163]; Scott, 2010_[164]; Winters, 2011_[165]). The drivers can be difficult to disentangle due to the frequent co-location of high-quality jobs and various types of amenities. Regardless of the final jury in this debate, one conclusion is uncontested – local conditions (employment and/or the quality of life) determine to a large extent the human capital composition of a region (Buenstorf, Geissler and Krabel, 2016_[166]; Falck, Fritsch and Heblich, 2011_[167]).

5.4. Demography

Traditional discourse

96. Closely related to the discussions on the link between human capital and productivity growth is the debate on the role of demography and of the age composition in particular. At the micro-level, as workers age, their productivity can decline mostly due to the weakening of the physical abilities and absenteeism related to the deteriorating health. The negative effects, however, can be counteracted by accumulated experience or never felt in occupations where mental ability (as opposed to the physical one) is of primary consequence (Garibaldi, Oliveira Martins and van Ours, 2011_[168]).

97. The relevance of the age composition in the productivity discourse in the developed countries has grown over the last few decades due to the ageing of the baby boomers and the resultant shifts in the demographics of labour. The empirical consensus, at least up until very recently, was that age structure matters (Feyrer, 2007_[169]) – ageing has a persistent, although small, negative effect on productivity growth (Sharpe, 2011_[170]; Aiyar, Ebeke and Shao, 2016_[171]).

98. Feyrer (2007_[169]) uses international data to explore the effects of the workforce age structure on productivity. The author finds that the larger share of young population (under 40) has a suppressing effect on productivity, while the opposite is true for the population in the 40s. The results for the older cohorts (in their 50s and 60s) tend to be negative but are mostly insignificant, offering only suggestive evidence.

99. Another age-related productivity determinant identified in the international literature is the dependency rate, i.e. the ratio of the non-working population (usually of young age) to the working population. It is usually found to have dampening effect on

growth in the OECD countries and in the EU (Lindh and Malmberg, 1999^[172]; 2009^[173]). Kogel (2005^[174]) comes to a comparable conclusion using international data on 70 countries. More specifically, the author demonstrates that the young-age dependency ratio is linked not only to lower capital accumulation but also to a reduced TFP growth.

100. In light of the recent technological advances, however, the conclusions of the empirical literature on the link between ageing and productivity may not hold any more in the developed countries. As long as the age composition of the population determines the rate of labour force growth, countries that experience a lack of prime-aged workforce would be hard pressed to adopt new labour-efficient technologies (Beaudry, Collard and Green, 2005^[175]).

101. In line with this argument, Acemoglu and Restrepo (2017^[176]) demonstrate that in the last two to three decades, there was no negative relationship between ageing of the population and GDP per capita growth in a large group of countries and in the OECD area in particular. The study shows that nations undergoing more rapid demographic transitions are more likely to adopt automation technologies. If sufficient amount of capital is present, the fast and wide-spread introduction of the labour-replacing technologies allows to counteract and even reverse the negative effects of the lack of the young and middle-aged workers.

The spatial dimension

102. The demographic and age profiles of regions differ substantially within countries. There are substantial differences in the age composition of the rural and urban areas in the EU, for example (Van Der Gaag and de Beer, 2015^[177]). If age structure of the labour force is related to productivity performance, the uneven age distribution should be linked to subnational productivity differences. The literature at the regional level, however, tends to be at least a decade old and does not directly consider the mitigating role of the age structure in the rates of technology adoption within countries.

103. Another limitation is that the extant studies usually focus on regions within one country and often arrive at divergent results. For example, Tang and MacLeod (2006^[178]) use the 1981-2001 data for Canada to test if older workers are less productive on average. Having established that this is the case, the authors conclude that the workforce ageing is expected to have a relatively small negative effect on productivity growth in Canadian regions. In contrast, Skans (2008^[179]) concludes that the share of 50-60 year old workers is linked to higher productivity of Swedish regions. In Germany, Brunow and Hirte (2009^[180]) discover a U-shaped relationship between the age of the available human capital (defined as the share of labour force in the high-skilled jobs) and productivity performance of NUTS3 regions with the 30-39 year olds being the least productive.

104. A recent study by Daniele, Honiden and Lembcke (2019^[181]) is a welcome contribution to the discourse, as it brings in the international regional perspective. The study does not assess, however, the effect of aging on productivity. Instead, it estimates whether the current productivity growth across the OECD regions is sufficiently large to offset the productivity-suppressing effects of ageing. The study concludes that the productivity growth in many regions is lower than what is required. This implies that in reality, adoption of robots and other labour saving techniques is likely to lag behind the shifting demographic structure.

5.5. Finance

Traditional discourse

105. In the most general terms, finance and financial systems are linked to economic growth via five mechanisms. Financial systems “(1) produce information *ex ante* about possible investments and allocate capital, (2) monitor investments and exert corporate governance after providing finance, (3) facilitate the trading, diversification, and management of risk, (4) mobilize and pool savings and (5) ease the exchange of goods and services” (Levine, 2005, p. 869_[182]). Besides the direct effects, financial systems influence productivity performance via multiple indirect mechanisms, which are related to business dynamics (entry and exit), innovativeness of existing firms, human and physical capital accumulation and other means (Heil, 2017_[183]).

106. In the properly functioning financial systems, promising start-ups can find the financial resources needed to fund their activities, while non-productive firms go out of business because they are unable to secure financial support to stay afloat. Similarly, efficient financial systems allow companies to achieve their maximum productivity performance by providing needed resources for investment in the R&D, capital and labour.

107. A recent detailed review of the literature on the relationship between finance and productivity (Heil, 2017_[183]) finds that policies ensuring the efficient operation of a financial system and facilitating the efficient allocation of resources in a country are a central precondition for the presence of a positive link between finance and productivity. Conversely, financial frictions, while less pronounced in the developed countries, may lead to a sub-par productivity performance.

108. For example, firm insolvency policies may help non-productive firms to survive, resulting in zombie-firms and slowing productivity growth. The literature also shows that inefficient policies within the banking sector can be particularly harmful to productivity growth, as they lead to resource misallocation (Duval, Hong and & Timmer, 2017_[184]; Storz et al., 2017_[185]; Schivardi, Sette and Tabellini, 2017_[186]).

109. In terms of the sources of financing, there is some evidence that equity finance may be more productivity-enhancing compared to debt finance, particularly for growing young and small firms. In addition, the availability of venture capital to fund promising start-ups is positively linked to productivity, as are mergers and acquisitions. The efficiency of the latter heavily depends on the quality of information, which can also be the domain of policy regulations.

The spatial dimension

110. Companies, particularly the new ones, often need external financing to realise their growth potential. A lack of financing is believed to be a major impediment to growth (Fritsch and Storey, 2014_[187]). While many forms of financing are available in the developed countries, access to finance can be place-specific (Ughetto, Cowling and Lee, 2019_[188]). For example, investment opportunities tend to disproportionately cluster in large cities (Lee and Luca, 2018_[189]) potentially suppressing productivity performance of companies located in the less central regions. At a regional level, entry of new bank branches was shown to improve access to finance for Polish companies (Hasan et al., 2019_[190]).

111. The empirical literature, nevertheless, does not seem to agree on the ability of a shorter distance to the sources of financing to alleviate credit constraints. While some studies report the beneficial effects of proximity (Bellucci, Borisov and Zazzaro, 2013_[191]), others find no effects (Carling and Lundberg, 2005_[192]). Whilst the conclusive evidence on the direct effects of proximity to financing on regional productivity is lacking, the spatially-dependent access to finance can shape several economic indicators relevant for productivity performance.

112. Perhaps most importantly, sufficient financial resources, often attracted from outside of a firm, allow companies to begin operations and/or to engage in the R&D and other innovative activities. For instance, in an empirical analysis of Italian innovative start-ups, Grilli (2018_[193]) finds that they are less likely to rely on business angel financing in regions with the weak financial systems. Evidence from the UK suggests that SMEs (particularly innovative and export-oriented) in the peripheral regions rely more on credit card financing compared to companies in more central locations (Brown, Liñares-Zegarra and Wilson, 2019_[194]). In Poland, the post-crisis restructuring of local banks was linked to an increased business entry (Hasan et al., 2019_[190]).

5.6. Institutions, policies and regulations

Traditional discourse

113. Regulations, and institutions more generally, can have a significant and lasting impact on productivity of firms and industries. A large body of both theoretical and empirical research tries to assess and quantify the degree to which productivity is driven by these factors. In addition to their ability to affect business behaviour directly, the productivity effects of institutions, policies and regulations also come indirectly by influencing other productivity determinants described above.

114. In the international comparisons of productivity performance, the literature underscores a central role played by institutions, which set the “playing field” and form an incentive structure (North, 1991_[195]). A strong link between *national* policies and institutions on the one hand and growth on the other, including the TFP growth, is well-established (Easterly and Levine, 2001_[1]). A causal relationship, however, is more difficult to establish. In a study of 127 countries, Hall and Jones (1999_[196]) argue that a large fraction of variation in the output per worker comes from dissimilar institutions, which the authors call social infrastructure. A protection of property rights is particularly important for the improved performance of the economic agents and the increased productivity (North, 1991_[195]).

115. Research at the national level also often disagrees on the types of policies that have a stronger effect on productivity. Depending on a study, policies in focus can be those related to international trade, fiscal, financial or macroeconomic affairs. For example, Edwards (1998_[197]) tries to track the effects of trade openness on productivity growth and finds that TFP grows faster in the open economies. A more recent study by Afonso and Jalles (2013_[198]) suggests that the TFP also grows faster in countries with greater debt ratio. McMillan and Rodrik (2011_[199]) show that in the developing countries, the undervalued currencies and the ease of resource flows contributes to the productivity-enhancing structural change.

116. Moving to the developed countries and to the industry-level evidence, policies and regulations affect the incentives, the ease of resource flows and other structural conditions

important for economic efficiency. In this area, literature explores the effects of regulatory reforms, labour regulations, privatisation and liberalisation of markets.

117. Nicoletti and Scarpetta (2003_[21]) assess the effects of privatisation and liberalisation across OECD. The analysis of data for manufacturing and service industries in 18 OECD countries reveals that policies promoting corporate governance and competition are linked to faster productivity growth. A positive effect of liberalisation on productivity in manufacturing is stronger in countries that are farther behind the productivity leader. The authors conclude that product market regulations and policies limiting business entry are detrimental to productivity growth.

118. Given a strong link between competition and business efficiency, policies shaping competitive environment should be related to productivity of firms, industries and countries. Buccirossi et al. (2013_[45]) explore the effects of the competition policy in the OECD countries on the industry-level TFP growth. The authors rely on the instrumental variable estimation and find that a well-designed and well-implemented competition policy has a strong positive effect, which is mostly driven by the components related to institutions and antitrust regulations. The impact of policies related to competition are often industry- or market-specific. Their effects, however, tend to proliferate to other industries and sectors via the input-output linkages. To illustrate, Bourles, Cette, Lopez, Mairesse and Nicoletti (2013_[200]) study how product market regulations affect multifactor productivity growth in downstream industries using data for 20 industries in 15 OECD countries. They report a negative effect of anti-competitive regulations upstream, which is particularly large closer to technological frontier.

