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## ABSTRACT

While a small group of fast-growth firms create a disproportionately large number of new jobs, there is also evidence of an increasing concentration of sales within these superstar firms associated with an overall decline in labour share. This study investigates the links between fast-growth firms and the rest of the economy using comprehensive UK firm-level data. First, we provide evidence of direct spillover effects of fast-growth firms for other firms within a region and industry. We find that in the manufacturing sectors, higher incidence rate of fast employment growth firms has an overall negative effect on the employment growth of other firms in the same industry-region (a competition-led crowding-out effect). A higher incidence rate of fast labour productivity growth firms instead has overall positive externalities on other firms' labour productivity. This suggests that the policy goals of promoting jobs and promoting productivity are not always complementary, and may in fact conflict. Analysis of professional service sectors yields different patterns, highlighting the distinct features of the sectors and the specific challenges faced by the firms. Moreover, we analyse the heterogeneity of these externalities across industries, the position in the production value chain, firm age and size, specific geographical location, and the degree of agglomeration.

Key words: Fast-growth, Externalities, Firm heterogeneity, Spatial agglomeration, Spillovers

CONTENTS

## 1. INTRODUCTION

The phenomenon of fast-growth firms with their exceptional growth and disproportionately high rate of jobs creation has caught the attention of policy makers and academic researchers alike over the past decade (Anyadike-Danes et al. 2009; Anyadike-Danes et al. 2013; Anyadike-Danes et al. 2015; Anyadike-Danes and Hart, 2015). In particular, since the recent financial crisis, fast-growth firms are considered to be a viable option to foster economic recovery, becoming central to the political debate on economic performance and industrial resilience (Anyadike-Danes et al., 2009; Storey and Greene, 2010; Coad et al., 2014; Mason and Brown, 2013; Bleda et al., 2013; OECD, 2013; Brown et al., 2014; Brown et al., 2017; Anyadike-Danes and Hart, 2017). Despite this interest, the existing literature has so far focused almost exclusively on the characteristics of fast-growth firms, seeking to identify the drivers and their characteristics. Recent evidence shows that firm growth is highly discontinuous and the fast-growth patterns are hard to predict (Haltiwanger et al 2013; Lawless 2014; Hölzl, 2014; Daunfeldt and Halvarsson, 2014).

Taking a different approach, some recent studies have started to look at the fast-growth phenomenon from a regional perspective. This is motivated by the mounting evidence that geographical characteristics play an important role in nurturing and promoting fast-growth firms, particularly through location-specific strategies, regional characteristics, and industrial agglomeration and specialization (Stam, 2005; Duschl et al 2015; Friesenbichler and Hoelzl, 2016). We have adopted this line of enquiry and shifted our research focus to attempting to understand what high growth firm phenomenon means for regional growth.

Further, in the context of the rising regional inequalities across the UK, it is increasingly important to understand the wider implications of the fast-growth phenomenon for the overall regional growth (McCann, 2016). While there is a policy objective to assist firms to achieve fast-growth, it is useful to know if there are any “side effects” on jobs and the productivity of other firms in the same region and sector. As such, this research can also be seen as a contribution to the on-going debates on the productivity conundrum and the discussions about meeting the challenges raised by the UK’s new industry strategy.

The idea that region-specific characteristics affect firms’ productivity and competitiveness is well-established in regional science, with both theoretical and empirical analysis focusing on geographical factors and spillover effects arising from

location externalities, industrial spatial agglomeration, and diversification (Jacobs, 1969; Glaeser et al 1992; Frenken et al. 2007; Boschma, 2016). However, to date, there are very few studies that explicitly test the relevance of fast-growth firms externalities in a region and their economic significance within the industrial sector or along supply chains (Abukabar and Mitra, 2017).

Our empirical investigation attempts to fill these gaps by analysing the spillover effects of fast-growth firms on the economic performance of non-fast-growth firms. We identify the main channels through which fast-growth firms affect the productivity gains and job creation of other firms in various regions and industries across the UK. Our main research question focuses on how fast-growth firms indirectly promote productivity and employment growth in the wider economy, analysing how the fast-growth externalities act, and if they spread through a range of channels such as industrial competition, vertical integration, or spatial agglomeration and diversification. To the best of our knowledge this is the first study to look at the spillover effects of fast-growth firms in detail, linking fast-growth and industrial externality theories so as to identify the main externalities of the presence of fast-growth and their spillover effects on surrounding firms and related industries.

By linking the ONS Business Structure Database (BSD) with additional data at the industrial and regional level over the period 1997-2013, we test three channels through which fast-growth firms may affect the productivity and employment growth of other firms, considering industrial spillovers at the horizontal level within the same industry, externalities across vertically-integrated industrial value chain, and Jacobsian location externalities. We define fast-growth firms in two ways. First, the employment-based OECD high-growth firm definition (OECD-HGF), and second, the labour productivity-based super-growth heroes definition (SGH) (Du and Bonner, 2017). These two definitions not only capture different elements of the wider business population but seem to identify different channels for the external effects of fast-growth firms.

Controlling for industry-region specific characteristics, our analysis reveals varied externalities of the fast-growth phenomenon at the regional and industrial horizontal level. Focusing on the manufacturing sectors, on the one hand, a higher incidence rate of fast-employment-growth firms has a negative spillover effect on the overall employment growth of other firms in the same industry-region. This suggests a competition-led crowding-out effect. On the other hand, a higher proportion of fast-productivity-growth firms in a region has a positive spillover effect on the labour

productivity of non-fast-growth firms, suggesting a competition-led improvement in efficiency and an increased level of knowledge spillovers.

