



## Regional Studies

ISSN: (Print) (Online) Journal homepage: <https://www.tandfonline.com/loi/cres20>

# Agglomeration externalities of fast-growth firms

Jun Du & Enrico Vanino

To cite this article: Jun Du & Enrico Vanino (2020): Agglomeration externalities of fast-growth firms, *Regional Studies*, DOI: [10.1080/00343404.2020.1760234](https://doi.org/10.1080/00343404.2020.1760234)

To link to this article: <https://doi.org/10.1080/00343404.2020.1760234>



© 2020 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group



[View supplementary material](#)



Published online: 26 Jun 2020.



[Submit your article to this journal](#)



Article views: 421



[View related articles](#)



[View Crossmark data](#)

# Agglomeration externalities of fast-growth firms

Jun Du<sup>a</sup>  and Enrico Vanino<sup>b</sup> 

## ABSTRACT

Small groups of fast-growth firms contribute disproportionately to job creation, yet little is known about their broader impact on the economy. This paper provides the first evidence of the agglomeration externalities of fast-growth firms, examining their economic impact on non-fast-growth firms operating within the same region (NUTS-2) and industry (SIC2), and through backward and forward linkages. Using comprehensive firm-level data on UK firms between 1997 and 2013, the analysis shows robust evidence of positive spillovers of fast-growth firms on the labour productivity of non-fast-growth firms in the same industry and region. However, the externalities in relation to the employment growth of non-fast-growth firms are negative, suggesting labour poaching and local competition effects.

## KEYWORDS

fast growth; externalities; firm heterogeneity; agglomeration; spillovers

JEL J24, L52, R11, R58

HISTORY Received 21 December 2018; in revised form 3 April 2020

## INTRODUCTION

Fast-growth firms have attracted increasing attention from policy-makers and academic researchers because of their disproportionate contribution to economic growth and job creation. Since the recent financial crisis, fast-growth firms have been considered a viable option to foster economic recovery and are central to the political debate on economic performance and industrial resilience (Anyadike-Danes et al., 2013; Bleda & Del Rio, 2013; Brown et al., 2017; Coad et al., 2012; Mason & Brown, 2013; Organisation for Economic Co-operation and Development (OECD), 2013; Storey & Greene, 2010). However, the existing literature has focused so far almost exclusively on the characteristics of fast-growth firms, seeking to identify the drivers and to predict the likelihood of fast-growth episodes (Haltiwanger et al., 2013; Hölzl, 2014; Lawless, 2014).

Following a different approach, recent studies have investigated the emergence of the fast-growth phenomenon at the regional level, examining if and how location-specific characteristics, industrial agglomeration and specialization could promote fast-growth (Duschl et al., 2015; Stam, 2005). The idea that region-specific characteristics affect firms' productivity and growth is

well established in economic geography and regional science, with both theoretical and empirical analysis focusing on local agglomeration externalities (Glaeser et al., 1992; Jacobs, 1969). However, empirical evidence about the ways in which agglomeration externalities occur and how they may affect firms' growth is still mixed (Abukabarr & Mitra, 2017; De Groot et al., 2009).


The study fills this gap by analysing the impact of fast-growth firms on the economic performance of industrially related and proximately located non-fast-growth firms. We define fast-growth firms using both employment- and productivity-based definitions to capture different business population and alternative spillover channels. To the best of our knowledge, this is the first study to examine the spillover effects of fast-growth firms. By using firm-, region- and industry-level data for the UK over the period 1997–2013, we identify the main channels through which these firms indirectly affect the productivity and employment growth of other firms in the region, and investigate if these externalities spread horizontally or through forward and backward linkages.

The results show that, on the one hand, a higher proportion of fast-employment-growth firms has negative effects on the average employment growth of other firms in the same industry and region, consistent with


## CONTACT

<sup>a</sup> (Corresponding author)  j.du@aston.ac.uk

Aston Business School, Aston University, Birmingham, UK.

<sup>b</sup>  e.vanino@sheffield.ac.uk

Department of Economics, University of Sheffield, Sheffield, UK.

 Supplemental data for this article can be accessed at <https://doi.org/10.1080/00343404.2020.1760234>

competition-led crowding-out and labour-poaching effects. On the other hand, a higher proportion of fast-productivity-growth firms has positive spillover effects on the labour productivity of non-fast-growth firms, suggesting competition-led efficiency improvement and potential knowledge spillovers. By analysing the externalities among vertically integrated industries, we find that an increase in demand by fast-growth firms has positive market-creating spillover effects on other firms in upstream sectors. Also, a higher proportion of fast-growth suppliers results in increased productivity growth in downstream sectors, potentially because of learning and demonstration effects as a result of knowledge spillovers.

The analysis reveals the heterogeneous effects of fast-growth externalities. First, these results are particularly strong for small and old non-fast-growth firms, especially in low-tech sectors. Second, stronger negative externalities on employment growth mainly affect peripheral areas, while the most agglomerated core regions experience positive spillover effects from increased proportions of fast-growth firms, suggesting that the negative externalities on employment growth might be exacerbated by a limited supply in peripheral local labour markets. In contrast, the stronger positive externalities on labour productivity from fast-growth firms in highly agglomerated areas suggest the presence of knowledge spillovers and efficiency improvements because of increased competitive pressure and learning effects stimulated by fast-growth firms.

The paper is structured as follows. The next section reviews the main theoretical and empirical contributions in the existing literature. We then discuss the data and present the summary statistics, before explaining the methodological approach. Finally, we present and discuss the econometric results, and conclude by highlighting the policy implications and future directions for research.

## LITERATURE REVIEW

The study is mainly related to two broad literatures. First is the fast-growth firms literature that has expanded exponentially in the last two decades. This strand of the literature has extensively highlighted how fast-growth firms, although forming a small fraction of the business population, generate a disproportionately high rate of new jobs (Brown et al., 2017; Henrekson & Johansson, 2010; National Endowment for Science, Technology and the Arts (NESTA), 2009). Moreover, the exceptional growth of fast-growth firms is not linked to cyclical economic fluctuations, as their contribution to job creation has been observed in times of both economic upturn and recession (Hart & Anyadike-Danes, 2015). Since the recent financial crisis, fast-growth firms have been considered as a viable option by many governments to help foster economic recovery, and have become central in the political and academic debate about economic resilience and growth (Acs et al., 2008; Anyadike-Danes & Hart, 2018; Bleda & Del Rio, 2013; Coad et al., 2014a; Mason & Brown, 2013; OECD, 2013; Storey & Greene, 2010).

The existing literature on this topic has mostly looked at the characteristics and industrial distribution of fast-growth firms, highlighting their prevalence among younger (Haltiwanger et al., 2013), more innovative and knowledge-intensive firms (Daunfeldt et al., 2014), but also stressing how fast-growth phenomena are broadly spread among firms of all sizes and industry (Henrekson & Johansson, 2010; Lawless, 2014; Moreno & Coad, 2015; NESTA, 2009). However, the predictability of fast-growth episodes remains fairly limited, given their highly episodic nature (Hözl, 2014; Moreno & Coad, 2015; Parsley & Halabisky, 2008) and their lack of persistence over time (Acs et al., 2008; Brown et al., 2017; Daunfeldt & Halvarsson, 2015; Du & Bonner, 2017), leaving in some respects the fast-growth literature theoretically and empirically underdeveloped (Coad, 2009; Coad et al., 2013; Denrell, 2004; Leitch et al., 2010).

Recent studies have started investigating the spatial development of fast-growth firms, although little is known about how fast-growth firms might be related to regional development (Brown & Mawson, 2016; Li, 2016). Several studies suggest that regional characteristics play an important role in affecting the development of fast-growth firms, fostered by location-specific characteristics, industrial agglomeration and specialization (Duschl et al., 2015; Stam, 2005). The main regional factors usually discussed in this literature include industrial agglomeration, human capital, transportation costs, institutional factors and the entrepreneurial ecosystem (Arauzo-Carod et al., 2010). While these factors have been investigated to explain the incidence of fast-growth, much less attention has been paid to the external impact of such firms' activities and their interactions with the local economy. Given the relevant policy focus on fast growth, and the considerable resources allocated by governments to stimulate such growth, it becomes increasingly important to understand the wider economic impact of the fast-growth phenomenon in the economy.

In this regard, by linking the fast-growth literature to the main economic geography theories on agglomeration externalities, it would be possible to analyse the spillovers arising from the co-location in agglomerated regions and industries of fast-growth and other firms (Abukabarr & Mitra, 2017; Glaeser et al., 1992). In particular, following the Marshall–Arrow–Romer (MAR) theories on localization economies, the agglomeration of fast-growth firms in a given region and industry could generate both positive and negative externalities for other spatially proximate and industrially related non-fast-growth firms. Marshallian externalities linked to localization economies mainly operate through three different channels: sharing specialized suppliers, labour pooling and matching, and knowledge externalities (Glaeser et al., 1992; Marshall, 1920). First, by sharing intermediate inputs from specialized suppliers, fast-growth and non-fast-growth firms could reduce the costs of obtaining inputs or of shipping goods to customers (Fujita, Krugman, & Venables, 1999). In addition, fast-growth firms could also generate spillover effects for other firms in vertically integrated industries. In particular,

these could be for non-fast-growth suppliers and consumers, who could internalize the externalities related to increased demand, and introduce new improved inputs, innovation and efficiency gains induced by fast-growth firms in other related sectors (Humphrey & Schmitz, 2002; Jabbour & Mucchielli, 2007). However, while firms may be able to tap into better supply chains when co-locating with fast-growth firms, they may also have to bear increased costs of production because of the negative externalities related to higher agglomeration. These negative spillovers are usually linked to high rental and transportation costs, and crowding-out effects related to the tougher competition by fast-growth firms in both the up- and downstream markets (Broersma & Van Dijk, 2007; Combes & Gobillon, 2015).