119. At the same time, if competition is distorted as a result of inadequate policies or for other reasons, non-productive zombie firms may be more likely to survive. The rise in capital and labour misallocation can be one reason for their existence (Gouveia and Osterhold, 2018_[201]), which slows down the aggregate productivity growth (Cette, Fernald and Mojon, 2016_[202]; Gopinath et al., 2017_[203]; Andrews and Petroulakis, 2017_[204]). In addition to slowing down the aggregate productivity growth, zombie firms create negative spillovers to “healthy firms” by crowding out available resources and further distorting competition (Caballero, Hoshi and Kashyap, 2008_[205]; Schivardi, Sette and Tabellini, 2017_[186]). From a policy perspective, lowering exit and restructuring barriers promotes the least productive companies to leave the market, while their more productive cousins may be able to restructure and increase productivity.

120. Finally, labour policies can affect productivity in multiple ways. A deregulation of labour market should increase the flexibility and the speed of adjustments in the economy potentially increasing its efficiency. On the other hand, deregulation (and a lack of employment protection) decreases incentives to invest in human capital (Belot, Boone and Van Ours, 2007_[206]) and may lead (at least in some industries) to a greater share of temporary entry-level positions with a lower overall productivity and output (Blanchard and Landier, 2002_[207]). A recent study by Damiani, Pompei and Ricci (2016_[208]) documents a suppressing impact of deregulation of temporary employment on total factor productivity in 10 industries across 14 OECD countries. The effect is found to be stronger in the industries that are more likely to hire temporary workers. In line with the previous literature, the authors find that deregulation is linked to lower training and job-specific skill acquisition.

The spatial dimension

121. At a first glance, the national institutions as well as industry-wide policies and regulations, which are important for aggregate productivity performance, are not likely to have spatial dimension. In reality, industrial composition of regions often creates unique mixes of policy and regulatory environments that can form system-like interactions specific to a particular region.

122. Most importantly, there are also subnational institutions, policies and regulations, which have direct and indirect effects on economic growth of regions and places. These local development policies, not accounted for in the aggregate productivity research, can have profound effects on regional productivity. The efficient policy design in this area, however, is often hampered by a lack of systematic knowledge about what works and what does not in promoting subnational productivity and under which circumstances. This calls for rigorous policy-oriented productivity research at a regional level.

6. Clearly spatial issues: agglomerations, governance, borders

123. A large body of regional science research examines in detail a range of factors directly related to space, which are (naturally) not a part of the mainstream productivity discourse at the national and industry level. At least three of such factors deserve special attention. Below the effects of agglomerations, urban governance and borders on the subnational productivity performance are discussed.

6.1. Agglomerations

124. When it comes to the spatial context, the link between urban agglomerations and productivity is perhaps most clearly established by both theoretical and empirical research. Agglomeration economies are the benefits that arise when people and firms co-locate (Glaeser, 2011_[209]). The sources of agglomeration economies include technological spillovers, labour pooling, and intermediate input linkages (Marshall, 1890_[210]) or sharing, matching and learning (Duranton and Puga, 2004_[211]).

125. It is generally believed that agglomeration leads to increased productivity. The early estimates by Sveikauskas (1975_[212]) show a 6% increase in labour productivity for a doubling of the population, although these estimates were later challenged on the methodological grounds (Moomaw, 1981_[213]; Ciccone and Hall, 1996_[214]). More rigorous estimates, nevertheless, give a comparable magnitude of productivity increase, which ranges between 3% and 8% (Rosenthal and Strange, 2003_[215]). Puga (2010_[216]) provides an extensive overview of the evidence in support of the agglomeration economies.

126. Besides the pure agglomeration effects, productivity in cities is increased via sorting of more productive individuals and the selection process in which the most productive entrepreneurs and companies are started and manage to survive¹¹ in larger urban areas (Behrens, Duranton and Robert-Nicoud, 2014_[124]). The empirical literature finds a strong positive link between measures of agglomeration (usually population size or population density) and productivity at the level of both regions and firms.

127. For instance, Ahrend, Lembcke and Schumann (2017_[217]) estimate that 1% increase in the size of a large (above 500 000 residents) metropolitan area within the OECD is associated with 0.12% increase in average labour productivity. The effect comes via both selection and improved productivity of metropolitan workers. The latter can be explained by several mechanisms. First, larger cities allow for better matches between employees and firms leading to better performance (Venables, 2011_[218]). Second, the higher productivity of metropolitan workers can be driven by learning-by-working in large cities. The productivity premium of the large-city employment experience is found to be larger for workers with higher initial ability and to last even after workers leave large agglomerations (de la Roca and Puga, 2017_[219]).

128. At the firm level, Andersson and Loof (2011_[220]) find that manufacturing firms located in larger regions of Sweden are more productive. The authors also discover the learning effects of being situated in larger agglomerations. Harris and Moffat (2012_[221])

¹¹ The literature shows that selection is not able to fully explain spatial productivity differentials (Combes et al., 2012_[248]).

look at the TFP of manufacturing plants in Britain. Their study confirms that production facilities in larger cities tend to enjoy higher TFP levels, although there are also effects of broader regions within the country.

6.2. Governance

129. The benefits of agglomerations often come with a number of challenges such as pollution, congestion and the issues of public health and sanitation (OECD, 2012_[222]), which, in turn, can suppress productivity. An efficient governance structure can be a lever for enhancing productivity-boosting effects of agglomerations and for mitigating their negative consequences, although rigorous literature on the links between governance structure and productivity indicators is scarce.

130. The urban governance structure differs in the level of fragmentation. A high level of urban governance fragmentation can improve public goods provision, at least in theory, via inter-jurisdictional competition and availability of more choices for residents (Ahrend et al., 2014_[223]). On the other extreme, high fragmentation entails increased coordination costs where it could be difficult to find an efficient governance structure that ensures maximum productivity gains.

131. To illustrate, Functional Urban Areas (FUAs), defined by the patterns of economic activity and interdependence (OECD, 2018_[224]), usually do not coincide with administrative borders. Sometimes, FUAs can consist of more than hundred municipalities (OECD, 2013_[225]). In the case of a pronounced spatial mismatch between administrative boundaries and the flows of economic activity, both vertical and horizontal coordination of transportation networks or spatial planning, for example, becomes complicated, potentially decreasing economic prospects of a region via additional bureaucracy, congestion and a lack of appeal to highly skilled workers (Ahrend et al., 2014_[223]).

132. Another disadvantage of a highly fragmented governance structure is the likely inability of local governmental units to recognize positive externalities at the FUA level (Pinto, 2007_[226]). In general, policy areas with significant externalities, such as growth (Cheshire and Magrini, 2009_[227]) or transport and land-use planning (OECD, 2015_[228]) may suffer under more fragmented governance due to the increased coordination costs.

133. The empirical work on fragmentation has shown both positive (Stansel, 2005_[6]) and negative (Zhang and Zou, 1998_[229]; Xie, Zou and Davoodi, 1999_[230]) effects on economic performance. Generally, studies in the U.S. report a positive association while studies in Europe tend to discover a negative one (Ahrend et al., 2014_[223]). Cheshire and Gordon (1996_[231]) argue that a limited number of jurisdictions with a close match of the highest tier authority to the FUA should increase the chances of forming a ‘territorially competitive club’, due to smaller transaction costs and spillover losses. Cheshire and Magrini (2009_[227]) examine this argument in Europe and find that the proportion of the functional region’s population residing in the largest administrative jurisdiction is positively associated with economic growth.

134. The most relevant study in this context is an examination of the relationship between horizontal administrative fragmentation in city governance and the magnitude of productivity premiums across five countries (Ahrend et al., 2014_[223]). The results suggest that cities with twice as many municipalities and no common governance body experience 6% lower growth. This growth penalty is reduced to 3% if a governance body is present.

6.3. Geography and borders

1. Geography can define economic performance via several mechanisms. The features of terrain and (the availability of) waterways have naturally shaped economic opportunities since time immemorial. Historically, the productive structures of regions tended to capitalise on the natural resources available locally. Now, the legacy of the industrial composition often continues to impact human behaviour (Chinitz, 1961^[232]; Michaels, 2011^[233]).
2. Political fragmentation can also be linked to the “protective” features of the landscape, as national borders are more likely to follow mountains and rivers. As a result, areas with more rugged and otherwise “disrupted” space usually host more nation states. State fragmentation tends to be associated with better economic outcomes (at least in Europe), although the benefits accrue mainly to the central parts of the countries with border regions generally being underdeveloped (Kitamura and Lagerlöf, 2019^[234]).
3. International and interregional borders disrupt socio-economic space and processes by introducing barriers (Capello, Caragliu and Fratesi, 2018^[235]). The term “border effect” generally refers to the difference in trade among domestic regions compared to the international trade (Evans, 2003^[236]). The discontinuity of space is linked to both different legal frameworks but also to cultural, language and other differences (Naveed and Ahmad, 2016^[237]). As a result, border-related inefficiencies generally stem from physical, institutional and cultural or social disruptions and require different policy responses (Capello, Caragliu and Fratesi, 2018^[238]).
4. Because of the economic space discontinuity and due to the general remoteness from the markets in the central parts of the country, border regions often underperform economically (Capello, Caragliu and Fratesi, 2018^[235]). The disruption effect of the borders can be even more evident in the case of unstable borders, where the disruptions become in a sense dynamic (Kitamura and Lagerlöf, 2019^[234]). The negative effects of borders are regularly studied in the context of the disrupted trade flows (Bacchiega, Minniti and Palestini, 2016^[239]; Kashiha et al., 2016^[240]) and knowledge flows (Naveed and Ahmad, 2016^[237]), which are both linked to productivity performance, as already described.
5. The opposite, however, also holds – there are generally economic benefits of common economic space with unhindered flows of resources (Thirlwall, 1974^[241]). Productivity can increase after borders were removed via a multitude of mechanisms ranging from increased competition to heightened demand and market size to greater availability of knowledge and technology (Capello, Caragliu and Fratesi, 2018^[242]).
6. A proximity to a border often engenders a specific regional dynamics within border regions. The most able of them try and often succeed in developing compensatory mechanisms to counteract the suppressing border effects experienced by their economies. The success of the compensatory mechanisms may depend on factors beyond pure economy. For instance, the disruptions stemming from negative perceptions of people on the other side of the border may render compensatory mechanisms inefficient (Capello, Caragliu and Fratesi, 2018^[235]).

7. Interdependencies among productivity determinants

7. As follows from the literature overview above, productivity is driven by a plethora of factors at the national, sectoral and local levels. These factors are often interrelated and form a complex web of mutually dependent determinants that shape productivity of a region both directly and indirectly. The multifaceted nature of the productivity links to a range of characteristics and processes makes an empirical estimation of the effects on productivity a challenging task.

8. The international literature has paid ample attention to the interdependencies among various “traditional” productivity drivers. For example, innovation and business churn both affect productivity. However, as shown by Foster, Grim, Haltiwanger and Wolf (2018^[243]), the periods of rapid innovation in an industry are accompanied by intensive business entry. Thus, innovation, in addition to affecting productivity via multiple channels described above, has an additional indirect effect via stimulating business entry and related to it experimentation with production processes and an increased competitive pressure. In a related manner, innovation itself can be driven – at least in part – by a myriad of other factors.