Further, by analysing the externalities along vertically-integrated value chains, we find that an increase in the demand for services and products by fast-growth firms has a positive market-creating spillover effect on employment in the upstream sectors. A higher incidence rate of fast-growth suppliers results in increased productivity and efficiency gains in the downstream sectors, potentially due to learning and demonstration effects. A more granular spatial analysis shows that geographical distance plays a role in determining the externalities of fast-growth firms, largely corroborating our main findings.

When analysing these effects for different sub-samples of firms by age, size, and technological intensity, we find that the results set out above are driven by small and old non-fast-growth firms, especially in the low-tech sectors, for which the fast-growth spillover effects are stronger. In addition, by disaggregating the general spillover effects at the regional and sectoral levels, we highlight two opposite but linked trends. In fact, the strongest negative externalities on employment growth take place in peripheral rural areas, while the major urban areas experience a positive spillover effect from an increased incidence rate of fast-growth firms, suggesting that the negative externalities on employment growth might be stronger in areas where access to skilled workers is limited and the competitive pressure in local labour markets is particularly fierce. In contrast, the distribution of the spillover effect on labour productivity is the opposite, suggesting that both externalities seem to be mainly driven by the pressure of increased competition stimulated by fast-growth firms.

This study has three key contributions. It provides the first evidence of the external economic impact of fast-growth firms beyond that of direct job creation and productivity improvement within the firm itself. This expands the boundary of the current fast-growth firm literature and opens up a new array of important research questions about the externalities of highly performing firms in the economy. Second, the analysis focuses on the complex fast-growth patterns at the regional and industrial levels, enhancing our understanding of the dynamic relationship between fast-growth and non-fast-growth firms within and across sectors. Third, by comparing the externalities using both employment and productivity-based definitions of fast-growth, and among different industrial sectors, we show their different spillover impacts and mechanisms, and highlight the importance of understanding the fast-growth phenomenon in more depth and the need for designing policies specifically for different contexts.

Several key messages emerge. First of all, the policy goals of job creation and productivity growth are not always complementary at the regional and industrial level. While national and subnational policies are designed to promote fast-growth, it is useful to be mindful that the policy implications of this will have different, and even conflicting, effects on the employment and productivity growths of non-fast-growth firms. Indeed, where fast-growth prompts negative externalities, further investigations are needed to uncover the causes, and to determine the appropriate measures to promote long-term balanced growth.

Second, having more fast productivity growth firms in a region is beneficial for other firms overall, thanks to competition effects and knowledge spillovers. However, more fast employment growth firms may put a strain on other firms' abilities to attract skills and labour. This suggests that policy should promote "good" growth instead of any growth.

Third, the external impacts of the high-growth phenomena are highly heterogeneous across industries, the position in the value chain, firm age and size, specific geographical location, and the degree of agglomeration. This variability should be considered when designing specific policy instruments.

Fourth, research on fast-growth firms needs to go beyond looking at within-firm growth to better understand the external impacts of fast-growth firms and their dynamics on the rest of the economy. Further investigation is needed to understand what may cause these negative external effects of high-growth firms, and what appropriate measures need to be taken to promote long-term balanced growth.

The rest of the paper is organised as follows. Section 2 reviews the main relevant theoretical and empirical contributions in the fast-growth literature, and in the firm externalities and regional science literatures. It also presents our research hypothesis. Section 3 discusses the data and summary statistics. Section 4 explains the variables used and the econometric methodology adopted in the empirical investigation. Section 5 presents and discusses the econometric results. Section 6 concludes by summarising the key results and presenting some policy implications.

# 2. LITERATURE REVIEW

## 2.1 Fast-growth firms: the limited predictability

Research in the fast-growth literature (extensively reviewed by Henrekson and Johansson, 2010 and more recently by Coad et al. 2014) has strongly corroborated the ability of fast-growth firms to create new jobs. Although forming only a small fraction of the business population, these fast-growth firms generate a disproportionately high number of new jobs in the UK and elsewhere (Anyadike-Danes et al. 2009; NESTA, 2009; Brown et al., 2017). Hart and Anyadike-Danes (2015) show evidence that the exceptional rise of fast-growth firms is not linked to cyclical economic fluctuations in that their contribution to job creation has been observed in times of both economic upturn and recession. Since the recent financial crisis, fast-growth firms are considered to be a viable option for fostering economic recovery (Coad et al., 2014; Mason and Brown, 2013) and are becoming central to the political and academic debate about economic prosperity (Storey and Greene, 2010). As a result, promoting fast-growth firms has become the main focus of many industrial policies (Acs, Parsons, and Tracy 2008; Shane 2009; Mason and Brown 2013; Bos and Stam 2014; Lee 2014; Autio and Rannikko 2016; Brown et al 2017). An increasing number of regional and national governments and international organizations are interested in improving the performance of stagnant mature economies through the creation of new jobs and growth in productivity (Acs et al. 2008; OECD, 2010, 2013; Anyadike-Danes et al., 2013; Bleda et al., 2013; Brown et al., 2014; Anyadike-Danes et al, 2015; Anyadike-Danes and Hart, 2017).