Second, by locating close to each other, fast-growth and other firms within the same industry could enjoy the benefits of ‘thick’ labour markets, having access to a large pool of suitably skilled workers (Combes & Duranton, 2006; Glaeser & Resseger, 2010). Clustering reduces the costs of managing labour needs, especially in an environment with high turnover, reducing the uncertainty about the future demand for labour and about the possible future skills required (De Groot et al., 2009). In addition, the clustering of firms within the same industry could facilitate the transfer of workers from unsuccessful firms to successful ones, facilitating the match between firms and workers, and result in the reinforcement of dense agglomeration (Duranton & Puga, 2004; Helsley & Strange, 1990). In this regard, the agglomeration of fast-growth firms could facilitate, on the one hand, the match between skilled workers and firms’ requirements, or the flow of labour and skills from fast-growth to other firms within the same industry. However, on the other hand, a rapid increase in the agglomeration of fast-growth firms could also create negative spillover effects related to labour poaching, where tougher competition in the local labour market could draw the limited numbers of skilled workers available towards the most successful firms in the cluster, that is, the fast-growth firms (Coad et al., 2014b; Combes & Duranton, 2006; Morris et al., 2019).

Finally, an increase in the agglomeration of fast-growth firms could also generate relevant knowledge externalities for other firms within the same region and industry, where fast-growth and other firms could share ideas and knowledge, mainly through informal interactions and the movement of workers (Storper & Venables, 2004). Firms can learn from other firms, through localized knowledge spillovers, which are mainly relevant in the case of tacit rather than codified knowledge, and intensifying the benefits of the interaction within the local labour market and with actors along the supply chain (Polanyi, 1967). The existing literature suggests that firms operating in regions and sectors characterized by greater levels of agglomeration experience higher rates of growth, thanks to the indirect effect of tacit or explicit externalities originated from better performing companies (Audretsch & Dohse, 2007; Raspe & Van Oort, 2007). Thus, it is reasonable to hypothesize that fast-growth firms might indirectly

affect the performance of spatially proximate and industrially related non-fast-growth firms because of their dynamism, innovation, productivity growth and employment creation. In addition, horizontal externalities could arise through imitation, cooperation, competition and the movement of workers between fast- and non-fast-growth firms. Thus, spatially agglomerated fast-growth firms operating within the same industry could, on the one hand, trigger positive externalities, through demonstration effects and competition-led efficiency improvements, but, on the other hand, they could also lead to competition-led crowding out effects as a result of the tougher competition for common resources and inputs of production, such as skills and intermediate inputs (Glaeser et al., 1992; Porter, 1990).

The processes through which agglomeration externalities from fast-growth firms may occur are indeed complex, and could be mediated by a mix of different economic forces, such as the level of agglomeration and concentration in the local industry, the availability of skills and the intensity of the vertical integration. Thus, fast-growth externalities may result in differentiated effects for other co-located firms within the same industry. As such, the overall effects of fast-growth agglomeration externalities may be context dependent, based on the resources and knowledge available across regions and industries (Neffke et al., 2011).

## DATA

### Data sources

The empirical analysis draws on a mix of data sources at the firm, industry and region level. First, we use firm-level data from the Office for National Statistics (ONS) Business Structure Database (BSD) covering all businesses in manufacturing industries in the UK between 1997 and 2013 (ONS, 2017). The BSD provides information on firms’ age, ownership, turnover, employment, industrial classification and postcode. Second, we include several variables at the region and industry levels, calculated by aggregation from the BSD database at the NUTS-2 region and SIC2 (Standard Industrial Classification) industry level, such as employment, net entry rate and agglomeration index. To estimate vertical backward and forward linkages, we make use of the ONS input–output tables, estimating supply and demand for all sectors at the SIC2 level in the UK. In addition, the research and development (R&D) intensities at the NUTS-2 region and SIC2 industry level are estimated using the UK Innovation Survey database (ONS, 2018).

### Fast-growth definitions

Thanks to these detailed and comprehensive data, we can identify the incidence and distribution of fast-growth firms across the UK regions and industries in the UK using alternative measures. There is an ongoing debate over the merits and drawbacks of different definitions of fast-growth firms (Anyadike-Danes et al., 2015; Daunfeldt et al., 2014; Du & Bonner, 2016; Moreno & Coad, 2015). Recent evidence shows that employment and sales growth

based measures are only modestly correlated, and different definitions produce different subsets of the business population (Daunfeldt et al., 2014; Du & Bonner, 2017; Shepherd & Wiklund, 2009). Hence, in this study we examine two different fast-growth definitions, based on employment and productivity growth, to capture the top performers in terms of different growth mechanisms.<sup>1</sup>

First, the employment-based high-growth-firms (HGFs) definition captures firms with at least 10 employees that have an annual average growth in employment of 20% or more over a three-year period (Eurostat-OECD, 2007). Also to include firms with fewer than 10 employees, we adopt the small HGFs definition introduced by Clayton et al. (2013), capturing firms with fewer than 10 employees which grow by more than eight new employees over a three-year period. Second, we follow Du and Bonner (2016, 2017) to define productivity-based super-growth heroes (SGHs). This metric captures firms that have experienced a positive labour productivity growth over a three-year period, whereby both turnover and employment have grown relative to the base year, implying faster growth in turnover than in employment, and in addition with labour productivity levels above the SIC3 industry average. Firms are defined as fast-growth firms for the three years constituting the growth episode in order to identify precisely each of the years in which firms have registered particularly fast growth.

Table 1 presents summary statistics about the characteristics and distribution of the overall sample of manufacturing firms, HGFs and SGHs in the UK. Fast-growth firms represent around 4–5% of manufacturing firms in the sample. During this period, about 150,000 manufacturing firms have experienced at least one SGH period, while almost 120,000 have registered at least one HGF period. By comparing these two groups, we observe that during this period only 15% of these firms have experienced both an SGH and an HGF episode. Fast-growth firms are usually larger than the average firm in terms of

employment and turnover, and have higher labour productivity. It appears that the average firm age of SGHs or HGFs is around 12–14 years. Both SGHs and HGFs have a higher probability of being foreign owned and of being more likely to be part of a business group. However, in our sample, the percentages of small and medium-sized enterprises (SMEs), young and high-tech firms do not differ significantly between fast-growth firms and the average firms.<sup>2</sup>

Figure 1 presents the geographical distribution of SGHs and HGFs employment as the average share of total employment for each NUTS-2 UK region during the period 1997–2013. The two maps highlight a different geographical distribution for these two groups of fast-growth firms. In fact, the SGHs incidence rate is particularly high in large cities' regions, such as the Greater London area, Hampshire (Southampton), the East Midlands (with Nottingham and Derby), and the Leeds and Newcastle regions. These are thus mainly in highly agglomerated areas, as suggested by the positive correlation between this fast-growth metric and the Ellison and Glaeser (1997) agglomeration index, and thus in turn with productivity growth as shown in the previous literature (Bertinelli & Black, 2004; Duranton & Puga, 2004). HGFs instead seem more evenly distributed both in urban and rural regions, with relatively higher incidence in Surrey, Sussex, Cheshire and County Durham, but also in more agglomerated regions, such as the Greater Manchester area and the region of Edinburgh in Scotland. This is consistent with previous evidence suggesting that employment fast growth can happen everywhere (Moreno & Coad, 2015).

### Fast-growth externalities

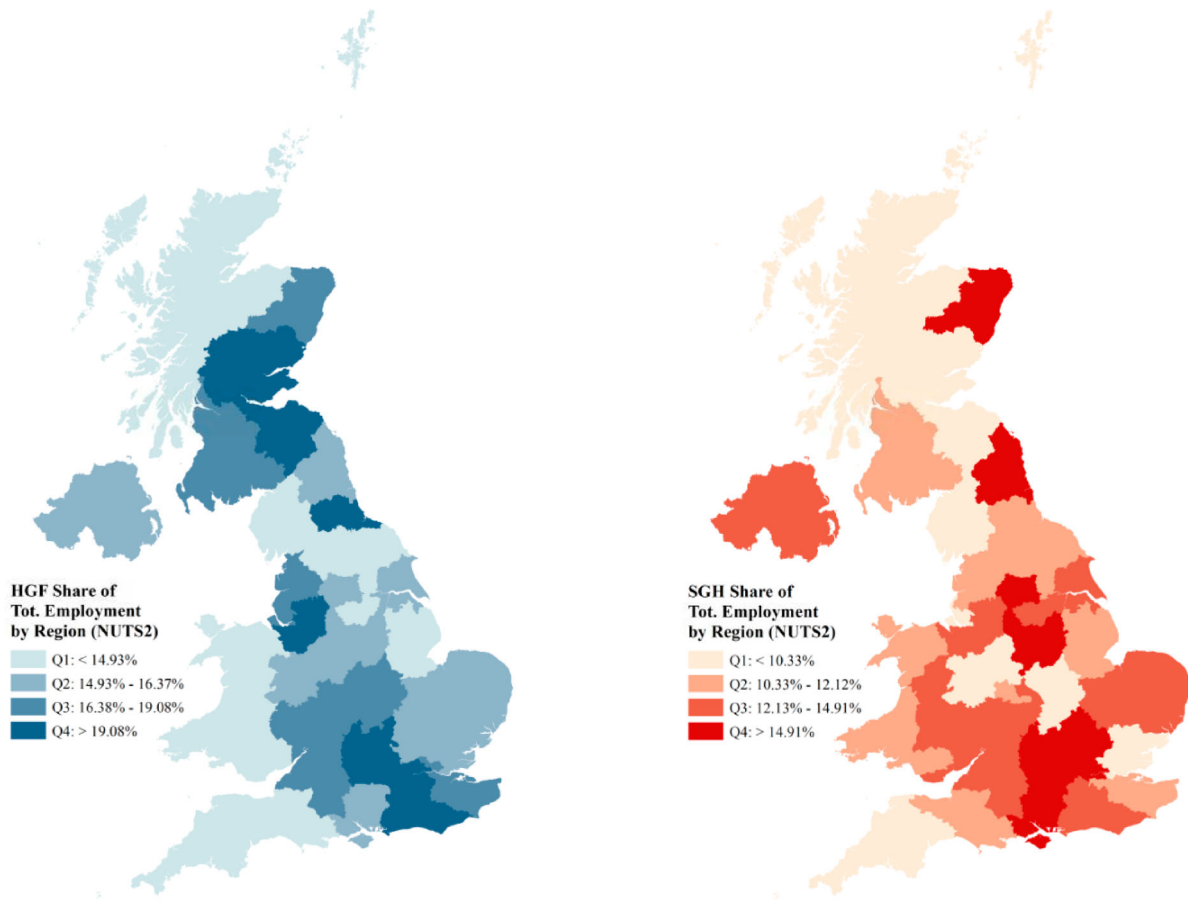
Following the theoretical predictions discussed above, and the established empirical literature on the identification of agglomeration externalities developed since the seminal paper by Javorcik (2004), we consider three possible