9. Another example is the role played by MNEs in boosting productivity of host industries and countries. The degree of MNE penetration obviously depends on laws and regulations that delineate the freedom that multinationals can enjoy in doing their business. Given that the presence of MNEs is a delicate issue in many contexts, where international enterprises can be perceived both as heroes and villains of globalisation, designing efficient policies for MNE attraction is not easy. At the same time, positive spillovers from MNEs are more likely if there are (technological) complementarities between multinationals and domestic firms in production processes.

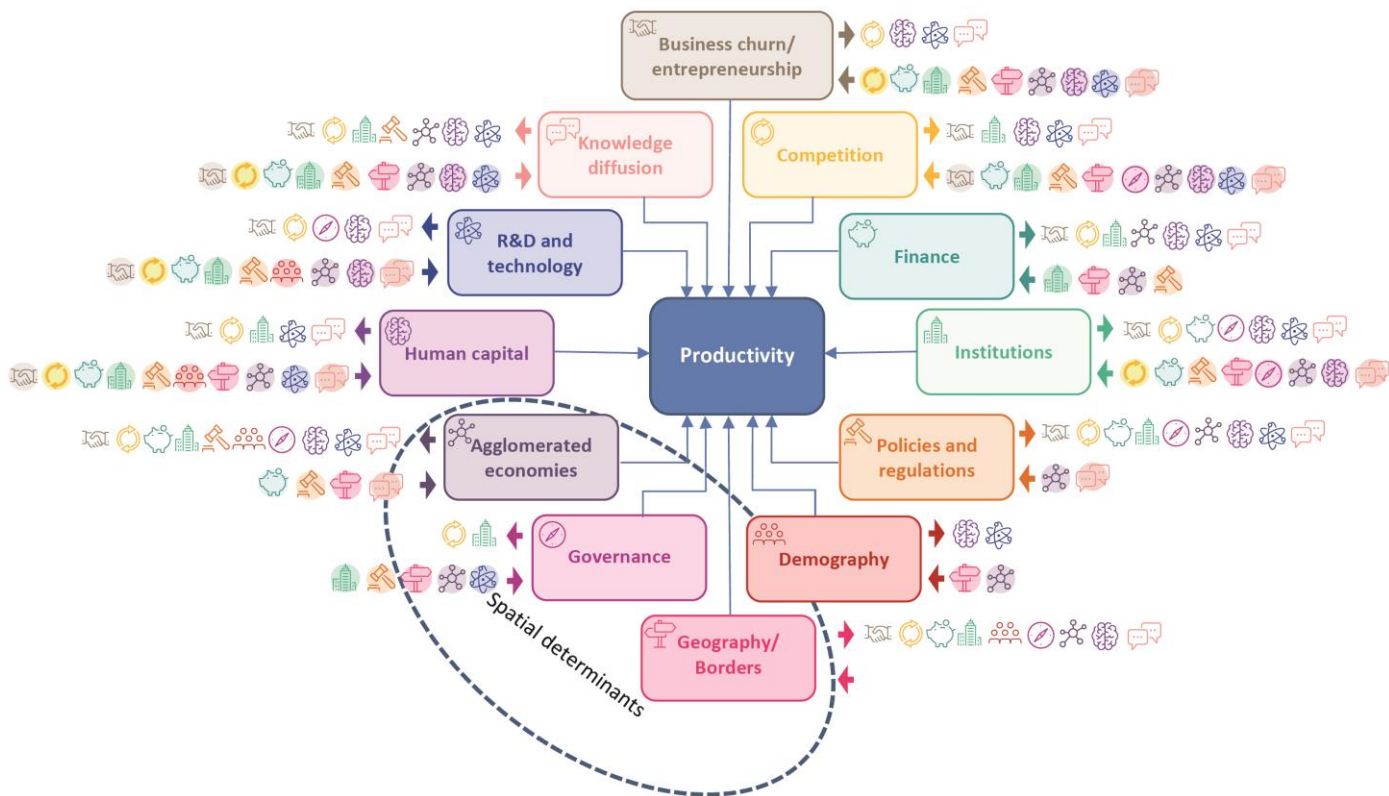
10. Many of the interdependencies, however, crucially depend on the spatial dimension. For instance, for the MNEs to promote productivity of their host regions, the latter need to possess sufficient absorptive capacity. Likewise, the positive effects of innovative technologies in production depend on the quality of local human capital, which makes utilisation of advanced production processes possible and increases the likelihood of technology adoption.

11. The academic research increasingly challenges the linear model of economic performance and instead gravitates to a systemic approach in which a dense web of local factors (institutions, regulations, networks, FDIs, MNEs, universities, human capital and others) work in tandem to promote or suppress innovation, entrepreneurship and other central indicators of economic vibrancy important for productivity.

12. As an example, research universities, which are often the central players within regional innovation systems and local entrepreneurial ecosystems, can influence productivity of the nearby firms (by disseminating technologies, preparing qualified workers and other means), shape the stock of locally available human capital (by teaching and attracting high-skilled individuals to the area), intensify knowledge diffusion, R&D and entrepreneurship. An university can also contribute to the expansion of the local cultural amenities, formation of local networks and be a factor that attracts MNEs.

13. Figure 7.1. The inter-linked nature of productivity determinants offers an overview of the interdependencies among the “traditional” productivity drivers. While the displayed relationships are quite multi-dimensional, the Figure is a simplified representation of the productivity-driving dynamics. It omits entirely the underlying spatial factors, which, in turn, are also interdependent and affect the “traditional” productivity determinants and regional productivity both directly and indirectly.

Figure 7.1. The inter-linked nature of productivity determinants



Source: Own synthesis of the literature.

8. The role of spatial dimension for policy complementarity

14. The complex and mostly interlinked productivity drivers make the empirical isolation of the effects on productivity an uneasy task. They also imply that policy design can and should build on the interdependencies to achieve multiple desirable outcomes at the same time. While a range of international, national and sector- or industry-specific policy efforts have a promise in promoting productivity, place-based measures are also important particularly for diminishing inequalities. The spatial dimension is central to policy complementarity and the ability of policies to address several challenges linked to a sub-par productivity performance simultaneously.

15. At the international level, the changing nature of economic processes that are increasingly shaped by new technologies and a virtual space requires coherent trade, competition and taxation policies across international borders (OECD, 2019^[244]). As overviewed in the previous subsections, the distortions of the international economic space, which hinder the flow of resources and fair competition, are usually detrimental to productivity performance of firms, industries, regions and countries in the long run. Productivity is not the only outcome that is promoted by clear, consistent and not burdensome regulatory regimes. According to the literature, other expected outcomes include enhanced business dynamism, knowledge and technology diffusion to name a few.

16. A range of national productivity-enhancing measures is broad and is likely to have differing effects across the subnational regions depending on the local economic, social and demographic characteristics. At the very basic level, improving the educational systems to more adequately address the needs of the changing economies in general and of the new production processes in particular, is necessary. Many skills become obsolete or are replaced with new technologies, while different (or new) sets of skills come into high demand. Ensuring that the educational systems keep pace with these changes is imperative for sustaining the high living standards and the growing (or at least non-shrinking) shares of the middle class in the future.

17. Beyond the primary and secondary education, universities continue to change their agenda to incorporate community outreach and local economic development functions in addition to the traditional education and research. Higher educational institutions are perhaps best positioned to address local and regional human capital needs determined by the industrial structure and other characteristics of their host regions.

18. Universities and other educational institutions can also contribute to an array of productivity-enhancing activities at both firm- and regional levels via, for example, training, technology diffusion and attracting higher value-added industries. Continued collaborations between universities and local policy-makers can prove fruitful for designing tailored policies that adequately address local challenges and are based on inputs from stakeholders at various levels.

19. Healthy competition policies and regulations are equally important. Here, a level field for economic activities by both small and large, as well as well-established and new, firms, industries and ways of doing business is needed. The fair competition encourages improvements of the managerial and production routines, stimulates development and implementation of new technologies and practices and accelerates exit (with subsequent re-use of resources) of the less efficient companies.

20. The literature shows that for policies to be effective, educated and holistic design needs to be coupled with competent implementation. For instance, market deregulation in India had intended effects only in the absence of restrictive labour market regulations (Aghion et al., 2008_[245]). In a similar vein, Buccirossi et al. (2013_[45]) argue that the positive effect of competition policies on productivity growth is strengthened in countries with efficient law enforcement institutions.

21. At a more localised level, programmes aimed at best practice sharing and technology diffusion; training, retraining and better employer-employee matching services; ensuring that adequate infrastructure (including high-speed Internet access) is in place; facilitating access to financing for young, small and otherwise disadvantaged companies as well as digital governance are likely to enhance local productivity and may alleviate inequalities.

References

- Acemoglu, D. et al. (2014), “Return of the Solow paradox? IT, productivity, and employment in US manufacturing”, *American Economic Review*, <http://dx.doi.org/10.1257/aer.104.5.394>. [111]
- Acemoglu, D. and P. Restrepo (2017), “Secular stagnation? The effect of aging on economic growth in the age of automation”, *American Economic Review: Papers & Proceedings*, Vol. 107 (5), pp. 174-79, <http://dx.doi.org/10.2139/ssrn.2899142>. [176]
- Acs, Z. (2006), “How is entrepreneurship good for economic growth?”, Vol. 1/1, pp. 97-107. [49]
- Acs, Z. and D. Audretsch (2006), *Handbook of entrepreneurship research: An interdisciplinary survey and introduction (Vol. 1)*, Springer Science & Business Media, Berlin. [48]
- Acs, Z., D. Audretsch and M. Feldman (2006), “R&D spillovers and recipient firm size”, *The Review of Economics and Statistics*, Vol. 76/2, p. 336, <http://dx.doi.org/10.2307/2109888>. [117]
- Acs, Z. et al. (2009), “The knowledge spillover theory of entrepreneurship”, *Small Business Economics*, Vol. 32/1, pp. 15-30, <http://dx.doi.org/10.1007/s11187-008-9157-3>. [53]
- Acs, Z. et al. (2017), “The lineages of the entrepreneurial ecosystem approach”, *Small Business Economics*, Vol. 49/1, <http://dx.doi.org/10.1007/s11187-017-9864-8>. [59]
- Adalet McGowan, M. and D. Andrews (2015), “Skill mismatch and public policy in OECD countries”, *OECD Economics Department Working Papers*, No. 1210, OECD Publishing, Paris, <https://dx.doi.org/10.1787/5js1pzw9lnwk-en>. [20]
- Afonso, A. and J. Jalles (2013), “Growth and productivity: The role of government debt”, *International Review of Economics & Finance*, Vol. 25, pp. 384-407, <http://dx.doi.org/10.1016/J.IREF.2012.07.004>. [198]
- Aghion, P. et al. (2005), “Competition and Innovation: An Inverted-U Relationship”, *The Quarterly Journal of Economics*, Vol. 120/2, pp. 701-728, <https://doi.org/10.1093/qje/120.2.701>. [35]
- Aghion, P. et al. (2009), “The effects of entry on incumbent innovation and productivity”, *The Review of Economics and Statistics*, Vol. 91/1, pp. 20-32, <http://www.nber.org/papers/w12027>. [39]
- Aghion, P. et al. (2004), “Entry and productivity growth: Evidence from microlevel panel data”, *Journal of the European Economic Association*, Vol. 2/2-3, pp. 265-276, <http://dx.doi.org/10.1162/154247604323067970>. [37]