Research on the characteristics and drivers of fast-growth firms has identified a number of stylized facts. Apart from the prolificacy of job generation, the existing literature looks at fast-growth firms' industrial and spatial distribution, focusing on their prevalence among younger (Haltiwanger et al 2013), more innovative, and knowledge-intensive firms (Daunfeldt et al., 2014), but also stressing that the fast-growth phenomenon is broadly spread across firms of all sizes, age, and industry (Anyadike-Danes et al., 2009; NESTA, 2009; Haltiwanger et al 2013; Lawless 2014). However, the most recent literature exploring the various characteristics that may capture the essence of the fast-growth phenomenon are supported by only small samples of observations. These characteristics include, for example, engagement in mid-level innovation (Bhidé, 2008), following a distinct business strategy of seeking market niches (Hinton and Hamilton, 2013), and the diverse characteristics of their top managerial teams (Barringer et al 2005). Though sometimes contradictory, such aspects identified in the management

literature seem to confirm that firm growth is the product of broad entrepreneurial, firm, and strategy factors interacting together (Barkham et al., 1996).

Despite all these findings, the predictability of fast-growth remains fairly limited given their highly episodic nature (Garnsey et al., 2006; Parsley and Halabisky, 2008; Mason and Brown 2010; Coad et al., 2014; Coad et al 2014a; Hölzl, 2014) and the lack of persistency over time (Acs et al 2008; Hölzl, 2009; Daunfeldt and Halvarsson, 2014; Du and Bonner, 2017). The population of fast-growth firms is in constant flux (Brown et al., 2017). Most studies have focused on the identification and description of fast-growth firms ex-post as a standard way of analyzing the fast-growth phenomenon. In some respects this has left the fast-growth entrepreneurship literature theoretically and empirically underdeveloped (Leitch et al. 2010; Demir et al. 2016). The inability to explain the fast-growth phenomenon stems from insufficient economic or management theories, and a lack of empirical models to capture firm growth rates (Coad 2009; Leitch, Hill and Neergaard, 2009). It has even led to a branch of the literature that advocates that the firm fast-growth process is random (Denrell, 2004; Coad et al 2013). Thus it follows that the key characteristics of fast-growth firms may still be largely unknown, with profound implications for policy-makers. Since the identification of potential fast-growth firms is so unreliable, it may well be that the goal of creating long-term jobs through the promotion of fast-growth firms may not be attainable, and that attempting to design policies that promote such firms is of dubious benefit.

### 2.2 Industrial configuration of regions and fast-growth externalities

Seeking an alternative approach to examining the fast-growth phenomenon, recent literature has started to look at the persistence of fast-growth at the industrial and regional levels, rather than at the level of the single firm. These studies investigate the relationships and strategies of fast-growth firms within the industrial and geographical contexts in which they operate. The spatial development of fast-growth has been investigated, although clarification is still needed about how local factors associate with the emergence and impact of fast-growth firms on stimulating the development of a region (Brown and Mawson 2016b; Li et al. 2016). There is mounting evidence to suggest that geographic and local characteristics may play a role in affecting the development of fast-growth firms. In particular, although location is not always relevant to explaining the barriers to business growth, growing evidence suggests that the fast-growth phenomenon is fostered by location-specific strategies, regional characteristics, and

industrial agglomeration and specialization (Stam, 2005; Duschl et al 2015; Friesenbichler and Hoelzl, 2016).

It is generally a well-established concept in regional science, having been widely debated and empirically illustrated, that the specific characteristics of a region affect firms' productivity and competitiveness. These theories, recently revived in the entrepreneurship literature focusing on the locational factors that determine new firm formation, were first mooted in the 1980s (Li et al., 2016; Huggins and Thompson, 2017). The locational factors usually discussed in this literature include neoclassical factors of agglomeration economics, the quality of the human capital and transportation infrastructure, institutional factors such as taxes and regulations, and behavioural factors including the locational preferences of entrepreneurs (Arauzo-Carod, et al 2010). In addition, it has been updated by examining the factors linked to local knowledge stock, local economic conditions, the entrepreneurial culture, social capital, natural amenities, local government, and geographical characteristics (Acs and Armington, 2006). These factors remain contextual to a region and scant attention has been paid to the external impact of the different activities and strategies carried out by individual firms and their interactions with the wider economy.

The importance of regional effects cannot be assessed in isolation but should always be examined in relation to the industrial mix, i.e., the competencies and engaged activities within the region that may co-determine its growth perspectives. Conceptually, externalities are usually defined as innovations and performance improvements occurring in one firm as a result of the activities carried out by other spatially or industrially connected firms, without full compensation (Glaeser et al, 1992). In this literature, three main types of externalities have been considered, namely those arising from industrial horizontal economies, from industrial vertical integration, and from the localisation externalities.

Within the industrial externalities theories, the most dominant form of technological externality is the horizontal spillover between firms in the same industry that are spatially concentrated. The two main theories of agglomeration economies focus on the dynamic externalities of horizontal spillovers but differ in terms of the sources and stimulants of such externalities. The first one derives from the well-known Marshall-Arrow-Romer (MAR) model. Marshall (1920) explains that the concentration of an industry within a region helps knowledge spillovers between firms and, therefore, the growth of that industry and its region. The resulting literature heatedly debates the driving force of such

knowledge spillovers. The MAR theory predicts, consistent with Schumpeter (1942), that local monopoly is good for innovation because it restricts the flow of ideas to others and so allows externalities to be internalised by the innovator, which consequently promotes innovation and growth. For example, starting from the seminal research of Henderson (1986), a recent literature provides evidence that labour productivity is higher in firms that have other firms from the same industry located nearby, which is in line with Marshall's theories of industrial agglomeration and productivity spillovers (Brascoupe et al., 2010; Graham et al., 2010; Martin et al., 2011; Damijian and Konings, 2011). Following Porter's predictions (1990), another strand of the literature agrees that knowledge spillovers in specialized geographically concentrated industries stimulate growth, but the author argues that it is local competition rather than local monopoly that fosters the pursuit and rapid adoption of innovation (Aharonson et al., 2007; Harris and Li, 2009).