**Table 1.** Characteristics of UK fast-growing firms in the manufacturing sectors, 1997–2013.

Observations (share of total, %)	Overall		SGH		HGF	
	2,823,945 (100%)		153,339 (5.4%)		120,690 (4.3%)	
	Mean	SD	Mean	SD	Mean	SD
Total employment	21.13	202.14	74.15	467.30	54.33	280.80
Turnover	2948.95	77,105.55	16,232.44	179,711.20	6756.48	51,204.58
Labour productivity	90.11	1967.61	174.75	731.81	162.92	1239.06
Average age (years)	12.63	10.06	14.39	10.18	12.42	8.90
Foreign ownership	2.32%	0.15	8.55%	0.28	5.62%	0.23
Group	62.95%	0.48	67.45%	0.47	76.21%	0.43
SMEs	98.80%	0.11	95.88%	0.20	98.19%	0.13
Young	53.98%	0.50	52.03%	0.50	54.33%	0.50
High-tech	24.64%	0.43	24.84%	0.43	25.73%	0.44

Note: Statistics are based on the Business Structure Database (BSD) between 1997 and 2013. Turnover is expressed in thousands of pounds. Super-growth heroes (SGHs): firms that have experienced a positive labour productivity growth over a three-year period with both turnover and employment growth and labour productivity is above three-year average labour productivity of its sector at the SIC3 level. High-growth firms (HGFs): the total employment of firms with more than 10 employees grows by more than 20% over a three-year period, or if the total employment of firms with fewer than 10 employees grows by more than eight new employees over a three-year period.





**Figure 1.** Share of high-growth firms (HGFs) and super-growth heroes (SGHs) over total employment per region (NUTS-2 level).- Note: Statistics are based on the Business Structure Database (BSD) between 1997 and 2013. SGHs are those firms that have experienced a positive labour productivity growth over a three-year period with both turnover and employment growth, and labour productivity is above the three-year average labour productivity of its sector at the SIC3 level. HGFs are the total employment of firms with more than 10 employees that grow by more than 20% over a three-year period, or if the total employment of firms with fewer than 10 employees grows by more than eight new employees over a three-year period.

measures of fast-growth spillovers. First, fast-growth industrial externalities at the horizontal level (*Horizontal FG<sub>rst</sub>*) relate to the spillover effects generating from fast-growth firms operating in the same SIC2 industry  $s$  and NUTS-2 region  $r$ , following MAR theory. This is measured by the share of fast-growth firms' employment  $FG\_EMPL_{rst}$  over the total employment  $EMPL_{rst}$  of each region and industry in a given year ( $t$ ):

$$Horizontal\ FG_{rst} = FG\_EMPL_{rst} / EMPL_{rst}$$

Second, we estimate backward and forward externalities along the vertical supply chain, considering the fast-growth spillovers originating from vertically integrated sectors which are part of the same value chain of production. To do so, we build two measures of vertical externalities for each sector: one for backward linkages with fast-growth suppliers, and the other for forward linkages with fast-growth customers (Frenken et al., 2007; Javorcik, 2004).

Following Javorcik's (2004) methodology, we use the average intermediate supply linkage between SIC2 industries pairs, with the 2005 UK input-output tables as a base year, as a measure of industrial integration between

all sector pairs in the UK ( $\alpha_{sj}$ ). For each sector ( $s$ ) we can then construct two measures of vertical externalities through backward linkages with the supplying sectors ( $j$ ) and forward linkages with customer sectors ( $z$ ). To do so, we weight the share of fast-growth firms' employment in each upstream (*Horizontal FG<sub>rjt</sub>*) and downstream sector (*Horizontal FG<sub>rzt</sub>*) of industry ( $s$ ) within the same region ( $r$ ) by the relative measure of vertical integration between each pair of sector ( $sj$ ) and ( $sz$ ), and averaging across all backward ( $j$ ) and forward sectors ( $z$ ):<sup>3</sup>

$$Backward\ FG_{rst} = \frac{1}{n} \sum_{j=1}^n \alpha_{sj} \times Horizontal\ FG_{rjt}$$

$$Forward\ FG_{rst} = \frac{1}{n} \sum_{z=1}^n \alpha_{sz} \times Horizontal\ FG_{rzt}$$

In this way, we can comprehensively estimate the externalities of fast-growth firms, considering not only those operating within the same region and industry but also the spillovers spreading throughout vertically integrated industries located within the same region.

## METHODOLOGY

We model fast-growth externalities for other non-fast-growth firms in the following way, controlling for firm, region and industry heterogeneity:

$$\begin{aligned} \Delta EMP_{irst} = & \beta_0 + \beta_1 \Delta Horiz.HGF_{rst} \\ & + \beta_2 \Delta Backw.HGF_{rst} \\ & + \beta_3 \Delta Forw.HGF_{rst} + \beta_4 FIRM_{it-1} \\ & + \beta_5 ENV_{rst-1} + j_t + j_i + j_{rs} + \varepsilon_{it} \\ & + \varepsilon_{rst}, \end{aligned} \quad (1)$$

$$\begin{aligned} \Delta LP_{irst} = & \beta_0 + \beta_1 \Delta Horiz.SGH_{rst} \\ & + \beta_2 \Delta Backw.SGH_{rst} + \beta_3 \Delta Forw.SGH_{rst} \\ & + \beta_4 FIRM_{it-1} + \beta_5 ENV_{rst-1} + j_t + j_i \\ & + j_{rs} + \varepsilon_{it} + \varepsilon_{rst}, \end{aligned} \quad (2)$$

In equation (1) the dependent variable  $\Delta EMP_{irst}$  represents the year-to-year employment growth of non-HGF firms ( $i$ ) at time ( $t$ ), while the key explanatory variable  $\Delta Horiz.HGF_{rst}$  indicates the horizontal externalities linked to an increased incidence of employment-based HGFs in SIC2 industry ( $s$ ) and NUTS-2 region ( $r$ ). The potential regional vertical externalities in the backward  $\Delta Backw.HGF_{rst}$  and forward sectors  $\Delta Forw.HGF_{rst}$  are also included for the spillover effects in sector ( $s$ ) and region ( $r$ ) of an increased incidence of fast-growth firms in the up- and downstream industries.

Similarly, equation (2) models the spillover effects of a higher proportion of productivity-based SGHs on the labour productivity growth of non-SGH firms. In this case, the dependent variable  $\Delta LP_{irst}$  measures the year-to-year labour productivity growth of non-SGHs in region ( $r$ ) and industry ( $s$ ) at time ( $t$ ) measured as total revenue per employee.<sup>4</sup> The key explanatory variables include  $\Delta Horiz.SGH_{rst}$ , an increase of the proportion of SGHs over total employment in region  $r$  and industry  $s$ , and the vertical externalities linked to an increase in proportion of SGHs in backward ( $\Delta Backw.SGH_{rst}$ ) and forward sectors ( $\Delta Forw.SGH_{rst}$ ).<sup>5</sup>

Both equations control for variables at different levels. First, the vector  $FIRM_{it-1}$  includes several firm-level characteristics, including lagged levels of employment, labour productivity, firm age, foreign and group ownership. Second,  $ENV_{rst-1}$ , represents the different control variables at the industry and region level. We control for the overall performance of sectors and regions where each firm operates at the NUTS-2 and SIC2 level, including lagged levels of employment, labour productivity growth and the net entry rate, in order to take into account the level of competition and the dynamism of the local industries.<sup>6</sup> In addition, we control for the region and industry R&D intensity and for the agglomeration index at the region-industry level, using the Ellison and Glaeser (1997) definition.<sup>7</sup> We also interact each externality metric with the agglomeration index in order to estimate the relationship

between fast-growth incidence rate and other firms' employment and productivity growth, while controlling for the self-selection of fast-growth and highly performing firms in industries and regions characterized by high levels of spatial agglomeration and industrial concentration (Autor et al., 2017; Combes & Gobillon, 2015).