- Aghion, P. et al. (2008), “The unequal effects of liberalization: Evidence from dismantling the License Raj in India”, *American Economic Review*, Vol. 98/4, pp. 1397-1412, <http://dx.doi.org/10.1257/aer.98.4.1397>. [245]
- Aghion, P. and P. Howitt (2006), “Appropriate growth policy: A unifying framework”, *Journal of the European Economic Association*, Vol. 4/2-3, pp. 269-314, <http://dx.doi.org/10.1162/jeea.2006.4.2-3.269>. [38]
- Aghion, P. and P. Howitt (1990), *A model of growth through creative destruction*, National Bureau of Economic Research, Cambridge, MA, <http://dx.doi.org/10.3386/w3223>. [30]
- Agrawal, A., J. Gans and A. Goldfarb (2019), “Artificial intelligence: The ambiguous labor market impact of automating prediction”, *Journal of Economic Perspectives*, <http://dx.doi.org/10.1257/jep.33.2.31>. [106]
- Ahrend, R. et al. (2014), “What makes cities more productive? Evidence on the role of urban governance from five OECD countries”, *OECD Regional Development Working Papers*, No. 2014/5, OECD Publishing, Paris, <https://dx.doi.org/10.1787/5jz432cf2d8p-en>. [223]
- Ahrend, R., A. Lembecke and A. Schumann (2017), “The role of urban agglomerations for economic and productivity growth”, *International Productivity Monitor*, Vol. 32, p. 161. [217]
- Aiyar, S., C. Ebeke and X. Shao (2016), “The impact of workforce aging on European productivity”, No. WP/16/238, IMF Working Paper. [171]
- Almeida, R. (2007), “The labor market effects of foreign owned firms”, *Journal of International Economics*, Vol. 72/1, pp. 75-96, <http://dx.doi.org/10.1016/J.JINTECO.2006.10.001>. [132]
- Alon, T. et al. (2018), “Older and slower: The startup deficit’s lasting effects on aggregate productivity growth”, *Journal of Monetary Economics*, Vol. 93, pp. 68-85, <http://dx.doi.org/10.1016/J.JMONECO.2017.10.004>. [34]
- Alvedalen, J. and R. Boschma (2017), “A critical review of entrepreneurial ecosystems research: Towards a future research agenda”, *European Planning Studies*, Vol. 25/6, pp. 887-903, <http://dx.doi.org/10.1080/09654313.2017.1299694>. [60]
- Amaral, A., R. Baptista and F. Lima (2011), “Serial entrepreneurship: Impact of human capital on time to re-entry”, *Small Business Economics*, Vol. 37/1, pp. 1-21, <http://dx.doi.org/10.1007/s11187-009-9232-4>. [71]
- Andersson, M., J. Larsson and J. Wernberg (2019), “The economic microgeography of diversity and specialization externalities – firm-level evidence from Swedish cities”, *Research Policy*, Vol. 48/6, pp. 1385-1398, <http://dx.doi.org/10.1016/J.RESPOL.2019.02.003>. [112]
- Andersson, M. and H. Löf (2011), “Agglomeration and productivity: Evidence from firm-level data”, *Annals of Regional Science*, Vol. 46/3, pp. 601-620, <http://dx.doi.org/10.1007/s00168-009-0352-1>. [220]

- Andrews, D., C. Criscuolo and P. Gal (2016), “The best versus the rest: The global productivity slowdown, divergence across firms and the role of public policy”, *OECD Productivity Working Papers*, No. 5, OECD Publishing, Paris, <https://dx.doi.org/10.1787/63629cc9-en>. [15]
- Andrews, D. and F. Petroulakis (2017), “Breaking the shackles: Zombie firms, weak banks and depressed restructuring in Europe”, *OECD Economics Department Working Papers*, Vol. 1433, <https://ssrn.com/abstract=3334840>. [204]
- Ascani, A., R. Crescenzi and S. Iammarino (2016), “Economic institutions and the location strategies of European multinationals in their geographic neighborhood”, *Economic Geography*, Vol. 92/4, pp. 401-429, <http://dx.doi.org/10.1080/00130095.2016.1179570>. [137]
- Ascani, A. and A. Morrison (2019), “Heterogeneous foreign direct investment and local innovation in Italian provinces”, *Structural Change and Economic Dynamics*, <http://dx.doi.org/10.1016/j.strueco.2019.06.004>. [150]
- Asheim, B. and H. Hansen (2009), “Knowledge bases, talents, and contexts: On the usefulness of the creative class approach in Sweden”, *Economic Geography*, <http://dx.doi.org/10.1111/j.1944-8287.2009.01051.x>. [78]
- Asheim, B. and A. Isaksen (2002), “Regional innovation systems: The integration of local ‘sticky’ and global ‘ubiquitous’ knowledge”, *Journal of Technology Transfer*, <http://dx.doi.org/10.1023/A:1013100704794>. [119]
- Asturias, J. et al. (2019), “Firm entry and exit and aggregate growth”, *SSRN Electronic Journal*, <http://dx.doi.org/10.2139/ssrn.3328873>. [33]
- Audretsch, D. and M. Belitski (2013), “The missing pillar: The creativity theory of knowledge spillover entrepreneurship”, *Small Business Economics*, Vol. 41/4, pp. 819-836, <http://dx.doi.org/10.1007/s11187-013-9508-6>. [82]
- Audretsch, D., D. Dohse and A. Niebuhr (2010), “Cultural diversity and entrepreneurship: A regional analysis for Germany”, *Annals of Regional Science*, Vol. 45/1, pp. 55-85, <http://dx.doi.org/10.1007/s00168-009-0291-x>. [73]
- Audretsch, D. and M. Keilbach (2004), “Entrepreneurship capital and economic performance”, *Regional Studies*, Vol. 38/8, pp. 949-959, <http://dx.doi.org/10.1080/0034340042000280956>. [50]
- Bacchiega, E., A. Minniti and A. Palestini (2016), “Quality, distance and trade: A strategic approach”, *Papers in Regional Science*, Vol. 95, pp. S165-S191, <http://dx.doi.org/10.1111/pirs.12113>. [239]
- Bailin Rivas, A. et al. (2019), “Like it or not? The impact of online platforms on the productivity of incumbent service providers”, *OECD Economics Department Working Papers*, No. 1548, OECD Publishing, Paris, <https://dx.doi.org/10.1787/080a17ce-en>. [108]

- Baptista, R. and J. Mendonça (2010), “Proximity to knowledge sources and the location of knowledge-based start-ups”, *Annals of Regional Science*, Vol. 45/1, pp. 5-29, <http://dx.doi.org/10.1007/s00168-009-0289-4>. [64]
- Bartelsman, E., G. van Leeuwen and M. Polder (2017), “CDM using a cross-country micro moments database”, *Economics of Innovation and New Technology*, <http://dx.doi.org/10.1080/10438599.2016.1202517>. [110]
- Beaudry, P., F. Collard and D. Green (2005), “Demographics and recent productivity performance: Insights from cross-country comparisons”, *Canadian Journal of Economics*, Vol. 38/2, pp. 309-344, <http://dx.doi.org/10.1111/j.0008-4085.2005.00282.x>. [175]
- Behrens, K., G. Duranton and F. Robert-Nicoud (2014), “Productive cities: Sorting, selection, and agglomeration”, *Journal of Political Economy*, Vol. 122 (3), pp. 507-553, <http://www.journals.uchicago.edu/t-and-c>. [124]
- Bellucci, A., A. Borisov and A. Zazzaro (2013), “Do banks price discriminate spatially? Evidence from small business lending in local credit markets”, *Journal of Banking & Finance*, Vol. 37/11, pp. 4183-4197, <http://dx.doi.org/10.1016/J.JBANKFIN.2013.06.009>. [191]
- Belot, M., J. Boone and J. Van Ours (2007), “Welfare-improving employment protection”, *Economica*, Vol. 74/295, pp. 381-396, <http://dx.doi.org/10.1111/j.1468-0335.2006.00576.x>. [206]
- Benhabib, J. and M. Spiegel (1994), “The role of human capital in economic development: Evidence from aggregate cross-country data”, *Journal of Monetary Economics*, Vol. 34/2, pp. 143-173, [http://dx.doi.org/10.1016/0304-3932\(94\)90047-7](http://dx.doi.org/10.1016/0304-3932(94)90047-7). [154]
- Berlingieri, G., P. Blanchenay and C. Criscuolo (2017), *The great divergence (s)*, OECD Science, Technology and Innovation Policy Paper No. 39. OECD Publishing. [12]
- Berlingieri, G., S. Calligaris and C. Criscuolo (2018), “The productivity-wage premium: Does size still matter in a service economy?”, *AEA Papers and Proceedings*, Vol. 108, pp. 328-33, <http://dx.doi.org/10.1257/pandp.20181068>. [11]
- Bernard, A. and J. Jensen (1999), “Exceptional exporter performance: Cause, effect, or both?”, *Journal of International Economics*, Vol. 47/1, pp. 1-25, [http://dx.doi.org/10.1016/S0022-1996\(98\)00027-0](http://dx.doi.org/10.1016/S0022-1996(98)00027-0). [40]
- Birch, D. (1987), *Job creation in America: How our smallest companies put the most people to work.*, University of Illinois at Urbana-Champaign’s Academy for Entrepreneurial Leadership Historical Research Reference in Entrepreneurship. [51]
- Blanchard, O. and A. Landier (2002), “The perverse effects of partial labor market reform: Fixed duration contracts in France”, *SSRN Electronic Journal*, pp. F214-F244, <http://dx.doi.org/10.2139/ssrn.262668>. [207]
- Bloom, N., R. Sadun and J. Van Reenen (2016), “Management as a technology?”, *National Bureau of Economic Research*, No. 22327, <http://dx.doi.org/10.3386/w22327>. [153]