These types of externalities are external to the firm but internal to a specific industry. Jacobs (1969), unlike the MAR and Porter models, theorizes instead the existence of localisation externalities, predicting that the most important spillovers come from outside the core industry and arise from the diversity and variety of the regional economic structure. She contends that it is the variety and diversity of geographically proximate industries that promotes innovation and growth, rather than geographical specialization. Thus, it is diversity rather than specialization that generates a higher probability of positive spillovers. These are further fostered by local competition, which speeds up technology adoption and performance growth (Lee et al., 2010).

Localization externalities might originate from sources of non-knowledge spillovers, such as tacit spillovers originating from social interactions among local producers, sharing production inputs such as labour (eg. Lichtenberg, 1960; Henderson, 1988; Arthur, 1989; and Rotemberg and Saloner, 1990), or exploiting the opportunities created by local markets. This part of the literature, which considers “static” localization externalities, tries to explain region/city specialization and the so-called “district effect”, where increased levels of efficiency are related to the use of the same type of process or to the sharing of suppliers and customers (Duranton and Puga, 2001). However, empirical findings on the impact of these externalities on growth are still very limited (Glaeser et al 1992).

More recent studies have shown that it is not diversity per se that matters, but instead the geographical concentration of firms in different but complementary and related industries (Frenken et al. (2007; Boschma and Iammarino, 2009; Van Oort, 2015; Cainelli et al., 2016). Several studies contend that growth opportunities emerge through spillovers and industrial linkages between firms that are geographically bonded, and contribute to this analysis by distinguishing between spillovers originating from related and unrelated varieties, based on the idea that the transmission of knowledge and other positive spillovers requires a common and complementary competence and a shared industrial base. This implies that another type of industrial externality might arise from participation in a production value chain, which permits the transmission of knowledge, information, and technologies (and thus performance enhancement) between suppliers and customers that are vertically integrated and for which the cognitive distance is not too large (Nooteboom, 2000).

### 2.3. Research Hypothesis

Overall, linking these two literatures of fast-growth firms and firms' industrial-regional externalities provides the theoretical background and the conceptual framework needed to formulate some preliminary hypotheses regarding the wider economic effect of fast-growth firms on the performance of non-fast-growth firms operating within the same region or industry.

The industrial and spatial spillover literature argues that firms in regions and sectors that are characterised by greater levels of agglomeration economies experience higher rates of firm growth, whether measured in terms of employment or productivity growth, thanks to the indirect effect of tacit or explicit externalities that originate from better performing companies in terms of innovation, efficiency, and upscaling (Audretsch and Dohse 2007; Raspe and Van Oort 2008; Chyi et al. 2012). Thus, it is reasonable to hypothesize that fast-growth firms have a wider economic impact on the performance of spatially- and industrially-related non-fast-growth firms, due to their dynamicity, innovativeness, rapid improvement in efficiency, and proliferous job creation.

As suggested by the previous literature, fast-growth externalities could spread through the spatial agglomeration of a region or industry due to the industrial proximity and integration with other non-fast-growth firms. Following the models of Marshall-Arrow-Romer (MAR) and Porter discussed earlier, horizontal externalities could arise through imitation, cooperation, competition, and the fast movement of labour and skills between

fast-growth and non-fast-growth firms, making fast-growth spillovers more likely to occur within the same industry (Acs 2002). Spatially concentrated fast-growth firms operating in the same industry could thus trigger positive externalities through demonstration effects and competition-led efficiency improvements, but this could also lead to competition-led crowding-out effects as a result of the increased competition for common resources and inputs of production. In addition, according to the related-variety theory developed by Frenken (2007), fast-growth firms could also have a wider economic impact on the performance of different but vertically integrated industries, in particular for non-fast-growth suppliers and consumers. This could internalize the externalities related to increased demand, introduction of improved inputs, cycles of innovation, and efficiency gains induced by fast-growth firms in other related sectors. Finally, following Jacobs' theory (1969), geographical externalities could arise from the spatial proximity of fast-growth and non-fast-growth firms, regardless of industrial relatedness, due to the diversity and variety of the regional economic structure. In this case, fast-growth externalities could spread to unrelated but proximate non-fast-growth firms thanks to local cooperation strategies, or an increase in local demand for inputs of production and services, or the introduction of innovation and efficiency-improving techniques, or the dissemination of tacit spillovers due to social interaction between neighbouring firms.

From a policy perspective it is important to understand the spatial and industrial heterogeneity of the fast-growth distribution in order to evaluate the wider spillover impact on non-fast-growth firms' economic performance. Supporting programmes should be designed and administered locally rather than nationally, with region and industry specific objectives (Brown and Mason 2012; Brown et al., 2017). Our region-industry analysis on the fast-growth externalities could support this effort by investigating the heterogeneous spillover effects that fast-growth firms have on job creation and productivity growth across regions and sectors, helping policy makers to tailor programmes to local development needs (OECD 2013).