By using an ordinary least squares (OLS) first-difference fixed-effects model, we can identify the relationship between fast-growth externalities and the economic performance of non-fast-growth firms. In particular, the first-difference model allows one to measure the effect of a standard deviation increase in the externalities of fast-growth incidence rates on other firms' employment and productivity growth. In this way, we can identify the dynamic evolution of fast-growth firms and of their related spillovers, given their definition being based on rapid growth and of a volatile nature. In particular, we are interested in understanding how the variation in fast-growth firms agglomeration affects employment and productivity growth for other firms clustered within the same industry.<sup>8</sup> In addition, the firm, industry and regional control variables, together with firm-level ( $j_i$ ), year ( $j_t$ ) and region-industry fixed-effects ( $j_{rs}$ ), improve the estimation precision by accounting for a range of firm heterogeneities and controlling for time-invariant firm, industry and region specific effects. Standard errors are clustered at the region, industry and year level.

### Robustness tests and heterogeneity analysis

To test the robustness of our baseline specifications we perform several checks. First, we adopt a multilevel (ML) first-difference fixed-effects methodology in order to consider the hierarchical nature of the data, relaxing the stringent assumption that observations within subunits are uncorrelated and modelling the non-independence of units in the same cluster (i.e., region and industry), including variables in the model at different levels (Gelman & Hill, 2007; Raspe & Van Oort, 2007; Srholec, 2010).

Second, we implement a dynamic system generalized method of moments (GMM) instrumenting the possible endogenous variables with their three-period lagged values. In this case, we consider the fast-growth variables as predetermined and therefore not correlated with the error term, but expected to influence non-fast-growth firms' performance. System GMM has been found to be more efficient compared with difference GMM, particularly in the presence of heteroskedasticity (Arellano & Bond, 1991). To evaluate the overall goodness of fit of the GMM models, we report the Hansen test of overidentifying restrictions, which presents an evaluation of the exogeneity of the subset of instruments. We also test for the presence of first- and second-order serial autocorrelation, for potential inconsistency with predetermined variable regressions (Windmeijer, 2006). Results from these two methodologies are reported in Table A2 in Appendix A in the supplemental data online.

Third, it might be argued that the results, especially in terms of labour productivity, could be driven by firm exits, where less productive non-fast-growth firms exit the

market in the face of mounting competition from fast-growth firms, pushing up the overall productivity of surviving firms. To account for this possibility, in Table A3 in Appendix A online we have followed two different approaches. We have replicated our analysis on a balanced panel of firms always active throughout the sample period. We have also controlled for firm exits by implementing a Heckman (1979) selection model, in which the first stage of the procedure controls for survival selection using lagged levels of labour productivity as an additional selection variable.

Finally, we analyse the heterogeneous distribution of fast-growth externalities across regions, industries and firms' characteristics. We estimate the baseline models, splitting the sample by firms' age, size and industrial technological intensity. Recent studies suggest that small firms are more likely to rely on spillovers, especially because of their limited ability to invest significant resources in internal capabilities, and thus expecting a particularly strong influence of fast-growth externalities on their performance (Abukabarr & Mitra, 2017; Audretsch & Dohse, 2007). We then expect to find different effects of fast-growth externalities on younger, entrepreneurial and more dynamic firms in comparison with established companies. We also test whether fast-growth externalities are stronger in knowledge-intensive, where external collaborations are more developed and firms can rely on stronger absorptive capacity to internalize spillovers, or in low-tech industries because of the scope of catch-up for firms distant from the technological frontier (De Silva & McComb, 2012; Sena et al., 2013). Finally, we analyse the heterogeneous distribution of fast-growth externalities across NUTS-2 regions and SIC2 industries to compare the spatial and industrial differences in the strength of these spillovers.

## RESULTS

### Employment growth

Table 2 reports the estimates of the effect of fast-growth externalities on employment growth. In column 1 we find an overall negative horizontal spillover effect of fast-employment growth rate on the employment growth of other firms operating within the same region and sector. This may be interpreted as a sign of competition-led crowding out effects when facing a strong expansion of employment in fast-growth firms. This evidence is consistent with theories of trade-offs faced by firms clustering in thick local markets, between benefits linked to labour pooling and specialized suppliers, and higher costs of labour poaching and competition (Combes & Duranton, 2006). In this regard, labour poaching effects might be particularly relevant, given the skills shortages experienced in the UK, in particular in manufacturing industries (Calvo & Coulter, 2017; Haskel et al., 2005; Kemeny, 2017; Morris et al., 2019). In addition, this finding seems consistent with the recent evidence of 'superstar firms' in manufacturing industries, where rapid growth of mark-ups leads to an increased concentration of labour and skills in few fast-growing firms

(Autor et al., 2017). According to back-of-the envelope calculations, increasing the fast-growth incidence rate by 10% leads to an overall slower employment growth by 0.082% in the same manufacturing industry and region, *ceteris paribus*. This translates to more than 35,000 fewer jobs per year across UK regions,<sup>9</sup> a sizeable impact compared with the estimated number of around 400,000 new jobs created by fast-growth firms in a given year.<sup>10</sup>

Turning to vertical externalities, while there is no statistically significant effect linked to backward fast-growth externalities, we observe a strong positive spillover effect of a higher proportion of forward fast-growth firms, both in high- and low-tech sectors, which stimulates demand-driven employment growth for supplying non-fast-growing firms. In addition, the interaction between agglomeration and spillover effects suggests a mediating role of agglomeration in determining the externalities impact, where the externalities are more pronounced in more agglomerated industries and regions, in line with the previous literature (Audretsch & Dohse, 2007). In particular, an increase in the proportion of fast-growth firms in downstream sectors will lead to a larger increase in the employment growth of non-fast-growth firms in more agglomerated upstream sectors. Furthermore, by comparing the results among firms of different ages and sizes, we find mostly that small and old firms drive the overall results. We observe that horizontal externalities and the moderating effects of agglomeration are stronger for small firms, probably because of their limited resources, while old non-fast-growth firms benefit more from forward fast-growth spillovers, presumably benefiting from established supply linkages, but they also suffer more from the competition within the same sector in agglomerated regions and industries (Abukabarr & Mitra, 2017).

### Productivity growth

Table 3 presents the results of fast-growth spillovers on productivity growth, finding overall a positive and significant impact of horizontal externalities on the labour productivity growth of non-fast-growth firms, particularly in low-tech sectors. Higher proportions of fast-productivity-growth firms seem to spill labour productivity growth to other non-fast-growth firms, both within the same sector and along the vertically integrated supply chains. Overall, a 10% increase in the incidence of fast-productivity-growth firms within the same industry and region would prompt a 0.12% increase in the average labour productivity of non-fast-growth manufacturers. Interestingly, the marginal effect of the spillovers is higher for low-tech firms (0.17%), suggesting that there is more scope for productivity catch up in low-tech sectors, possibly through demonstration effects (Grillitsch & Nilsson, 2019). In addition to knowledge spillover effects, positive productivity externalities within the same sector could be driven by competition-led efficiency improvement. This refers to the pressure from competitors which affect productivity levels within the same industry. Product-market competition could enhance within-industry productivity through selection processes (Foster et al., 2001; Syverson, 2011) or



**Table 2.** Region–industry spillovers effect of fast-growing firms (HGFs) on the employment growth of non-fast-growth firms in the manufacturing sectors.

	(1) Manufacturing	(2) Large	(3) SME	(4) Old	(5) Young	(6) Low-tech	(7) High-tech
<i>Horiz.HGF<sub>rst</sub></i>	−0.0082*** (0.00229)	0.00116 (0.00230)	−0.0546*** (0.0204)	−0.00579** (0.00275)	0.00149 (0.00379)	−0.000986 (0.00296)	−0.00131 (0.00368)
<i>Forw.HGF<sub>rst</sub></i>	0.00217*** (0.000688)	0.00366 (0.00561)	0.00226*** (0.000691)	0.00143* (0.000819)	0.00333*** (0.00115)	0.00175** (0.000859)	0.00170 (0.00130)
<i>Backw.HGF<sub>rst</sub></i>	−0.000241 (0.000576)	−0.000419 (0.000577)	0.0107** (0.00530)	−7.62e−05 (0.000688)	−0.000265 (0.000959)	0.000204 (0.000644)	−0.00108 (0.00134)
<i>Horiz.HGF#Aggl<sub>rst</sub></i>	−1.229** (0.601)	−4.743 (5.885)	−1.206** (0.603)	−2.923*** (0.708)	0.432 (0.973)	−1.348* (0.751)	−1.425 (1.042)
<i>Forw.HGF#Aggl<sub>rst</sub></i>	0.378** (0.178)	−1.259 (1.598)	0.442** (0.179)	0.437** (0.203)	0.550* (0.316)	0.342* (0.203)	0.259 (0.390)
<i>Backw.HGF#Aggl<sub>rst</sub></i>	0.0366 (0.179)	2.371 (1.846)	0.00984 (0.179)	0.0419 (0.198)	0.151 (0.315)	−0.00250 (0.205)	0.359 (0.372)
<i>Agglom.Index<sub>rst</sub></i>	0.199 (0.169)	0.649 (1.059)	0.245** (0.107)	0.0860 (0.209)	0.374** (0.160)	0.145* (0.092)	0.319 (0.395)
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region–industry controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,945,976	24,719	1,921,257	990,990	954,986	1,477,091	468,885
Firms	351,971	3135	348,836	128,402	223,569	267,559	91,305
<i>R</i> <sup>2</sup>	0.1226	0.1641	0.1266	0.1884	0.1449	0.1192	0.1044

Note: Estimations are based on the Business Structure Database (BSD) between 1997 and 2013 using an ordinary least squares (OLS) first-difference model with firm, region, industry and year fixed-effects. Robust standard errors clustered at the region, industry and year level are reported in parentheses. Statistical significance levels: \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ . Other control variables included but not reported: firm employment, labour productivity, age, foreign ownership and group participation; region–industry employment growth, labour productivity growth, net entry rate, and research and development (R&D) intensity.