- Bloom, N., R. Sadun and J. Van Reenen (2012), “Americans do IT better: US multinationals and the productivity miracle”, *American Economic Review*, Vol. 102/1, pp. 167-201, <http://dx.doi.org/10.1257/aer.102.1.167>. [131]
- Boschma, R. (2005), “Proximity and innovation: A critical assessment”, *Regional Studies*, Vol. 39/1, pp. 61-74, <http://dx.doi.org/10.1080/0034340052000320887>. [246]
- Boschma, R. and K. Frenken (2011), “Technological relatedness, related variety and economic geography”, in P. Cooke, B. Asheim, R. Boschma, R. Martin, D. (ed.), *Handbook of regional innovation and growth*, Edward Elgar, Cheltenham. [113]
- Boschma, R. and M. Fritsch (2009), “Creative class and regional growth: Empirical evidence from seven European countries”, *Economic Geography*, Vol. 85/4, pp. 391-423, <http://dx.doi.org/10.1111/j.1944-8287.2009.01048.x>. [80]
- Bourlès, R. et al. (2013), “Do product market regulations in upstream sectors curb productivity growth? Panel data evidence for OECD countries”, *Review of Economics and Statistics*, Vol. 95/5, pp. 1750-1768, http://dx.doi.org/10.1162/REST_a_00338. [200]
- Broström, A., M. Mckelvey and C. Sandström (2009), “Investing in localized relationships with universities: What are the benefits for R&D subsidiaries of multinational enterprises?”, *Industry and Innovation*, Vol. 16/1, pp. 59-78, <http://dx.doi.org/10.1080/13662710902728076>. [149]
- Brown, R., J. Liñares-Zegarra and J. Wilson (2019), “Sticking it on plastic: Credit card finance and small and medium-sized enterprises in the UK”, *Regional Studies*, Vol. 53/5, pp. 630-643, <http://dx.doi.org/10.1080/00343404.2018.1490016>. [194]
- Brown, W. and D. Scott (2012), “Human capital location choice: Accounting for amenities and thick labor markets”, *Journal of Regional Science*, Vol. 52/5, pp. 787-808, <http://dx.doi.org/10.1111/j.1467-9787.2012.00772.x>. [158]
- Brunow, S. and G. Hirte (2009), “The age pattern of human capital and regional productivity: A spatial econometric study on German regions”, *Papers in Regional Science*, Vol. 88/4, pp. 799-823, <http://dx.doi.org/10.1111/j.1435-5957.2009.00228.x>. [180]
- Buccirosi, P. et al. (2013), “Competition policy and productivity growth: An empirical assessment”, *Review of Economics and Statistics*, Vol. 95/4, pp. 1324-1336, http://dx.doi.org/10.1162/REST_a_00304. [45]
- Buenstorf, G., M. Geissler and S. Krabel (2016), “Locations of labor market entry by German university graduates: Is (regional) beauty in the eye of the beholder?”, *Jahrbuch für Regionalwissenschaft*, Vol. 36/1, pp. 29-49, <http://dx.doi.org/10.1007/s10037-015-0102-z>. [166]
- Caballero, R., T. Hoshi and A. Kashyap (2008), “Zombie lending and depressed restructuring in Japan”, *American Economic Review*, Vol. 98/5, pp. 1943-1977, <http://dx.doi.org/10.1257/aer.98.5.1943>. [205]

- Campbell, J. (1998), “Entry, exit, embodied technology, and business cycles”, *Review of Economic Dynamics*, Vol. 1/2, pp. 371-408, <http://dx.doi.org/10.1006/REDY.1998.0009>. [31]
- Cantwell, J. and S. Iammarino (2005), *Multinational corporations and European Regional Systems of Innovation*, Routledge, <http://dx.doi.org/10.4324/9780203986714>. [143]
- Capello, R., A. Caragliu and U. Fratesi (2018), “Breaking down the border: Physical, institutional and cultural obstacles”, *Economic Geography*, Vol. 94/5, pp. 485-513, <http://dx.doi.org/10.1080/00130095.2018.1444988>. [238]
- Capello, R., A. Caragliu and U. Fratesi (2018), “Compensation modes of border effects in cross-border regions”, *Journal of Regional Science*, <http://dx.doi.org/10.1111/jors.12386>. [235]
- Capello, R., A. Caragliu and U. Fratesi (2018), “The regional costs of market size losses in a EU dismembering process”, *Papers in Regional Science*, Vol. 97/1, pp. 73-90, <http://dx.doi.org/10.1111/pirs.12347>. [242]
- Capello, R. and C. Lenzi (2015), “Knowledge, innovation and productivity gains across European regions”, *Regional Studies*, Vol. 49/11, pp. 1788-1804, <http://dx.doi.org/10.1080/00343404.2014.917167>. [8]
- Carling, K. and S. Lundberg (2005), “Asymmetric information and distance: An empirical assessment of geographical credit rationing”, *Journal of Economics and Business*, Vol. 57/1, pp. 39-59, <http://dx.doi.org/10.1016/J.JECONBUS.2004.07.002>. [192]
- Castaldi, C., K. Frenken and B. Los (2015), “Related variety, unrelated variety and technological breakthroughs: An analysis of US state-level patenting”, *Regional Studies*, Vol. 49/5, pp. 767-781, <http://dx.doi.org/10.1080/00343404.2014.940305>. [114]
- Castellani, D. and F. Pieri (2013), “R&D offshoring and the productivity growth of European regions”, *Research Policy*, Vol. 42/9, pp. 1581-1594, <http://dx.doi.org/10.1016/J.RESPOL.2013.05.009>. [136]
- Cette, G., J. Fernald and B. Mojon (2016), “The pre-Great Recession slowdown in productivity”, *European Economic Review*, Vol. 88, pp. 3-20, <http://dx.doi.org/10.1016/J.EUROECOREV.2016.03.012>. [202]
- Cheshire, P. and I. Gordon (1996), “Territorial competition and the predictability of collective (in)action”, *International Journal of Urban and Regional Research*, Vol. 20/3, pp. 383-399, <http://dx.doi.org/10.1111/j.1468-2427.1996.tb00324.x>. [231]
- Cheshire, P. and S. Magrini (2009), “Urban growth drivers in a Europe of sticky people and implicit boundaries”, *Journal of Economic Geography*, Vol. 9, pp. 85-115, <http://dx.doi.org/10.1093/jeg/lbn044>. [227]
- Chinitz, B. (1961), “Contrasts in agglomeration: New York and Pittsburgh”, *The American Economic Review*, Vol. 51/2, pp. 279-289. [232]

- Ciccone, A. and R. Hall (1996), “Productivity and the density of economic activity”, [214]
American Economic Review, Vol. 86, pp. 54-70, <https://www.nber.org/papers/w4313.pdf>
 (accessed on 13 December 2018).
- Cockburn, I., R. Henderson and S. Stern (2018), “The impact of artificial intelligence on [122]
 innovation”, *NBER Working Paper*, Vol. 24449, <http://dx.doi.org/10.3386/w24449>.
- Coelli, T. et al. (2005), *An introduction to efficiency and productivity analysis*, Springer, [23]
 Berlin.
- Cohen, W., R. Nelson and J. Walsh (2002), “Links and impacts: The influence of public [115]
 research on industrial R&D”, *Management science*, Vol. 48 (1), pp. 1-23.
- Combes, P. et al. (2012), “The productivity advantages of large cities: distinguishing [125]
 agglomeration from the firm selection”, *Econometrica*, Vol. 80/6, pp. 2543-2594,
<http://dx.doi.org/10.3982/ECTA8442>.
- Combes, P. et al. (2012), “The productivity advantages of large cities: Distinguishing [248]
 agglomeration from the firm selection”, *Econometrica*, Vol. 80/6, pp. 2543-2594,
<http://dx.doi.org/10.3982/ECTA8442>.
- Cooke, P. and L. de Propris (2011), “A policy agenda for EU smart growth: The role of [83]
 creative and cultural industries”, *Policy Studies*, Vol. 32/4, pp. 365-375,
<http://dx.doi.org/10.1080/01442872.2011.571852>.
- Coyle, D. (2018), “Do-it-yourself digital: The production boundary, the productivity puzzle [17]
 and economic welfare”, *Economica*, <http://dx.doi.org/10.1111/ecca.12289>.
- Crescenzi, R. and S. Iammarino (2017), “Global investments and regional development [141]
 trajectories: The missing links”, *Regional Studies*, Vol. 51/1, pp. 97-115,
<http://dx.doi.org/10.1080/00343404.2016.1262016>.
- Crescenzi, R., C. Pietrobelli and R. Rabellotti (2016), “Regional strategic assets and the [138]
 location strategies of emerging countries’ multinationals in Europe”, *European Planning
 Studies*, Vol. 24/4, pp. 645-667, <http://dx.doi.org/10.1080/09654313.2015.1129395>.
- Crescenzi, R., C. Pietrobelli and R. Rabellotti (2014), “Innovation drivers, value chains and [140]
 the geography of multinational corporations in Europe”, *Journal of Economic Geography*,
 Vol. 14/6, pp. 1053-1086, <http://dx.doi.org/10.1093/jeg/lbt018>.
- Criscuolo, C., J. Haskel and M. Slaughter (2010), “Global engagement and the innovation [42]
 activities of firms”, *International Journal of Industrial Organization*, Vol. 28/2, pp. 191-
 202, <http://dx.doi.org/10.1016/J.IJINDORG.2009.07.012>.
- Criscuolo, C. and R. Martin (2009), “Multinationals and U.S. productivity leadership: [126]
 Evidence from Great Britain”, *The Review of Economics and Statistics*, Vol. 91 (2),
 pp. 263-281, <http://87.230.13.240/bin/view/CERIBA/TrueSpread>.

- Criscuolo, C. and J. Timmis (2017), “The relationship between global value chains and productivity”, *International Productivity Monitor*, Vol. 32, pp. 61-83. [134]
- D’Costa, S., E. Garcilazo and J. Oliveira Martins (2013), “The impact of structural and macroeconomic factors on regional growth”, *OECD Regional Development Working Papers*, No. 2013/11, OECD Publishing, Paris, <https://dx.doi.org/10.1787/5k451mplq91w-en>. [22]
- Damiani, M., F. Pompei and A. Ricci (2016), “Temporary job protection and productivity growth in EU economies”, *International Labour Review*, Vol. 155(4), pp. 587-622, <http://dx.doi.org/10.2139/ssrn.1793087>. [208]
- Daniele, F., T. Honiden and A. Lembcke (2019), “Ageing and productivity growth in OECD regions: Combatting the economic impact of ageing through productivity growth?”, *OECD Regional Development Working Papers*, No. 2019/08, OECD Publishing, Paris, <https://dx.doi.org/10.1787/9dcb3116-en>. [181]
- Dauth, W. et al. (2018), *Adjusting to robots: Worker-level evidence*, mimeo. [104]
- de la Roca, J. and D. Puga (2017), “Learning by working in big cities”, *Review of Economic Studies*, pp. 106-142, <http://dx.doi.org/10.1093/restud/rdw031>. [219]
- De Propris, L. and N. Driffield (2005), “The importance of clusters for spillovers from foreign direct investment and technology sourcing”, *Cambridge Journal of Economics*, Vol. 30/2, pp. 277-291, <http://dx.doi.org/10.1093/cje/bei059>. [145]
- DeStefano, T., R. Kneller and J. Timmis (2018), “Broadband infrastructure, ICT use and firm performance: Evidence for UK firms”, *Journal of Economic Behavior and Organization*, <http://dx.doi.org/10.1016/j.jebo.2018.08.020>. [109]
- Dettori, B., E. Marrocu and R. Paci (2011), “Total Factor Productivity, intangible assets and spatial dependence in the European regions”, *Regional Studies*, Vol. 46/10, pp. 1401-1416, <http://dx.doi.org/10.1080/00343404.2010.529288>. [157]
- Di Gregorio, D. and S. Shane (2003), “Why do some universities generate more start-ups than others?”, *Research Policy*, Vol. 32/2, pp. 209-227, [http://dx.doi.org/10.1016/S0048-7333\(02\)00097-5](http://dx.doi.org/10.1016/S0048-7333(02)00097-5). [67]
- Doms, M. and E. Bartelsman (2000), “Understanding productivity: Lessons from longitudinal microdata”, *Journal of Economic literature*, Vol. 38/3 *Journal of Economic literature*, pp. 569-594, <http://dx.doi.org/10.1257/jel.38.3.569>. [25]
- Dunne, T., M. Roberts and L. Samuelson (1988), “Patterns of firm entry and exit in U.S. manufacturing industries”, *The RAND Journal of Economics*, Vol. 19/4, pp. 495-515, <http://dx.doi.org/10.2307/2555454>. [46]
- Duranton, G. and D. Puga (2004), “Micro-foundations of urban agglomeration economies”, in Henderson, J. and J. Thisse (eds.), *Handbook of Regional and Urban Economics*, Elsevier, Amsterdam, [http://dx.doi.org/10.1016/S0169-7218\(04\)07048-0](http://dx.doi.org/10.1016/S0169-7218(04)07048-0). [211]