## 3. EMPIRICAL ANALYSIS

### 3.1 Data sources

The empirical analysis of this study draws on a mix of data sources at the firm, industrial and regional levels. First, we use firm-level data from the ONS Business Structure Database (BSD) accessed through the UK Data Service, covering all businesses in the

UK between 1997 and 2013[1] (ONS, 2017). The annual BSD dataset is a live register of data based on annual abstracts from the Inter-Departmental Business Register (IDBR) collected by HM Revenue and Customs via VAT and Pay As You Earn (PAYE) records that cover the population of firms operating in the UK. The BSD data provide information on firms' age, ownership, turnover, employment, industrial affiliation at the SIC 4-digit level, and postcode. After removing missing values, outliers, and public-owned companies, the data includes information on almost 6,250,000 firms across 17 years, giving a total of more than 36,600,000 observations.

Secondly, we include several variables at the region and industry levels to capture spillover effects and contextual differences between regions. Most of these variables have been calculated by aggregation from the BSD database at the NUTS 2-digit[2] and SIC 2-digit region-industry level, such as total employment, net entry rate, and the region-industry agglomeration index. To estimate the vertical integration between industries we make use of the ONS input-output tables, estimating the product and services supplied and demanded, and the gross value added (GVA) for all sectors at the SIC 2-digit level in the UK. In addition, the R&D intensities at the NUTS 2-digit and SIC 2-digit regional and industrial levels are estimated from the firm-level UK Innovation Survey (UKIS) database, from wave 4 to 8, accessed through the UK Data Service as part of the wider Community Innovation Survey (CIS) covering all EU countries.

Despite the fact that fast-growth firms are spread across all industries (Anyadike-Danes et al., 2009; NESTA, 2009; Lawless 2014), recent studies show that almost one in three

[1] The ONS BSD database is updated up to 2016, but we had to focus on the 1997-2013 period because of the limited availability of the other sources of data used in this study, specifically, the ONS input-output data and the UKIS data.

[2] The Nomenclature of Territorial Units for Statistics (NUTS) is a geocode standard for referencing the subdivisions of countries for statistical purposes for all the member states of the EU. In the UK, NUTS 1 corresponds to Wales, Scotland, Northern Ireland, and the 9 statistical regions of England; NUTS 2 comprises 40 boundaries including Northern Ireland, most English counties, groups of unitary authorities in Wales, and groups of council areas in Scotland. At the NUTS 3 level are represented 174 boundaries including districts of England, groups of unitary authorities in Wales, groups of council areas in Scotland, and groups of districts in Northern Ireland. Throughout this analysis we have used the NUTS code as the spatial unit of reference for three reasons. First, because it is the only official statistical geographical nomenclature widely used across the EU when dealing with spatial analysis. Second, because it allows us to disaggregate the spatial analysis according to a hierarchy of three NUTS levels. Third, NUTS is the only territorial nomenclature commonly shared between England, Wales, Scotland and Northern Ireland.

fast-growth firms in the UK belongs to the business service sector, followed by the wholesale and retail sector (19%), and the manufacturing industries (15%) (Du and Bonner, 2017). Thus, we focus our attention on the main sectors that produce the largest number of fast-growth firms, namely the manufacturing and professional services sectors.[3]

### 3.2 Variables and summary statistics

*Fast-growth definitions*

Thanks to the availability of firm-level population data from the BSD, we are able to identify the incidence and distribution of fast-growth firms across regions and industries in the UK. However, defining fast-growth firms is in fact more challenging than it might first appear (Coad et al 2014). To date, there is still debate over the merits and drawbacks of different definitions (Coad et al. 2014; Daunfeldt, Elert, and Johansson 2014; Lee 2014; Anyadike-Danes, Hart, and Du 2015; Moreno and Coad 2015; Anyadike-Danes and Hart, 2017). While each definition has its advantages and disadvantages, it remains unclear which one is best able to accurately represent the population of the fast-growth phenomenon (Du and Bonner, 2016). Clearly, the choice of growth metric is important. There is evidence that employment and sales growth are only modestly correlated, and firms usually face a trade-off between employment and productivity growth (Shepherd and Wiklund, 2009; Daunfeldt et al 2014). In addition, Du and Bonner (2017) have shown that defining UK fast-growth firms based on productivity produces different subsets of the business population from those defined using the employment criterion. Hence, it is our objective to examine the sensitivity of relying on differing specific fast-growth definitions when investigating the wider economic impact of fast-growth firms. In addition, by adopting two different definitions of fast-growth firms – one based on labour productivity growth and the other on employment growth – we also aim to investigate distinct growth mechanisms among firms and their different spillovers.[4]

[3] Manufacturing sectors include all industries with a SIC (2003) code between 15 and 37. The professional services sector includes the industries with a SIC (2003) code from 70 to 74, including real estate activities, renting of machineries, computer consultancy, research and development, and other business activities.

[4] We recognize that labour productivity, calculated by turnover per employee, is not an ideal measure of firm productivity. Unfortunately, the IBDR data, although generous in its coverage, has limited variables.

The employment-based OECD-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 3-year period (OECD, 2007). Firms with fewer than 10 employees are usually not included in the OECD-HGFs metric due to the difficulty of defining a meaningful high-growth threshold given the very small number of initial employees. However, we adopt the small HGFs definition recently introduced by Clayton et al. (2013) that captures firms with fewer than 10 employees that grow by more than 8 new employees over a 3 year period. We then include small HGFs together with the OECD metric in order to create a consistent definition of employment-based fast-growth firms that represents the business population of all sizes (for simplicity, labelled as ***HGFs*** in the rest of this study). Correspondingly, the 3-year period in which the fast employment growth is observed is called an ***HGF period***.