**Table 3.** Region–industry spillovers effect of fast-growing firms (SGHs) on the productivity growth of non-fast-growth firms in the manufacturing sectors.

	(1) Manufacturing	(2) Large	(3) SME	(4) Old	(5) Young	(6) Low-tech	(7) High-tech
<i>Horiz.SGH<sub>rst</sub></i>	0.0122** (0.00545)	0.178*** (0.0415)	0.00947* (0.00550)	−0.00486 (0.00681)	0.0327*** (0.00870)	0.0170** (0.00766)	0.00652 (0.00798)
<i>Forw.SGH<sub>rst</sub></i>	−0.00171 (0.00163)	0.00678 (0.0118)	−0.00182 (0.00164)	0.00118 (0.00198)	0.00505* (0.00268)	0.00248 (0.00198)	0.00808** (0.00315)
<i>Backw.SGH<sub>rst</sub></i>	0.00290** (0.00142)	0.0360 (0.0203)	0.00344** (0.00143)	0.00459*** (0.00169)	0.000571 (0.00241)	0.000967 (0.00164)	0.00549* (0.00318)
<i>Horiz.SGH#Aggl<sub>rst</sub></i>	−0.511 (1.509)	21.70 (13.31)	−0.769 (1.518)	−3.389 (1.963)	3.087 (2.242)	−1.580 (1.936)	2.731 (2.527)
<i>Forw.SGH#Aggl<sub>rst</sub></i>	0.225 (0.496)	3.604 (3.760)	0.131 (0.498)	0.182 (0.609)	0.109 (0.797)	0.328 (0.562)	1.481 (1.097)
<i>Backw.SGH#Aggl<sub>rst</sub></i>	0.991** (0.399)	−6.680 (3.536)	1.069*** (0.401)	1.630*** (0.485)	−0.0102 (0.656)	1.196*** (0.435)	−1.091 (1.035)
<i>Agglom.Index<sub>rst</sub></i>	0.585** (0.211)	0.403 (2.113)	0.526** (0.218)	0.653 (0.512)	0.512 (0.648)	0.933** (0.454)	−0.857 (1.029)
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region–industry controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,889,243	20,707	1,868,536	962,391	926,852	1,437,390	451,853
Firms	349,496	3089	346,407	127,185	222,311	266,541	90,006
<i>R</i> <sup>2</sup>	0.2108	0.1815	0.2114	0.2021	0.2212	0.2153	0.2050

Note: Estimations are based on the Business Structure Database (BSD) between 1997 and 2013 using an ordinary least squares (OLS) first-difference model with firm, region, industry and year fixed-effects. Robust standard errors clustered at the region, industry and year level are reported in parentheses. Statistical significance levels: \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ . Other control variables included but not reported: firm employment, labour productivity, age, foreign ownership and group participation; region–industry employment growth, labour productivity growth, net entry rate, and research and development (R&D) intensity.

through within-organization efficiency improvements (Abukabarr & Mitra, 2017; Schmitz, 2005).

Along the vertical supply chain, higher incidence rates of backwards fast-growth firms seem to stimulate strong positive effects for non-fast-growth firms' productivity growth downwards, especially for small, old and high-tech firms. The positive spillover effect of fast-growth incidence along supply chains echoes the recent evidence suggesting knowledge externalities between fast-growth suppliers and non-fast-growth customers (Isaksson, Simeth, & Seifert, 2016). In addition, we find a positive and significant moderating effect of agglomeration for the fast-productivity-growth backward externalities on non-fast-growth customers. Higher fast-growth among suppliers stimulates productivity improvement of other firms in more agglomerated industries-regions (De Silva & McComb, 2012; Sena et al., 2013).

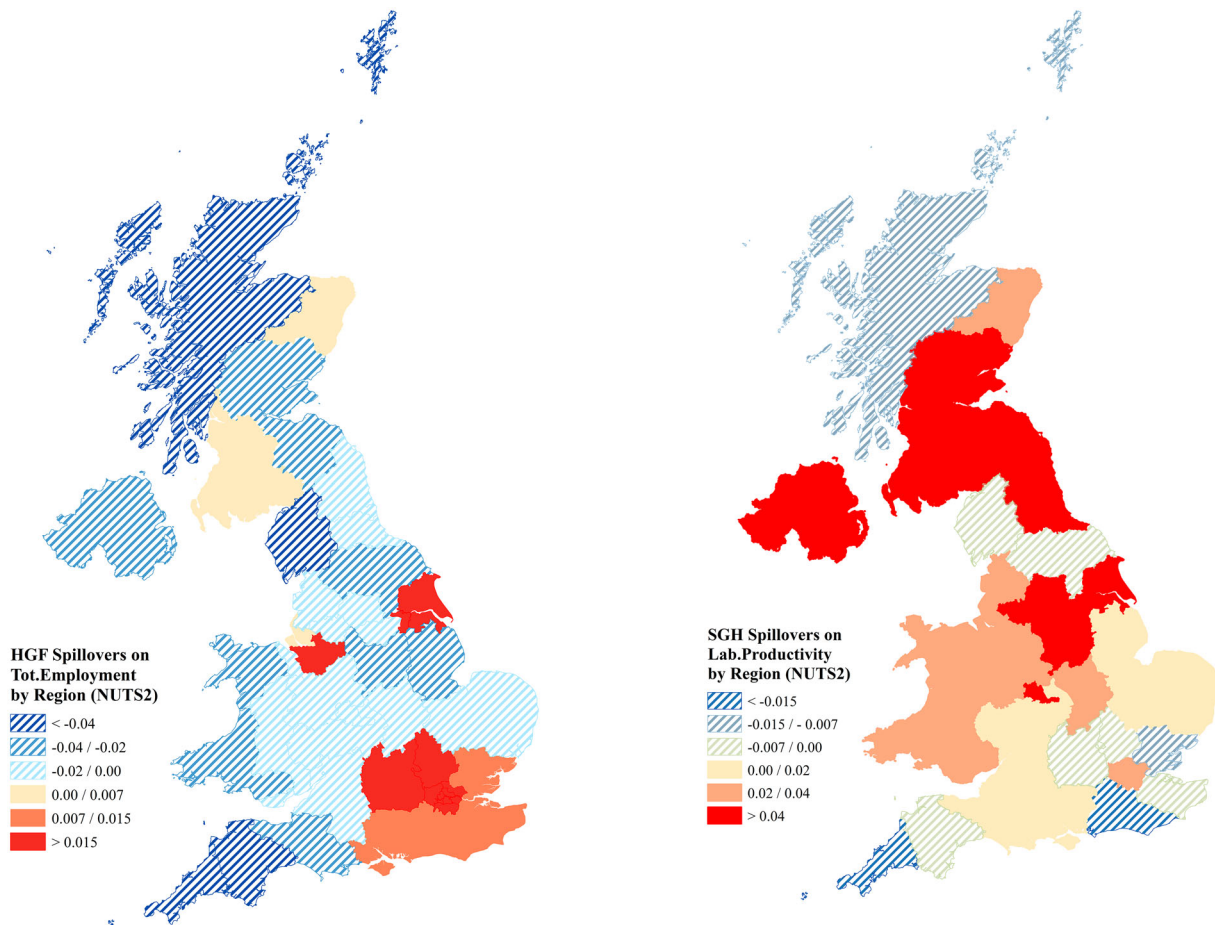
Overall, the results highlight different externality channels through which fast-growth firms affect vertically integrated industries. On the one hand, employment growth externalities are linked to agglomeration economies and fast-growth-driven increased demand in downstream sectors. On the other hand, productivity spillovers through

agglomeration economies seem more likely to be knowledge and technology driven, originating from fast-growth suppliers (Grillitsch & Nilsson, 2019).

The findings from our baseline specifications are robust and consistent with the results of the GMM and ML estimations provided in Table A2 in Appendix A in the supplemental data online. Even when considering the hierarchical nature of the main variables of interest, and after instrumenting the possible endogenous variables with their lagged values, we find consistent evidence that fast-growth firms have negative externalities for the employment growth of other firms, while there are positive spillovers in terms of productivity. Finally, the results are also robust in relation to potential selection-bias driven by the exit of less productive non-fast-growth firms. Both approaches, developed in Table A3 in Appendix A online to control for this issue, show consistent results with our baseline specifications, corroborating the overall robustness of our econometric methodology.<sup>11</sup>

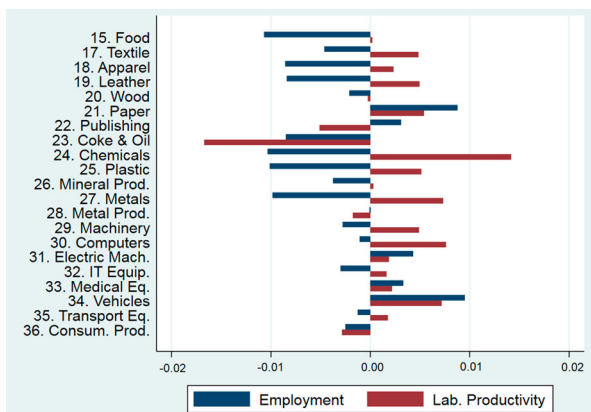
### Spatial and industrial heterogeneity

Based on the previous estimates, Figures 2 and 3 analyse the spatial and industrial heterogeneity of horizontal fast-



**Figure 2.** Average marginal effect of horizontal fast-growth spillovers on employment and productivity growth per region (NUTS-2 level).