- Duval, R., G. Hong and Y. & Timmer (2017), “Financial frictions and the great productivity slowdown”, *IMF Working Paper Research Department*, IMF. [184]
- Easterly, W. and R. Levine (2001), “What have we learned from a decade of empirical research on growth? It’s not factor accumulation: Stylized facts and growth models”, *The world bank economic review*, Vol. 15(2), pp. 177-219, <http://www.gdnet.org/pdfs/>. [1]
- Edwards, S. (1998), “Openness, productivity and growth: What do we really know?”, *The economic journal*, Vol. 108(447), pp. 383-398. [197]
- Evans, C. (2003), “The economic significance of national border effects”, *American Economic Review*, Vol. 93/4, pp. 1291-1312, <http://dx.doi.org/10.1257/000282803769206304>. [236]
- Falck, O., M. Fritsch and S. Heblich (2011), “The phantom of the opera: Cultural amenities, human capital, and regional economic growth”, *Labour Economics*, Vol. 18/6, pp. 755-766, <http://dx.doi.org/10.1016/J.LABECO.2011.06.004>. [167]
- Feld, B. (2012), *Startup communities: Building an entrepreneurial ecosystem in your city.*, John Wiley & Sons. [74]
- Feldman, M. (2001), “The entrepreneurial event revisited: Firm formation in a regional context”, *Industrial and Corporate Change*, Vol. 10/4, pp. 861-891, <http://dx.doi.org/10.1093/icc/10.4.861>. [68]
- Feyrer, J. (2007), “Demographics and productivity”, *Review of Economics and Statistics*, Vol. 89/1, pp. 100-109, <http://dx.doi.org/10.1162/rest.89.1.100>. [169]
- Florida, R. (2003), “Entrepreneurship, creativity and regional economic growth.”, in D. M. Hart (ed.), *The emergence of entrepreneurship policy*, Cambridge University Press, Cambridge. [75]
- Fons-Rosen, S. et al. (2013), *Quantifying productivity gains from foreign investment*, National Bureau of Economic Research., <http://www.nber.org/papers/w18920>. [130]
- Foster, L. et al. (2018), “Innovation, productivity dispersion, and productivity growth”, No. 24420, The National Bureau of Economic Research, Cambridge, MA, <http://dx.doi.org/10.4028/www.scientific.net/AMM.644-650.2943>. [243]
- Foster, L., J. Haltiwanger and C. Krizan (2001), “Aggregate productivity growth: Lessons from microeconomic evidence”, *New developments in productivity analysis*, pp. 303-372. [29]
- Fritsch, M. and C. Schwirten (1999), “Enterprise-university co-operation and the role of public research institutions in regional innovation systems”, *Industry and Innovation*, Vol. 6/1, pp. 69-83, <http://dx.doi.org/10.1080/13662719900000005>. [118]
- Fritsch, M. and D. Storey (2014), “Entrepreneurship in a regional context: Historical roots, recent developments and future challenges”, *Regional Studies*, Vol. 48/6, pp. 939-954, <http://dx.doi.org/10.1080/00343404.2014.892574>. [187]

- Gal, P. et al. (2019), “Digitalisation and productivity: In search of the holy grail – Firm-level empirical evidence from EU countries”, *OECD Economics Department Working Papers*, No. 1533, OECD Publishing, Paris, <https://dx.doi.org/10.1787/5080f4b6-en>. [14]
- Garibaldi, P., J. Oliveira Martins and J. van Ours (2011), *Ageing, health, and productivity: The economics of increased life expectancy*, <http://dx.doi.org/10.1093/acprof:oso/9780199587131.001.0001>. [168]
- Geroski, P. (1995), “What do we know about entry?”, *International Journal of Industrial Organization*, Vol. 13/4, pp. 421-440, [http://dx.doi.org/10.1016/0167-7187\(95\)00498-X](http://dx.doi.org/10.1016/0167-7187(95)00498-X). [47]
- Geroski, P., S. Machin and J. Reenen (2006), “The profitability of innovating firms”, *The RAND Journal of Economics*, Vol. 24/2, pp. 198-211, <http://dx.doi.org/10.2307/2555757>. [92]
- Girma, S. and K. Wakelin (2007), “Local productivity spillovers from foreign direct investment in the U.K. electronics industry”, *Regional Science and Urban Economics*, Vol. 37/3, pp. 399-412, <http://dx.doi.org/10.1016/J.REGSCIURBECO.2006.11.006>. [146]
- Glaeser, E. (2011), *Triumph of the city*, Penguin Press, New York. [209]
- Glaeser, E. and M. Resseger (2010), “The complementarity between cities and skills”, *Journal of Regional Science*, Vol. 50/1, pp. 221-244, <http://dx.doi.org/10.1111/j.1467-9787.2009.00635.x>. [5]
- Goldfarb, A. and D. Trefler (2018), “Artificial intelligence and international trade”, *NBER Working Paper* 24254, <http://dx.doi.org/10.3386/w24254> (accessed on 24 July 2019). [120]
- Gopinath, G. et al. (2017), “Capital allocation and productivity in South Europe”, *Quarterly Journal of Economics*, Vol. 132/4, pp. 1915-1967, <http://dx.doi.org/10.1093/qje/qjx024>. [203]
- Gouveia, A. and C. Osterhold (2018), “Fear the walking dead: Zombie firms, spillovers and exit barriers”, *OECD Productivity Working Papers*, Paris, <http://www.bportugal.pt>. [201]
- Graetz, G. and G. Michaels (2018), *Robots at work*, MIT Press Journals, http://dx.doi.org/10.1162/rest_a_00754. [102]
- Graetz, G. and G. Michaels (2018), “Robots at Work”, *The Review of Economics and Statistics*, Vol. 100/5, pp. 753-768, http://dx.doi.org/10.1162/rest_a_00754. [100]
- Graves, P. and P. Linneman (1979), “Household migration: Theoretical and empirical results”, *Journal of Urban Economics*, Vol. 6/3, pp. 383-404, [http://dx.doi.org/10.1016/0094-1190\(79\)90038-X](http://dx.doi.org/10.1016/0094-1190(79)90038-X). [159]
- Griffith, R., S. Redding and J. Reenen (2004), “Mapping the two faces of R&D: Productivity growth in a panel of OECD industries”, *The Review of Economics and Statistics*, Vol. 86/4, pp. 883-895. [43]
- Griliches, Z. (1979), “Issues in assessing the contribution of research and development to productivity growth”, *The Bell Journal of economics*, Vol. 10(1), pp. 92-116. [88]

- Griliches, Z. and L. Séneca (2000), *R&D, education, and productivity: A retrospective*, Harvard University Press. [94]
- Grilli, L. (2018), “There must be an angel? Local financial markets, business angels and the financing of innovative start-ups”, *Regional Studies*, Vol. 53/5, pp. 620-629, <http://dx.doi.org/10.1080/00343404.2018.1479524>. [193]
- Guadalupe, M., O. Kuzmina and C. Thomas (2012), “Innovation and foreign ownership”, *American Economic Review*, Vol. 102 (7), pp. 3594-3627, <http://dx.doi.org/10.2139/ssrn.1717243>. [133]
- Hall, B. and J. Mairesse (1995), “Exploring the relationship between R&D and productivity in French manufacturing firms”, *Journal of Econometrics*, Vol. 65/1, pp. 263-293, [http://dx.doi.org/10.1016/0304-4076\(94\)01604-X](http://dx.doi.org/10.1016/0304-4076(94)01604-X). [96]
- Hall, B., J. Mairesse and P. Mohnen (2010), “Measuring the returns to R&D”, *Handbook of the Economics of Innovation*, Vol. 2, pp. 1033-1082, [http://dx.doi.org/10.1016/S0169-7218\(10\)02008-3](http://dx.doi.org/10.1016/S0169-7218(10)02008-3). [93]
- Hall, R. and C. Jones (1999), “Why do some countries produce so much more output per worker than others?”, *The Quarterly Journal of Economics*, Vol. 114(1), pp. 83-116, <http://www.stanford.edu/chadj>. [196]
- Harris, R. and J. Moffat (2012), “Is productivity higher in British cities?”, *Journal of Regional Science*, Vol. 52/5, pp. 762-786, <http://dx.doi.org/10.1111/j.1467-9787.2012.00778.x>. [221]
- Hasan, I. et al. (2019), “The economic impact of changes in local bank presence”, *Regional Studies*, Vol. 53/5, pp. 644-656, <http://dx.doi.org/10.1080/00343404.2018.1475729>. [190]
- Havranek, T. and Z. Irsova (2011), “Estimating vertical spillovers from FDI: Why results vary and what the true effect is”, *Journal of International Economics*, Vol. 85/2, pp. 234-244, <http://dx.doi.org/10.1016/J.JINTECO.2011.07.004>. [135]
- Heil, M. (2017), “Finance and productivity: A literature review”, No. 1374, OECD Economic Department Working Papers, Paris. [183]
- Higoacuten, D. and N. Vasilakos (2011), “Foreign Direct Investment spillovers: Evidence from the British retail sector”, *World Economy*, Vol. 34/4, pp. 642-666, <http://dx.doi.org/10.1111/j.1467-9701.2011.01330.x>. [147]
- Houseman, S., T. Bartik and T. Sturgeon (2015), “Measuring manufacturing”, in M. Mandel (ed.), *Measuring globalization: Better trade statistics for better policy*, WE Upjohn Institute for Employment Research,. [91]
- Iammarino, S. and P. McCann (2013), *Multinationals and economic geography: Location, technology and innovation*, Edward Elgar Publishing. [139]