Turning to productivity-based fast-growth firms, we follow Du and Bonner (2016; 2017) to define Super Growth Heroes (SGHs). Stemming from a Growth Heroes definition proposed by Du and Bonner (2016), ***Super Growth Heroes (SGHs)*** captures firms that have experienced a positive labour productivity growth over a 3-year period whereby both turnover and employment have grown relative to the base year, implying faster growth in turnover than employment, and in addition, with a labour productivity level above the SIC 3-digit level industry average.[5] The SGHs metric is notably a more stringent definition compared to Growth Heroes, imposing conditions on both productivity growth and level. Similarly, the 3-year period in which the fast productivity growth of an SGH is observed is called an ***SGH period***.

We base our analysis on these two definitions for several reasons. Firstly, employment and productivity are both important performance indicators. Although they are rarely compared side by side in the fast-growth firm studies, their differences may lead to important policy implications. Indeed, recent evidence suggests that there may be little correlation between productivity and employment growth (Anyadike-Danes and Hart, 2017). Our previous study using the same data shows that a small number of both HGFs and SGHs not only registered impressive employment and labour productivity growth

[5] We choose a 3-year period of observation to define an SGH in order to reduce the short-term volatility of the variable driven by frequent adjustments in a firm's turnover and employment. In terms of the length of the time, we have deliberately taken the same rolling periods as for the HGFs for easier comparison.

over the period examined, but also disproportionately contributed to the aggregate labour productivity growth and to the creation of new jobs in the overall economy (Du and Bonner, 2016). However, firms in the employment-based fast-growth definition had a markedly different contribution to the net job creation and productivity growth in the economy than those firms in the productivity-based definitions.

In particular, during 1997-2013, employment-based HGFs have contributed to the net creation of jobs in the economy by more than 95%, even if this amounts to only about 4% of the employment stock in the country. However, this sharp growth in employment has not, on average, been accompanied by a labour productivity growth, and in fact its overall contribution to labour productivity growth in the economy has been negative. On the other hand, although the firms that satisfy the productivity-based SGH definition have still contributed disproportionately to the net creation of new jobs in the UK with respect to their size (about 5% of total firms) (albeit on a smaller scale than the HG firms that have contributed almost 15% of the net job creation in the UK) (Du and Bonner, 2017) SGHs have registered an outstanding labour productivity growth by contributing to the productivity growth in the UK economy by almost 43% over the 1997-2013 period. They have increased employment at the same time, which is the most desirable pattern of growth from a policy-making point of view.

Firms experiencing both employment and productivity growth contribute greatly to the majority of the overall economic growth in several countries (Acs et al., 2008; Acs, 2013; Virtanen and Heimonen, 2013). Although analysis of these firms and their dynamic evolution would be expected to be particularly relevant at a time of global economic crisis, hardly any study has investigated the factors that influence the performance of SGHs and their impact on the surrounding local economy (Abubakar and Mitra, 2017).

Secondly, we base our analysis on these two specific definitions rather than on the many other employment-based and productivity-based fast-growth metrics because of their relative similarities in terms of group size, contribution to the economy, industrial distribution and size, and because of their comprehensive inclusiveness. [6] As in Table 1,

[6] Other frequently used definitions of fast-growth firms in the literature are High-Growth firms with more than 10 employees (OECD, 2007), High-Impact firms (Acs et al., 2010), High-Employment Growth firms (Clayton et al.,2013), Growth-Heroes (Du and Bonner, 2016), High-Growth Entrepreneurs (Audretsch, 2012), Millennium 2000 (Hart et al., 2016) and Gazelles (Acs et al., 2008).

both SGHs and HGFs represent between 4-5% of the business population in the UK during the period 1997-2013.

A firm records an SGH or HGF period if it satisfies the previously defined requirements over a 3-year period. We measure fast-growth using 3-year rolling windows (i.e., 1997/2000, 1998/2001, and so on) rather than on fixed 3-year periods end to end (i.e. 1997/2000, 2000/2003, etc.). This approach allows us to track the dynamic evolution of fast-growth periods during each 3-year period, providing a comprehensive coverage of the growth episodes experienced by firms and not relying on arbitrarily predetermined and fixed growth windows that underpin the OCED definition of a High-Growth Firm (Eurostat-OECD, 2007).[7,8]

*Fast-growth incidence rate: statistics*

Table 1 presents the summary statistics of the characteristics and distribution for the overall sample of firms in the UK, and for HGFs and SGHs in the manufacturing and professional services sectors. Fast-growth firms represent around 4-5% of the total manufacturing firm observations in our final sample, a slightly higher figure than for the professional services sector (around 3%). During the period of 1997-2013, about 150,000 manufacturing firms have experienced at least one SGH period, while almost 120,000 have registered at least one HGF period (367,000 and 374,000 respectively in

[7] As a practical example, a firm has a fast-growth episode if it has experienced positive labour productivity growth over 2000-2003, when both turnover and employment have grown compared to 2000, and the labour productivity level remains above the SIC 3-digit level industry average over the period. It might not satisfy the fast-growth requirements if we only consider two fixed 3-year periods (i.e. 1997-2000 and 2000-2003). However, by using moving and overlapping windows, we might find that the same firm has met the requirements to be identified as a fast-growth firm in the 3-years window between 1999 and 2002.