Note: The marginal effects of the impact of horizontal fast-growth industry-region spillovers aggregated at the NUTS-2 level were estimated using an ordinary least squares (OLS) first-difference fixed-effects model. Fast-growth firms are defined as super-growth heroes (SGHs) for the productivity growth models and as high-growth firms (HGFs) for the employment growth models.



**Figure 3.** Average marginal effect of horizontal fast-growth spillovers on employment and productivity growth per industry (SIC2 level).

Note: The marginal effects of the impact of fast-growth industry–region spillovers aggregated at the industry SIC2 level were estimated using an ordinary least squares (OLS) first-difference fixed-effects model. Fast-growth firms are defined as super-growth heroes (SGHs) for the productivity growth models and as high-growth firms (HGFs) for the employment growth models.

growth externalities. At the regional level, [Figure 2](#) shows that the negative externalities on the employment growth of non-fast-growth firms are stronger in peripheral areas, as the South West, Scotland and Cumbria, where local labour markets are less developed, and the costs of labour poaching and concentration are higher because of the particularly fierce competition of fast-growth firms (Sena et al., 2013). In contrast, the positive spillover effect of fast-productivity growth is more evenly scattered across the UK, with particularly strong positive externalities for productivity growth in the Greater Birmingham area, East Midlands, Yorkshire, Newcastle and South of Scotland, especially in highly agglomerated areas in line with previous evidence (Coad et al., 2014a; Stam, 2005).

Turning to the industrial distribution, [Figure 3](#) shows that the industries mostly negatively affected in terms of employment growth by fast-growth spillovers are the fuels, apparel, mineral products and food-processing sectors. On the contrary, the automotive industry, the sector producing medical and precision instruments, and electric machinery industries seem to benefit the most in terms of employment spillovers. These findings suggest an overall negative spillover effect, especially on employment growth in medium-low-tech sectors, highlighting a concentration of the labour share in these sectors to a smaller number of fast-growth companies (Autor et al., 2017). On the contrary, medium-high-tech manufacturing sectors seem to experience positive externalities from fast-growth firms in terms of employment growth, in line with previous predictions (Grillitsch & Nilsson, 2019; Moreno & Coad, 2015). Productivity spillovers seem to follow a similar pattern, with strong positive effects for the machinery, metals, computers and information technology equipment industries, and a negative effect for the medium-low-tech sectors of leather, apparel and oil. These findings suggest that

positive fast-growth externalities are more relevant in high-tech sectors, propagated through external collaborations between firms, and strongly relying on the internal absorptive capacity of non-fast-growth firms needed to internalize the spillovers (De Silva & McComb, 2012; Sena et al., 2013).

## CONCLUSIONS

This is the first study to evaluate the agglomeration externalities of fast-growth firms. Overall, we find that a higher incidence of fast-employment growth has negative spillover effects on employment growth at the horizontal level, while a higher incidence of fast-productivity growth generates positive spillover effects in terms of labour productivity.

Furthermore, we find positive inter-industry externalities: high-employment-growth firms in the downstream sectors have positive demand-driven spillover effects on employment in upstream sectors, while backwards productivity externalities from fast-growth firms in upstream sectors are mainly relevant to non-fast-growth customers. These findings are more pronounced among small and old firms, in both low- and high-tech sectors. In addition, agglomeration plays an important role in mediating these externalities, with spatially heterogeneous effects driven by stronger negative externalities on employment growth in peripheral regions, and with positive spillover effects, in terms of both employment and productivity growth, in densely agglomerated regions and industries.

The results highlight several policy implications. First, the policy goals of job creation and productivity growth might not always be complementary. While national and subnational policies might be designed to promote fast growth, it is important to understand the indirect implications for the employment and productivity growths of non-fast-growth firms.

Second, having more fast-productivity-growth firms in a region is beneficial for the productivity growth of other firms overall. However, more fast-employment-growth firms may put a strain on other firms' abilities to attract workers and to upscale. This points to the skills and labour competition between employers in places experiencing skill shortages, skill mismatches and the local labour market-sorting problems. The imbalance between skill supply and skill demand is a longstanding challenge faced by the UK. Reforms and investment have been put in place by all previous governments to address these issues, but with limited success (Payne & Keep, 2011; Sissons & Jones, 2016). More promising policy designs would lean towards subnational approaches that emphasize place-based strategies to diagnose local labour market imbalances (Green, 2012), emphasize demand-led skills development (Froy, 2013), and improve local skills utilization and integration (Sissons & Jones, 2016).

Third, the externalities of the fast-growth phenomenon are highly heterogeneous across industries, positions in the supply chains, firms and regional characteristics. This variability should be considered when designing specific policy instruments. This lends clear support to linking



industrial strategy with skills policy, aiming to drive regional economic growth (Payne & Keep, 2011). However, demand-driven skills development is crucial in responding to specific needs of skills for workplace and fast-pacing technological changes.

Research on fast-growth firms needs to go beyond the within-firm growth analysis to understand better the overall welfare effect of the fast-growth phenomenon on the economy. Future research needs to analyse further the specific mechanisms through which the agglomeration externalities related to fast-growth firms operate, both within and across industries and regions, given their increasing relevance in the economy. This will then help to design appropriate policies to promote long-term and balanced growth.

## ACKNOWLEDGEMENTS

The authors appreciate all the comments and suggestions received at the UK Enterprise Research Centre (ERC) stakeholder meetings and Annual Conference 2017, Regional Studies Association (RSA) Winter Conference 2017, Associations of American Geographers (AAG) Annual Conference 2017, and the RSA Conference 2017. The views expressed in the paper are those of the authors and do not necessarily represent those of the funders. The UK statistical data used in this study are from the Office for National Statistics (ONS) and are Crown copyright and reproduced with the permission of the controller of HMSO and the Queen's Printer for Scotland. The use of the ONS statistical data in this work does not imply the endorsement of the ONS in relation to the interpretation or analysis of the statistical data. This work uses research data sets that may not exactly reproduce National Statistics aggregates.

## DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

## FUNDING

The study was funded by the UK Economic and Social Research Council (ESRC) [grant number ES/R010129/5]; the Department for Business, Energy & Industrial Strategy; Innovate UK; and the British Business Bank through the UK Enterprise Research Centre (ERC). The financial and other support provided by the funders is fully acknowledged.

## NOTES

1. Other frequently used definitions of fast-growth firms in the literature are high-growth firms (Eurostat-OECD, 2007), high-impact firms (Acs et al., 2008), high-employment growth firms (Clayton et al., 2013), growth-heroes

(Du & Bonner, 2016), high-growth entrepreneurs (Audretsch, 2012) and gazelles (Acs et al., 2008).

2. Manufacturing sectors include all industries with an SIC (2003) code between 15 and 36. Firms with more than 250 employees are considered to be large, otherwise they are SMEs. Firms operating for more than five years are considered old, and young otherwise. Following the Eurostat classification, manufacturing high-tech firms have SIC codes (2003) equal to: (24) chemicals and pharmaceuticals; (29) machinery and engineering; (30) computers and office machinery; (31) electrical machinery; (32) information technology (IT) and communication equipment; (33) medical, precision and optical instruments; (34) motor vehicles; and (35) transport equipment.

3. As a robustness check, we estimated the vertical industrial integration externalities also at the sector-country level, considering the incidence of fast-growth suppliers and customers located across the country. These results are consistent and are available from the authors upon request.

4. The Business Structure Database does not provide enough information to estimate total factor productivity (TFP) for the population of businesses in the UK, and thus we rely on labour productivity. Using the Annual Business Survey (ONS, 2019), we have replicated our baseline specifications estimating TFP, but only for a limited sample of firms (around 12,000). The results (available from authors upon request) are consistent with the main findings, indicating that turnover per employee can be used in this case as a good proxy for productivity.

5. We also estimate the spillover effects of HGFs' externalities on the labour productivity growth of non-HGFs and the impact of SGHs' externalities on the employment growth of non-HGFs. The results are robust with respect to the main findings and are available from the authors upon request.

6. To test the robustness of the results and to control for potential omitted variable bias, additional checks also included in the estimations the level of unemployment, the share of population with a tertiary education degree and the gross domestic product (GDP) growth at the NUTS-2 level, as well as region-year and industry-year fixed effects, in order to take into account further region- and industry-specific time trends. The results (available from the authors upon request) show that the inclusion of these additional control variables and fixed effects does not affect the precision and significance of the estimates.

7. The Ellison and Glaeser (1997) region-industry agglomeration index is measured as the difference between the squared share of employment of an industry ( $s$ ) in a given region ( $r$ ) and the squared share of employment of a region ( $r$ ) in the country divided by the squared share of employment of the industry ( $s$ ) in the country and by the Herfindhal index of industrial concentration.

8. Additional results (available from the authors upon request) show that the methodology is robust with regard to the use of variables in levels rather than differences.