- Isenberg, D. (2011), *The entrepreneurship ecosystem strategy as a new paradigm for economic policy: Principles for cultivating entrepreneurship*, Presentation at the Institute of International and European Affairs. [61]
- Jenssen, J. and H. Koenig (2002), “The effect of social networks on resource access and business start-ups”, *European Planning Studies*, Vol. 10/8, pp. 1039-1046, <http://dx.doi.org/10.1080/0965431022000031301>. [85]
- Jorgenson, D., M. Ho and K. Stiroh (2008), “A retrospective look at the U.S. productivity growth resurgence”, *Journal of Economic perspectives*, Vol. 22(1), pp. 3-24. [90]
- Jorgenson, D. and K. Stiroh (2000), “U.S. economic growth at the industry level”, *The American Economic Review*, Vol. 90/2, pp. 161-167. [24]
- Kancs, D. and B. Siliverstovs (2016), “R&D and non-linear productivity growth”, *Research Policy*, Vol. 45/3, pp. 634-646, <http://dx.doi.org/10.1016/J.RESPOL.2015.12.001>. [99]
- Kashiha, M. et al. (2016), “Border effects in a free-trade zone: Evidence from European wine shipments”, *Journal of Economic Geography*, Vol. 17 (2), <https://academic.oup.com/joeg/article-abstract/17/2/411/2930594> (accessed on 16 May 2019). [240]
- Keller, W. (2000), “Do trade patterns and technology flows affect productivity growth?”, *The World Bank Economic Review*, Vol. 14(1), pp. 17-47, <https://academic.oup.com/wber/article-abstract/14/1/17/1712149>. [89]
- Keller, W. and S. Yeaple (2009), “Multinational enterprises, international trade, and productivity growth: Firm level evidence from the United States”, *The Review of Economics and Statistics*, Vol. 91/4, pp. 821-831. [44]
- Kirchhoff, B. et al. (2007), “The influence of university R&D expenditures on new business formations and employment growth”, *Entrepreneurship theory and practice*, Vol. 31 (4), pp. 543-559. [65]
- Kitamura, S. and N. Lagerlöf (2019), “Geography and State Fragmentation”, *Journal of the European Economic Association*, <http://dx.doi.org/10.1093/jeea/jvz032>. [234]
- Klinger, J., J. Mateos-Garcia and K. Stathoulopoulos (2018), “Deep learning, deep change? Mapping the development of the Artificial Intelligence General Purpose Technology”, <http://arxiv.org/abs/1808.06355> (accessed on 25 July 2019). [121]
- Koch, M., I. Manuylov and M. Smolka (2019), “Robots and firms”, *CESifo Working Paper* 7608. [101]
- Kögel, T. (2005), “Youth dependency and total factor productivity”, *Journal of Development Economics*, Vol. 76/1, pp. 147-173, <http://dx.doi.org/10.1016/J.JDEVECO.2003.11.003>. [174]
- Kramer, J. et al. (2011), “Intangible assets as drivers of innovation: Empirical evidence on multinational enterprises in German and UK regional systems of innovation”, [142]

- Technovation*, Vol. 31/9, pp. 447-458,
<http://dx.doi.org/10.1016/J.TECHNOVATION.2011.06.005>.
- Krätke, S. (2010), “‘Creative cities’ and the rise of the dealer class: A critique of Richard Florida’s approach to urban theory”, *International Journal of Urban and Regional Research*, Vol. 34/4, pp. 835-853, <http://dx.doi.org/10.1111/j.1468-2427.2010.00939.x>. [79]
- Kromann, L. et al. (2016), “Automation and productivity: A cross-country, cross-industry comparison”, *SSRN Electronic Journal*, <http://dx.doi.org/10.2139/ssrn.3096432>. [103]
- Kromann, L. and A. Sørensen (2019), “Automation, performance and international competition: Firm-level comparisons of process innovation”, *Economic Policy* forthcoming, http://www.economic-policy.org/wp-content/uploads/2019/03/997_Automation-Performance-and-International-Competition.pdf (accessed on 24 July 2019). [105]
- Laursen, K. and A. Salter (2004), “Searching high and low: What types of firms use universities as a source of innovation?”, *Research Policy*, Vol. 33/8, pp. 1201-1215, <http://dx.doi.org/10.1016/J.RESPOL.2004.07.004>. [116]
- Lee, N. and D. Luca (2018), “The big-city bias in access to finance: Evidence from firm perceptions in almost 100 countries”, *Journal of Economic Geography*, Vol. 19/1, pp. 199-224, <http://dx.doi.org/10.1093/jeg/lbx047>. [189]
- Lee, S., R. Florida and Z. Acs (2004), “Creativity and entrepreneurship: A regional analysis of new firm formation”, *Regional Studies*, Vol. 38/8, pp. 879-891, <http://dx.doi.org/10.1080/0034340042000280910>. [54]
- Levine, R. (2005), “Finance and growth: Theory and evidence”, *Handbook of Economic Growth*, Vol. 1, pp. 865-934, [http://dx.doi.org/10.1016/S1574-0684\(05\)01012-9](http://dx.doi.org/10.1016/S1574-0684(05)01012-9). [182]
- Lindh, T. and B. Malmberg (2009), “European Union economic growth and the age structure of the population”, *Economic Change and Restructuring*, Vol. 42/3, pp. 159-187, <http://dx.doi.org/10.1007/s10644-008-9057-1>. [173]
- Lindh, T. and B. Malmberg (1999), “Age structure effects and growth in the OECD, 1950-1990”, *Journal of Population Economics*, Vol. 12 (3), pp. 431-449. [172]
- Mack, E. and H. Mayer (2016), “The evolutionary dynamics of entrepreneurial ecosystems”, *Urban Studies*, Vol. 53/10, pp. 2118-2133, <http://dx.doi.org/10.1177/0042098015586547>. [62]
- Mairesse, J. and M. Sassenou (1991), *R&D productivity: A survey of econometric studies at the firm level*, National Bureau of Economic Research, Cambridge, MA, <http://dx.doi.org/10.3386/w3666>. [95]
- Malecki, E. (1993), “Entrepreneurship in regional and local development”, *International regional science review*, Vol. 16(1-2), pp. 119-153. [52]

- Markusen, A. (2006), “Urban development and the politics of a creative class: Evidence from a study of artists”, *Environment and Planning A*, Vol. 38/10, pp. 1921-1940, <http://dx.doi.org/10.1068/a38179>. [76]
- Marrocu, E., R. Paci and S. Usai (2013), “Productivity growth in the old and new Europe: The role of agglomeration externalities”, *Journal of Regional Science*, Vol. 53/3, pp. 418-442, <http://dx.doi.org/10.1111/jors.12000>. [156]
- Marshall, A. (1890), *Principles of economics*, MacMillan, London, UK. [210]
- Mason, C. and R. Brown (2014), *Entrepreneurial ecosystems and growth-oriented entrepreneurship*, OECD - LEED, The Hague. [57]
- Mason, C. and R. Harrison (2006), “After the exit: Acquisitions, entrepreneurial recycling and regional economic development”, *Regional Studies*, Vol. 40/1, pp. 55-73, <http://dx.doi.org/10.1080/00343400500450059>. [70]
- Matthias Arnold, J. and B. Javorcik (2009), “Gifted kids or pushy parents? Foreign direct investment and plant productivity in Indonesia”, *Journal of International Economics*, Vol. 79/1, pp. 42-53, <http://dx.doi.org/10.1016/J.JINTECO.2009.05.004>. [129]
- McMillan, M. and D. Rodrik (2011), “Globalization, structural change and productivity growth”, *National Bureau of Economic Research*, Vol. w17143. [199]
- Michaels, G. (2011), “The Long Term Consequences of Resource-Based Specialisation”, *The Economic Journal*, Vol. 121/551, pp. 31-57, <http://dx.doi.org/10.1111/j.1468-0297.2010.02402.x>. [233]
- Milanovic, B. (2016), *Global inequality: A new approach for the age of globalization*, Harvard University Press. [9]
- Molero, J. and A. Garcia (2008), “The innovative activity of foreign subsidiaries in the Spanish Innovation System: An evaluation of their impact from a sectoral taxonomy approach”, *Technovation*, Vol. 28/11, pp. 739-757, <http://dx.doi.org/10.1016/J.TECHNOVATION.2008.03.005>. [144]
- Monteiro, G., A. Gouveia and S. Santos (2017), “Product markets’ deregulation: A more productive, more efficient and more resilient economy?”, *OECD Productivity Working Papers*, No. 9, OECD Publishing, Paris, France. [3]
- Moomaw, R. (1981), “Productivity and city size: A critique of the evidence”, *The Quarterly Journal of Economics*, Vol. 96/4, pp. 675-688, <https://academic.oup.com/qje/article-abstract/96/4/675/1883458> (accessed on 13 December 2018). [213]
- Moretti, E. (2004), “Estimating the social return to higher education: Evidence from longitudinal and repeated cross-sectional data”, *Journal of Econometrics*, Vol. 121/1-2, pp. 175-212, <http://dx.doi.org/10.1016/J.JECONOM.2003.10.015>. [162]

- Mortensen, D. (2003), *Wage dispersion: Why are similar workers paid differently?*, MA: MIT Press., Cambridge. [10]
- Mueller, P. (2006), “Entrepreneurship in the region: Breeding ground for nascent entrepreneurs?”, *Small Business Economics*, Vol. 27/1, pp. 41-58, <http://dx.doi.org/10.1007/s11187-006-6951-7>. [55]
- Mueller, P. (2006), “Exploring the knowledge filter: How entrepreneurship and university–industry relationships drive economic growth”, *Research Policy*, Vol. 35/10, pp. 1499-1508, <http://dx.doi.org/10.1016/J.RESPOL.2006.09.023>. [66]
- Navaretti, G., A. Venables and F. Barry (2006), *Multinational firms in the world economy*, Princeton University Press. [127]
- Naveed, A. and N. Ahmad (2016), “Technology spillovers and international borders: A spatial econometric analysis”, *Journal of Borderlands Studies*, Vol. 31/4, pp. 441-461, <http://dx.doi.org/10.1080/08865655.2016.1188669>. [237]
- Nelson, R. and S. Winter (1982), “The Schumpeterian tradeoff revisited”, *The American Economic Review*, Vol. 72(1), pp. 114-132, <http://dx.doi.org/10.1057/9780230226203.0037>. [32]
- Nickell, S. (1996), “Competition and corporate performance”, *Journal of Political Economy*, Vol. 104/4, pp. 724-746, <http://dx.doi.org/10.1086/262040>. [36]
- Nicoletti, G. and S. Scarpetta (2003), “Regulation, productivity and growth: OECD evidence”, *Economic Policy* 36, pp. 9-72, <http://dx.doi.org/10.1111/1468-0327.00102>. [21]
- North, D. (1991), “Institutions”, *Journal of economic perspectives*, Vol. 5 (1), pp. 97-112. [195]
- OECD (2019), *OECD Economic Outlook 2019(1)*, OECD Publishing, Paris, <https://dx.doi.org/10.1787/b2e897b0-en>. [244]
- OECD (2018), *Job creation and local economic development 2018: Preparing for the future of work*, OECD Publishing, Paris, <https://dx.doi.org/10.1787/9789264305342-en>. [19]
- OECD (2018), *OECD Regions and Cities at a Glance 2018*, OECD Publishing, Paris, https://dx.doi.org/10.1787/reg_cit_glance-2018-en. [224]
- OECD (2017), *OECD Digital Economy Outlook 2017*, OECD Publishing, Paris, <https://dx.doi.org/10.1787/9789264276284-en>. [123]
- OECD (2015), *Governing the City*, OECD Publishing, Paris, <http://dx.doi.org/10.1177/0263276411426158>. [228]
- OECD (2015), *How’s life? 2015: Measuring well-being*, OECD Publishing, Paris, https://dx.doi.org/10.1787/how_life-2015-en. [18]