8 Other studies that analyse fast-growth firms follow a different approach in which fast-growth firms are considered only across 3-year period cohorts recorded using the initial year of their growth period as the reference date, and not across the individual years constituting those cohorts (e.g. Anyadike-Danes and Hart, 2015; Anyadike-Danes and Hart, 2017). Following this approach might create a discrepancy when calculating the growth rate of fast-growth incidence rate in a region or industry on a year-to-year basis. Thus, we define fast-growth firms following the classic approach, and then calculate the fast-growth incidence rate for each of the individual years constituting the 3-years growth period, in order to interpret more easily the spillover effects originating from a year-to-year increase in the incidence rate of fast-growth firms. As a robustness check, in Tables A2, A4 and A5 in the appendix we replicate our main estimation models following a “cohort” approach, and estimate the spillover effects of a cohort-to-cohort increase in the incidence rate of fast-growth firms on the cohort-to-cohort employment and labour productivity growth of non-fast-growth firms, and yield consistent results.

the professional services sector). Almost 15% of the firms are identified as experiencing both SGH and HGF episodes at the same time during this period.

A simple mean comparison of the key firm characteristics suggests that fast-growth firms in both categories are larger than the average firm in terms of employment and turnover and are have considerably higher labour productivity. SGHs tend to be larger in employment size, have more than doubled turnover, and are slightly more productive. It appears that the average age of a fast-growth firm is around 12-14 years. Both types of firm have a higher probability of being foreign-owned than the average firm, although fewer than 10% of fast-growth firms overall are foreign owned. Fast-growth firms are more likely to be part of a business group with other affiliates. This evidence might suggest that firms need to be part of a business group in order to exploit group economies of scale and to experience rapid employment growth periods (Abubakar and Mitra, 2017). However, the percentage of SMEs, young, and high-tech firms do not differ significantly between fast-growth firms and the average firms in the overall sample. This suggests that individual firm characteristics such as size and age, as well as the sector's technological intensity may not be a good predictor of the fast-growth phenomenon.[9]

Figure 1 presents the geographical distribution of SGHs and HGFs employment as a share of total employment for each NUTS 2-digit UK region during the period 1997-2013. The two maps highlight a rather different geographical distribution of these two groups of fast-growth firms. In fact, while SGHs employment seems to be mainly agglomerated around urban and highly populated areas such as London, Liverpool, Manchester, Leeds, and Newcastle, HGFs are more evenly distributed across the country, with a slightly higher incidence rate in Oxfordshire, Kent, South Wales, the Midlands, South Yorkshire, Eastern Scotland, and Belfast. This finding might suggest a correlation between SGHs incidence rate and the spatial agglomeration and concentration of firms, particularly around urban areas, which has been found in the previous literature to boost the productivity growth of aggregated firms (Henderson 1988; Duranton and Puga, 2004;

[9] Firms with more than 250 employees are considered to be large while SMEs have fewer than 250 employees. Firms operating for more than 5 years are considered old; a shorter period than this would be young. Following the Eurostat classification, manufacturing high-tech firms have SIC codes (2003) equal to: (24) chemicals and pharmaceuticals; (29) machinery and engines; (30) computers and office machinery; (31) electrical machinery; (32) IT and communication equipment; (33) medical, precision and optical instruments; (34) motor vehicles; (35) transport equipment.

Bertinelli and Black, 2004; Liu, 2014; Combes et al. 2013; Ning et al.2016).The more even distribution of HGFs, with a relatively higher incidence rate in rural and sub-urban areas, is consistent with the high-growth literature that suggests that employment high-growth can happen everywhere (Moreno and Coad, 2015).

In order to analyse the industrial distribution of fast-growth firms across UK regions, we have calculated the average share of fast-growth firms over total employment in each sector at the SIC 2-digit level for each UK region at the NUTS 1-digit level. Due to space constraints, Figure 2 reports only the top 3 industries for each region in terms of fast-growth incidence rate. We observe a clear difference in the industrial distribution of HGFs and SGHs. HGFs register a larger share of total employment in sectors such as business services, food production, printing and media production, and the manufacture of environmental goods and non-metal products. On the other hand, SGHs represent a larger share of employment in a small number of industries across the country, which are markedly different from those where HGFs are predominant. In fact, SGHs are mainly focused in the machinery, automotive and transport equipment industries, which are particularly productivity-intensive. In addition, there are significantly more fast-growth firms in non-metal products and professional services sectors across several UK regions.

*Externalities of fast-growth firms*

Consistent with the theoretical literature discussed above, we consider three possible externalities linked to the presence of fast-growth firms across UK industries and regions. We start by estimating the fast-growth industrial spillover effects on non-fast-growth firms that operate in the same sectors or in vertically integrated industries. For this reason, we disentangle the fast-growth spillovers into horizontal and vertical industrial externalities.

Firstly, we estimate industrial externalities at the horizontal level, analysing the spillover effects generated from the share of fast-growth firms' employment in each industry and region. Our measure of the fast-growth firms' presence at the region-industry level $FG\_IH_{rst}$ follows the Marshall-Arrow-Romer (MAR) model of localisation spillovers arising from the spatial concentration of firms in the same industry, measured by the share of fast-growth firms' employment $FG\_EMPL_{rst}$ over the total employment $EMPL_{rst}$ of each region-industry at the NUTS 2-digit (*r*), SIC 2-digit level (*s*) in a given year (*t*):

$$FG\_IH_{rst} = FG\_EMPL_{rst}/EMPL_{rst}$$

A higher incidence rate of fast-growth firms operating in the same industry and located in the same region could trigger positive externalities through demonstration effects and competition-led efficiency and productivity improvements, but it could also lead to competition-led crowding-out effects as a result of the tougher competition for common resources and inputs, such as skills, labour, and other inputs of production.