9. Given the partial effect of the change in employment growth rate with respect to the change in the proportion

of high growth is estimated at 0.082% and the known sample mean of employment growth at 0.477%, the predicted change in employment level is estimated at 0.48%, which is  $(1 + 0.082\%) \times 0.477\%$ . A rough calculation of the employment level with a decrease of 0.48% for an average firm size of 21 employees and an average number of firms in the sample of 352,000 a year is then 35,288 fewer jobs.

10. The existing evidence suggests that fast-employment-growth firms (HGFs) generate the majority of all new jobs in the UK. For the period 2006–08, of the 2.4 million new jobs created by businesses employing 10 or more people, about 1.3 million were created by fast-growth firms, equating to roughly 54% of the total (NESTA, 2009).

11. In additional robustness tests we controlled for the possibility of a time lag in the materialization of knowledge spillovers by lagging the main independent variables (the fast growth spillovers) by up to three years. In addition, we tested the sensitivity of the results using the levels of variables rather than first differences as the main regressors in the specifications. The results for both robustness tests are very similar and consistent with the main findings, and are available from the authors upon request.

## ORCID

Jun Du  <http://orcid.org/0000-0002-0449-4437>

Enrico Vanino  <http://orcid.org/0000-0002-4740-1501>

## REFERENCES

- Abukabarr, Y. A., & Mitra, J. (2017). Knowledge spillovers and high-impact growth: Comparing local and foreign firms in the UK. *Journal of International Entrepreneurship*, 15(53), 1–32. <https://doi.org/10.1007/s10843-016-0195-7>
- Acs, Z. J., Desai, S., & Hessels, J. (2008). Entrepreneurship, economic development and institutions. *Small Business Economics*, 31(3), 219–234. <https://doi.org/10.1007/s11187-008-9135-9>
- Anyadike-Danes, M., Bonner, K., & Hart, M. (2013). *Exploring the incidence and spatial distribution of high growth firms in the UK and their contribution to job creation* (Working Paper No. 13/05). National Endowment for Science, Technology and the Arts (NESTA).
- Anyadike-Danes, M., & Hart, M. (2018). All grown up? The fate after 15 years of a quarter of a million UK firms born in 1998. *Journal of Evolutionary Economics*, 28(1), 45–76. <https://doi.org/10.1007/s00191-017-0549-x>
- Anyadike-Danes, M., Hart, M., & Du, J. (2015). Firm dynamics and job creation in the United Kingdom: 1998–2013. *International Small Business Journal: Researching Entrepreneurship*, 33(1), 12–27. <https://doi.org/10.1177/0266242614552334>
- Arauzo-Carod, J.-M., Liviano-Solis, D., & Manjón-Antolín, M. (2010). Empirical studies in industrial location: An assessment of their methods and results. *Journal of Regional Science*, 50(3), 685–711. <https://doi.org/10.1111/j.1467-9787.2009.00625.x>
- Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *Review of Economic Studies*, 58(2), 277–297. <https://doi.org/10.2307/2297968>
- Audretsch, D. B. (2012). Determinants of high-growth entrepreneurship. In *Report prepared for the OECD/DBA International Workshop on High-growth firms: Local policies and local determinants*.
- Audretsch, D. B., & Dohse, D. (2007). Location: A neglected determinant of firm growth. *Review of World Economics*, 143(1), 79–107. <https://doi.org/10.1007/s10290-007-0099-7>
- Autor, D., Dorn, D., Katz, L. F., Patterson, C., & Van Reenen, J. (2017). *Concentrating on the fall of the labor share* (Working Paper No. 23108). National Bureau of Economic Research (NBER).
- Bertinelli, L., & Black, D. (2004). Urbanization and growth. *Journal of Urban Economics*, 56(1), 80–96. <https://doi.org/10.1016/j.jue.2004.03.003>
- Bleda, M., & Del Rio, P. (2013). The market failure and the systemic failure rationales in technological innovation systems. *Research Policy*, 42(5), 1039–1052. <https://doi.org/10.1016/j.respol.2013.02.008>
- Broersma, L., & Van Dijk, J. (2007). The effect of congestion and agglomeration on multifactor productivity growth in Dutch regions. *Journal of Economic Geography*, 8(2), 181–209. <https://doi.org/10.1093/jeg/lbm041>
- Brown, R., & Mawson, S. (2016). Targeted support for high growth firms: Theoretical constraints, unintended consequences and future policy challenges. *Environment and Planning C: Government and Policy*, 34(5), 816–836. <https://doi.org/10.1177/0263774X15614680>
- Brown, R., Mawson, S., & Mason, C. (2017). Myth-busting and entrepreneurship policy: The case of high growth firms. *Entrepreneurship and Regional Development*, 29(5–6), 414–443. <https://doi.org/10.1080/08985626.2017.1291762>
- Calvo, G. A., & Coulter, S. (2017). *Industrial transformation in the aftermath of the crisis: an empirical analysis of industrial policies in France, Germany, Spain and the United Kingdom* (CES Open Forum Series No. 28). Center for European Studies at Harvard University.
- Clayton, R., Sadeghi, A., Spletzer, J., & Talan, D. (2013). High-employment growth firms: Defining and counting them. *Monthly Labor Review*, 3–13. Retrieved from <https://www.bls.gov/opub/mlr/2013/article/clayton.htm>
- Coad, A. (2009). *The growth of firms: A survey of theories and empirical evidence*. Edward Elgar.
- Coad, A., Cowling, M., & Siepel, J. (2012). *Growth processes of high-growth firms in the UK* (Working Paper No. 12/10). National Endowment for Science, Technology and the Arts (NESTA).
- Coad, A., Daunfeldt, S. O., Hölzl, W., Johansson, D., & Nightingale, P. (2014a). High-growth firms: Introduction to the special section. *Industrial and Corporate Change*, 23(1), 91–112. <https://doi.org/10.1093/icc/dtt052>
- Coad, A., Daunfeldt, S. O., Johansson, D., & Wennberg, K. (2014b). Whom do high-growth firms hire? *Industrial and Corporate Change*, 23(1), 293–327. <https://doi.org/10.1093/icc/dtt051>
- Coad, A., Frankish, J., Roberts, R. G., & Storey, D. J. (2013). Growth paths and survival chances: An application of Gambler's Ruin theory. *Journal of Business Venturing*, 28(5), 615–632. <https://doi.org/10.1016/j.jbusvent.2012.06.002>
- Combes, P. P., & Duranton, G. (2006). Labour pooling, labour poaching, and spatial clustering. *Regional Science and Urban Economics*, 36(1), 1–28. <https://doi.org/10.1016/j.regsciurbeco.2005.06.003>
- Combes, P. P., & Gobillon, L. (2015). The empirics of agglomeration economies. *Handbook of Regional and Urban Economics*, 5, 247–348. <https://doi.org/10.1016/B978-0-444-59517-1.00005-2>
- Daunfeldt, S. O., Elert, N., & Johansson, D. (2014). The economic contribution of high-growth firms: Do policy implications depend on the choice of growth indicator? *Journal of Industry, Competition and Trade*, 14(3), 337–365. <https://doi.org/10.1007/s10842-013-0168-7>
- Daunfeldt, S. O., & Halvarsson, D. (2015). Are high-growth firms one-hit wonders? Evidence from Sweden. *Small Business*