- OECD (2013), *An international benchmarking analysis of public programmes for high-growth firms*, OECD Publishing, Paris, <https://www.oecd.org/industry/high-growthreport.htm> (accessed on 22 May 2019). [63]
- OECD (2013), *OECD Regions at a Glance 2013*, OECD Publishing, Paris, https://dx.doi.org/10.1787/reg_glance-2013-en. [225]
- OECD (2012), *OECD Environmental Outlook to 2050*. [222]
- Partridge, M. and D. Rickman (2003), “The waxing and waning of regional economies: The chicken–egg question of jobs versus people”, *Journal of Urban Economics*, Vol. 53/1, pp. 76-97, [http://dx.doi.org/10.1016/S0094-1190\(02\)00501-6](http://dx.doi.org/10.1016/S0094-1190(02)00501-6). [163]
- Peck, J. (2005), “Struggling with the creative class”, *International journal of urban and regional research*, Vol. 29/4, pp. 740-770, <http://dx.doi.org/10.1111/j.1468-2427.2005.00620.x>. [77]
- Pinto, S. (2007), “Tax competition in the presence of interjurisdictional externalities: The case of crime prevention”, *Journal of Regional Science*, Vol. 47/5, pp. 897-913, <http://dx.doi.org/10.1111/j.1467-9787.2007.00535.x>. [226]
- Porter, M. (1998), *Clusters and the new economics of competition*, Harvard Business Review. [87]
- Pressman, L. et al. (2017), *The economic contribution of university/nonprofit inventions in the United States: 1996-2015*, <https://www.autm.net/AUTMMain/media/Advocacy/Documents/June-2017-Update-of-I-O-Economic-Impact-Model.pdf> (accessed on 5 August 2019). [151]
- Puga, D. (2010), “The magnitude and causes of agglomeration economies”, *Journal of Regional Science*, Vol. 50/1, pp. 203-219, <http://dx.doi.org/10.1111/j.1467-9787.2009.00657.x>. [216]
- Qian, H., Z. Acs and R. Stough (2013), “Regional systems of entrepreneurship: The nexus of human capital, knowledge and new firm formation”, *Journal of Economic Geography*, Vol. 13/4, pp. 559-587, <http://dx.doi.org/10.1093/jeg/lbs009>. [56]
- Rappaport, J. (2009), “Moving to nice weather”, in *Environmental Amenities and Regional Economic Development*, Routledge. [160]
- Rausch, S. and C. Negrey (2006), “Does the creative engine run? A consideration of the effect of creative class on economic strength and growth”, *Journal of Urban Affairs*, Vol. 28/5, pp. 473-489, <http://dx.doi.org/10.1111/j.1467-9906.2006.00310.x>. [81]
- Romer, P. (1990), “Endogenous technological change”, *Journal of political Economy*, Vol. 98 (5, Part 2), pp. S71-S102, <http://dx.doi.org/10.1093/acprof:osobl/9780199663897.003.0004>. [26]

- Rosenthal, S. and W. Strange (2003), “Geography, industrial organization, and agglomeration”, *The Review of Economics and Statistics*, Vol. 85/2, pp. 377-393, <http://dx.doi.org/10.1162/003465303765299882> (accessed on 13 December 2018). [215]
- Schivardi, F., E. Sette and G. Tabellini (2017), “Credit misallocation during the European financial crisis”, *CEPR Discussion Paper*, No. 1139, Bank of Italy. [186]
- Schumpeter, J. (1942), *Capitalism, socialism and democracy*, Routledge. [28]
- Scott, A. (2010), “Jobs or amenities? Destination choices of migrant engineers in the USA”, *Papers in Regional Science*, Vol. 89/1, pp. 43-63, <http://dx.doi.org/10.1111/j.1435-5957.2009.00263.x>. [164]
- Setzler, B. and F. Tintelnot (2019), “The effects of foreign multinationals on workers and firms in the United States”, No. 26149, National Bureau of Economic Research, <http://www.nber.org/papers/w26149> (accessed on 19 August 2019). [148]
- Shapiro, J. (2006), “Smart cities: Quality of life, productivity, and the growth effects of human capital”, *The Review of Economics and Statistics*, Vol. 88(2), pp. 324-335. [161]
- Sharpe, A. (2011), *Is ageing a drag on productivity growth? A review article on ageing, health and productivity: The economics of increased life expectancy*, International Productivity Monitor, <http://www.csls.ca/ipm/>. [170]
- Skans, O. (2008), “How does the age structure affect regional productivity?”, *Applied Economics Letters*, Vol. 15/10, pp. 787-790, <http://dx.doi.org/10.1080/13504850600749123>. [179]
- Slobodnitsky, T., L. Drucker and A. Geva (2018), “The contribution of multinational enterprises to labor productivity: The case of Israel”, *OECD Productivity Working Papers*, No. 11, OECD Publishing, Paris. [4]
- Sobel, R., N. Dutta and S. Roy (2010), “Does cultural diversity increase the rate of entrepreneurship?”, *Review of Austrian Economics*, Vol. 23/3, pp. 269-286, <http://dx.doi.org/10.1007/s11138-010-0112-6>. [72]
- Solow, R. (1956), “A contribution to the theory of economic growth”, *The Quarterly Journal of Economics*, Vol. 70 (1), pp. 65-94, <http://dx.doi.org/10.5897/JEIF2013.0518>. [27]
- Sorbe, S. et al. (2019), “Digital dividend: Policies to harness the productivity potential of digital technologies”, *OECD Economic Policy Paper*, No. 26, OECD Publishing, Paris. [13]
- Spigel, B. (2017), “The relational organization of entrepreneurial ecosystems”, *Entrepreneurship: Theory and Practice*, Vol. 41/1, pp. 49-72, <http://dx.doi.org/10.1111/etap.12167>. [69]
- Stam, E. (2015), “Entrepreneurial ecosystems and regional policy: A sympathetic critique”, *European Planning Studies*, Vol. 23/9, pp. 1759-1769, <http://dx.doi.org/10.1080/09654313.2015.1061484>. [58]

- Stansbury, A. and L. Summers (2017), “Productivity and pay: Is the link broken?”, *NBER Working Paper Series*, No. 24165, National Bureau of Economic Research, Cambridge, MA, <http://www.nber.org/papers/w24165>. [247]
- Stansel, D. (2005), “Local decentralization and local economic growth: A cross-sectional examination of US metropolitan areas”, *Journal of Urban Economics*, Vol. 57, pp. 55-72, <http://dx.doi.org/10.1016/j.jue.2004.08.002>. [6]
- Stiebale, J. and F. Reize (2011), “The impact of FDI through mergers and acquisitions on innovation in target firms”, *International Journal of Industrial Organization*, Vol. 29/2, pp. 155-167, <http://dx.doi.org/10.1016/J.IJINDORG.2010.06.003>. [128]
- Storz, M. et al. (2017), “Do we want these two to tango? On zombie firms and stressed banks in Europe”, *ECB Working Paper Series*, No. 2104. [185]
- Stuart, T., H. Hoang and R. Hybels (1999), “Interorganizational endorsements and the performance of entrepreneurial ventures”, *Administrative Science Quarterly*, Vol. 44/2, p. 315, <http://dx.doi.org/10.2307/2666998>. [86]
- Stuart, T. and O. Sorenson (2005), “Social networks and entrepreneurship”, in *Handbook of entrepreneurship research*, Springer, Boston, MA. [84]
- Sveikauskas, L. (1975), “Productivity of cities”, *Quarterly Journal of Economics*, Vol. 89/3, pp. 393-413. [212]
- Syverson, C. (2017), “Challenges to mismeasurement explanations for the US productivity slowdown”, *The Journal of Economic Perspectives*, Vol. 31/2, pp. 165-186, <https://www.jstor.org/stable/pdf/44235004.pdf> (accessed on 17 January 2019). [2]
- Syverson, C. (2011), “What determines productivity?”, *Journal of Economic Literature*, Vol. 49/2, pp. 326-365, <http://dx.doi.org/10.1257/jel.49.2.326>. [7]
- Tang, J. and C. Macleod (2006), “Labour force ageing and productivity performance in Canada”, *Canadian Journal of Economics / Revue canadienne d'économique*, Vol. 39 (2), pp. 582-603. [178]
- Thirlwall, A. (1974), “Regional economic disparities and regional policy in the common market”, *Urban Studies*, Vol. 11/1, pp. 1-12, <http://dx.doi.org/10.1080/00420987420080011>. [241]
- Tsai, K. and J. Wang (2004), “R&D productivity and the spillover effects of high-tech industry on the traditional manufacturing sector: The case of Taiwan”, *World Economy*, Vol. 27/10, pp. 1555-1570, <http://dx.doi.org/10.1111/j.1467-9701.2004.00666.x>. [97]
- Tybout, J. (2001), “Plant-and firm-level evidence on “ new” trade”, *NBER Working Paper Series*, No. 8418, National Bureau of Economic Research. [41]

- Ughetto, E., M. Cowling and N. Lee (2019), *Regional and spatial issues in the financing of small and medium-sized enterprises and new ventures*, Routledge, pp. 617-619, <http://dx.doi.org/10.1080/00343404.2019.1601174>. [188]
- Van Der Gaag, N. and J. de Beer (2015), “From demographic dividend to demographic burden: The impact of population ageing on economic growth in Europe”, *Tijdschrift voor Economische en Sociale Geografie*, Vol. 106/1, pp. 94-109, <http://dx.doi.org/10.1111/tesg.12104>. [177]
- Vandenbussche, J., P. Aghion and C. Meghir (2006), “Growth, distance to frontier and composition of human capital”, *Journal of Economic Growth*, Vol. 11/2, pp. 97-127, <http://dx.doi.org/10.1007/s10887-006-9002-y>. [155]
- Varian, H. (2018), “Artificial intelligence, economics, and industrial organization”, *NBER Working Paper*, <http://dx.doi.org/10.3386/w24839> (accessed on 24 July 2019). [107]
- Venables, A. (2011), “Productivity in cities: Self-selection and sorting”, *Journal of Economic Geography*, Vol. 11/2, pp. 241–251, <http://dx.doi.org/10.1093/jeg/lbq040>. [218]
- Veneri, P. and F. Murtin (2016), “Where is inclusive growth happening? Mapping multi-dimensional living standards in OECD regions”, *OECD Statistics Working Papers*, No. 2016/1, OECD Publishing, Paris, <https://dx.doi.org/10.1787/5jm3nptzwsxq-en>. [16]
- Verspagen, B. (1995), *R&D and productivity: A broad cross-section cross-country look*. [98]
- Walker, F. (1887), “The source of business profits”, *The Quarterly Journal of Economics* (1886-1906), p. 265. [152]
- Winters, J. (2011), “Why are smart cities growing? Who moves and who stays”, *Journal of Regional Science*, Vol. 51/2, pp. 253-270, <http://dx.doi.org/10.1111/j.1467-9787.2010.00693.x>. [165]
- Xie, D., H. Zou and H. Davoodi (1999), “Fiscal decentralization and economic growth in the United States”, *Journal of Urban Economics*, Vol. 45/2, pp. 228-239, <http://dx.doi.org/10.1006/juec.1998.2095>. [230]
- Zhang, T. and H. Zou (1998), “Fiscal decentralization, public spending, and economic growth in China”, *Journal of Public Economics*, Vol. 67/2, pp. 221-240, [http://dx.doi.org/10.1016/S0047-2727\(97\)00057-1](http://dx.doi.org/10.1016/S0047-2727(97)00057-1). [229]