- Economics*, 44(2), 361–383. <https://doi.org/10.1007/s11187-014-9599-8>
- De Groot, H. L. F., Poot, J., & Smit, M. J. (2009). Agglomeration externalities, innovation and regional growth: Theoretical perspectives and meta-analysis. In R. Capello & P. Nijkamp (Eds.), *Handbook of regional growth and development theories* (pp. 256–281). Edward Elgar.
- Denrell, J. (2004). Random walks and sustained competitive advantage. *Management Science*, 50(7), 922–934. <https://doi.org/10.1287/mnsc.1030.0143>
- De Silva, D. G., & McComb, R. P. (2012). Geographic concentration and high tech firm survival. *Regional Science and Urban Economics*, 42(4), 691–701. <https://doi.org/10.1016/j.regsciurbeco.2012.03.001>
- Du, J., & Bonner, K. (2016). *Decomposing UK aggregate labour productivity and growth: 1998–2013 using the ONS Business Structure Database data* (Research Paper No. 48). UK Enterprise Research Centre (ERC).
- Du, J., & Bonner, K. (2017). *Fast-growth firms in the UK: Definitions and policy implications* (Research Paper No. 63). UK Enterprise Research Centre (ERC).
- Duranton, G., & Puga, D. (2004). Micro-foundations of urban agglomeration economies. *Handbook of Regional and Urban Economics*, 4, 2063–2117. [https://doi.org/10.1016/S1574-0080\(04\)80005-1](https://doi.org/10.1016/S1574-0080(04)80005-1)
- Duschl, M., Scholl, T., Brenner, T., Luxen, D., & Raschke, F. (2015). Industry-specific firm growth and agglomeration. *Regional Studies*, 49(11), 1822–1839. <https://doi.org/10.1080/00343404.2013.861059>
- Ellison, G., & Glaeser, E. L. (1997). Geographic concentration in U.S. manufacturing industries: A dartboard approach. *Journal of Political Economy*, 105(5), 889–927. <https://doi.org/10.1086/262098>
- Eurostat-OECD. (2007). *Eurostat-OECD manual on business demography statistics*. Office for Official Publications of the European Communities.
- Foster, L., Haltiwanger, J., & Krizan, C. J. (2001). Aggregate productivity growth: Lessons from microeconomic evidence. In C. R. Hulten, E. R. Dean, & M. J. Harper (Eds.), *New developments in productivity analysis* (pp. 303–363). University of Chicago Press.
- Frenken, K., Van Oort, F., & Verburg, T. (2007). Related variety, unrelated variety and regional economic growth. *Regional Studies*, 41(5), 685–697. <https://doi.org/10.1080/00343400601120296>
- Froy, F. (2013). Global policy developments towards industrial policy and skills: Skills for competitiveness and growth. *Oxford Review of Economic Policy*, 29(2), 344–360. <https://doi.org/10.1093/oxrep/grt020>
- Fujita, M., Krugman, P. R. & Venables, A. (1999). *The spatial economy: Cities, regions, and international trade*. MIT Press.
- Gelman, A., & Hill, J. (2007). *Data analysis using regression and multilevel/hierarchical models*. Cambridge University Press.
- Glaeser, E., Kallal, H., Scheinkman, J., & Schleifer, A. (1992). Growth in cities. *Journal of Political Economy*, 100(1992), 1126–1152. <https://doi.org/10.1086/261856>
- Glaeser, E., & Resseger, M. G. (2010). The complementarity between cities and skills. *Journal of Regional Science*, 50(1), 221–244. <https://doi.org/10.1111/j.1467-9787.2009.00635.x>
- Green, A. E. (2012). *Skills for competitiveness: Country report for United Kingdom, OECD LEED Programme Report*. OECD.
- Grillitsch, M., & Nilsson, M. (2019). Knowledge externalities and firm heterogeneity: Effects on high and low growth firms. *Papers in Regional Science*, 98(1), 93–114. <https://doi.org/10.1111/pirs.12342>
- Haltiwanger, J., Jarmin, R. S., & Miranda, J. (2013). Who creates jobs? Small versus large versus young. *Review of Economics and Statistics*, 95(2), 347–361. [https://doi.org/10.1162/REST\\_a\\_00288](https://doi.org/10.1162/REST_a_00288)
- Hart, M., & Anyadike-Danes, M. (2015). *Contribution to job creation by high growth SMEs* (ERC Insight Report. July).
- Haskel, J., Hawkes, D., & Pereira, S. C. (2005). *Skills, human capital and the plant productivity gap: UK evidence from matched plant, worker and workforce data* (Discussion Paper No. 5334). Centre for Economic Policy Research (CEPR).
- Heckman, J. (1979). Sample selection bias as a specification error. *Econometrica*, 47(1), 153–161. <https://doi.org/10.2307/1912352>
- Helsley, R. W., & Strange, W. C. (1990). Matching and agglomeration economies in a system of cities. *Regional Science and Urban Economics*, 20(2), 189–212. [https://doi.org/10.1016/0166-0462\(90\)90004-M](https://doi.org/10.1016/0166-0462(90)90004-M)
- Henrekson, M., & Johansson, D. (2010). Gazelles as job creators: A survey and interpretation of the evidence. *Small Business Economics*, 35(2), 227–244. <https://doi.org/10.1007/s11187-009-9172-z>
- Hölzl, W. (2014). Persistence, survival, and growth: A closer look at 20 years of fast-growth firms in Austria. *Industrial and Corporate Change*, 23(1), 199–231. <https://doi.org/10.1093/icc/dtt054>
- Humphrey, J., & Schmitz, H. (2002). How does insertion in global value chains affect upgrading in industrial clusters? *Regional Studies*, 36(9), 1017–1027. <https://doi.org/10.1080/0034340022000022198>
- Isaksson, O. H., Simeth, M., & Seifert, R. W. (2016). Knowledge spillovers in the supply chain: Evidence from the high tech sectors. *Research Policy*, 45(3), 699–706.
- Jabbour, L., & Mucchielli, J. L. (2007). Technology transfer through vertical linkages: The case of the Spanish manufacturing industry. *Journal of Applied Economics*, 10(1), 115–136. <https://doi.org/10.1080/15140326.2007.12040484>
- Jacobs, J. (1969). *The economy of cities*. Random House.
- Javorcik, B. S. (2004). Does foreign direct investment increase the productivity of domestic firms? In search of spillovers through backward linkages. *American Economic Review*, 94(3), 605–627.
- Kemeny, T. (2017). Immigrant diversity and economic performance in cities. *International Regional Science Review*, 40(2), 164–208. <https://doi.org/10.1177/0160017614541695>
- Lawless, M. (2014). Age or size? Contributions to job creation. *Small Business Economics*, 42(4), 815–830. <https://doi.org/10.1007/s11187-013-9513-9>
- Leitch, C., Hill, F., & Neergaard, H. (2010). Entrepreneurial and business growth and the quest for a ‘comprehensive theory’: Tilting at windmills? *Entrepreneurship Theory and Practice*, 34, 249–260. <https://doi.org/10.1111/j.1540-6520.2010.00374.x>
- Li, M. (2016). Location determinants of high-growth firms. *Entrepreneurship and Regional Development*, 28(1–2), 97–125. <https://doi.org/10.1080/08985626.2015.1109003>
- Marshall, A. (1920). *Principles of economics*. Macmillan.
- Mason, C., & Brown, R. (2013). Creating good public policy to support high-growth firms. *Small Business Economics*, 40(2), 211–225. <https://doi.org/10.1007/s11187-011-9369-9>
- Moreno, F., & Coad, A. (2015). High-growth firms: Stylized facts and conflicting results. In C. A. Corbett, J. A. Katz, & A. McKelvie (Eds.), *Entrepreneurial growth: Individual, firm, and region* (pp. 187–230). Emerald.
- Morris, D., Vanino, E., & Corradini, C. (Forthcoming 2019). Effect of regional skill gaps and skill shortages on firm productivity. *Environment and Planning A: Economy and Space*. <https://doi.org/10.1177/0308518X19889634>
- National Endowment for Science, Technology and the Arts (NESTA). (2009). *The Vital 6 per cent. How high-growth innovative business generate prosperity and jobs*.
- Neffke, F., Henning, M., & Boschma, R. (2011). How do regions diversify over time? Industry relatedness and the development of new growth paths in regions. *Economic Geography*, 87(3), 237–265. <https://doi.org/10.1111/j.1944-8287.2011.01121.x>



- Office for National Statistics (ONS). (2017). *Business Structure Database, 1997–2017: Secure Access. 9th edition* (UK Data Service SN: 6697).
- Office for National Statistics (ONS). (2018). *UK Innovation Survey, 1994–2016: Secure Access. 6th edition* (UK Data Service. SN: 6699).
- Office for National Statistics (ONS). (2019). *Annual Business Survey, 2008–2017: Secure Access. 10th edition* (UK Data Service. SN: 7451).
- Organisation for Economic Co-operation and Development (OECD). (2013). *Entrepreneurship at a glance 2013*. OECD Publ.
- Parsley, C., & Halabisky, D. (2008). *Profile of growth firms: A summary of Industry Canada research*. Industry Canada, Small Business Research and Statistics.
- Payne, J., & Keep, E. (2011). *One step forward, two steps back? Skills policy in England under the coalition government* (SKOPE Research Paper No. 102). Centre on Skills, Knowledge and Organisational Performance (SKOPE).
- Polanyi, M. (1967). *The tacit dimension*. Doubleday.
- Porter, M. (1990). *The competitive advantage of nations*. Free Press.
- Raspe, O., & Van Oort, F. (2007). *What when space matters little for firm productivity? A multilevel analysis of localised knowledge externalities* (Papers in Evolutionary Economic Geography (PEEG) No. 0706). Utrecht University, Section of Economic Geography.
- Schmitz, J. A. (2005). What determines productivity? Lessons from the dramatic recovery of the U.S. And Canadian iron ore industries following their early 1980s crisis. *Journal of Political Economy*, 113(3), 582–625. <https://doi.org/10.1086/429279>
- Sena, V., Hart, M., & Bonner, K. (2013). *Innovation and UK high-growth firms* (Working Paper No. 13/12). National Endowment for Science, Technology and the Arts (NESTA).
- Shepherd, D., & Wiklund, J. (2009). Are we comparing apples with apples or apples with oranges? Appropriateness of knowledge accumulation across growth studies. *Entrepreneurship Theory and Practice*, 33(1), 105–123. <https://doi.org/10.1111/j.1540-6520.2008.00282.x>
- Sissons, P., & Jones, K. (2016). Local industrial strategy and skills policy in England: Assessing the linkages and limitations—a case study of the Sheffield City Deal. *Local Economy: Journal of the Local Economy Policy Unit*, 31(8), 857–872. <https://doi.org/10.1177/0269094216679602>
- Srholec, M. (2010). A multilevel approach to geography of innovation. *Regional Studies*, 44(9), 1207–1220. <https://doi.org/10.1080/00343400903365094>
- Stam, E. (2005). The geography of gazelles in the Netherlands. *Tijdschrift voor Economische en Sociale Geografie*, 96(1), 121–127. <https://doi.org/10.1111/j.1467-9663.2005.00443.x>
- Storey, D. J., & Greene, F. J. (2010). *Small business and entrepreneurship*. Financial Times/Prentice Hall.
- Storper, M., & Venables, A. J. (2004). Buzz: Face-to-face contact and the urban economy. *Journal of Economic Geography*, 4(4), 351–370. <https://doi.org/10.1093/jnlcgl/lbh027>
- Syverson, C. (2011). What determines productivity? *Journal of Economic Literature*, 49(2), 326–365. <https://doi.org/10.1257/jel.49.2.326>
- Windmeijer, F. (2006). *GMM for panel count data models* (Bristol Economics Discussion Papers No. 06/591). Department of Economics, University of Bristol.