Secondly, we estimate externalities at the vertical level, considering the fast-growth spillovers originating from vertically integrated sectors that are part of the same industrial value chain. To do so, we build two indexes of vertical integration for each sector: one for integration with its suppliers, and one for integration with its customers (Frenken et al., 2007; Cainelli et al., 2016). We first use UK input-output tables at the SIC 2-digit level for the 1997-2013 period to estimate the industrial integration between all sectors in the UK, measuring the relative shares of each sector (*j*) over the total consumption of sector (*s*) $(y_{jst}/y_{st})$ and the relative share of each sector (*z*) over the total demand for products supplied by sector (*s*) $(y_{zst}/y_{st})$. We then weight each relative share by the size of each supplying sector $(y_{jt}/Y_t)$ and consuming sector $(y_{zt}/Y_t)$ in the UK as a share of total GDP. This will give us a measure of the relative size of each sector, while also considering the relevance of each sector *(j)* as a supplier and each sector *(z)* as a consumer of sector *(s)*. For each sector *(s)* we can then finally construct the two indexes of vertical integration, one for supplying sectors *(j)* and the other for customer sectors *(z)*. We achieve this by weighting the share of fast-growth firms' employment in each supplying sector $(FG\_EMPL_{jt}/EMPL_{jt})$ and consuming sector $(FG\_EMPL_{zt}/EMPL_{zt})$ of industry (*s*) by the relative measure of vertical integration between each pair of sectors (*sj*) and (*sz*), and averaging across all supplying (*j*) and consuming sectors (*z*) for each year:

$$FG\_SUP_{jst} = \sum_{j} (FG\_EMPL_{jt}/EMPL_{jt})(y_{jt}/Y_t)(y_{jst}/y_{st})$$

$$FG\_CUS_{zst} = \sum_{z} (FG\_EMPL_{zt}/EMPL_{zt})(y_{zt}/Y_t)(y_{zst}/y_{st})$$

In this way, we are able to identify the spillovers effects on industry (*s*) related to the incidence rate of fast-growth firms in its supplying sectors (*j*) and consuming sectors (*z*), estimating the possible externalities related to market creation, introduction of improved

inputs, cycles of innovation, and efficiency gains induced by fast-growth suppliers and customers (Frenken et al., 2007)[10].

Thirdly, we also analyse the geographical externalities arising from the spatial proximity of fast-growth firms onto non-fast-growth firms. In this regard, we first estimate the spillover effect related to the incidence rate of fast-growth firms' employment over the total employment of firms located in the same postcode area at the district-level (*p*), regardless of the industry classification:

$$FG_{pt} = FG\_EMPL_{pt}/EMPL_{pt}$$

This analysis follows Jacobs' theory (1969) on spatial agglomeration in which externalities are independent from firms' industry characteristics but arise instead from the diversity and variety of the local economic structure. According to the related literature, a diversified industrial mix rather than sectoral specialization could increase the likelihood of spillovers and externalities in a given region. Following this prediction, we might expect that the incidence rate of fast-growth firms could impact other non-fast-growth firms located in the same postcode area, regardless of the industrial activity (Sena et al., 2013).

In addition, we measure the physical distance between each individual non-fast-growth firm (*i*) and its closest fast-growth firm (*j*) $d_{ijt}$, based on their latitude and longitude. In this way it is possible to calculate a Newtonian gravity force of attraction between each pair of fast-growth (*j*) and non-fast-growth firms (*i*) by dividing the product of their sizes in terms of total employment ($E_{it}$, $E_{jt}$) by the squares of their distance (Rodríguez-Pose and Zademach, 2006; Chen, 2015):

$$FG\ Gravity_{ijt} = \frac{E_{it} \times E_{jt}}{d_{ijt}^2}$$

[10] As a robustness check we have estimated the vertical industrial integration externalities also at the sector-region level, considering the incidence rate of fast-growth suppliers and customers located within the same region at the NUTS 2-digit level. The results are consistent and available upon request. However, we preferred not to include the vertical industrial integration externalities calculated at the sector-region level, mainly because of the very stringent assumption that firms buy only from local suppliers and sell only to local customers located within the same region.

In this way, we consider not only the physical distance, but also the size of firms and the possible relation between geographical distance and the economies of scale that are needed to exploit and absorb the possible spillover effects between fast-growth and non-fast-growth firms.

### 3.3 Statistical model and estimation

The main aim of our empirical analysis is to identify the spillover effects of fast-growth firms on the economic performance of other firms. To do so, we focus on two main sets of possible externalities; the first concerns the industrial externalities of fast-growth firms, while the second takes into consideration the spatial spillovers of fast-growth firms. We start by analysing the industrial externalities of fast-growth firms. We perform the estimations using a simple OLS first-difference fixed-effects model in order to isolate the causal link between the growth in the incidence rate of fast-growth firms, and the employment and labour productivity growth of non-fast-growth firms, while controlling for firm heterogeneity and other region-industry specific characteristics:

$$\Delta EMP_{it} = \beta_0 + \beta_1 \Delta HGF\_IH_{rst} + \beta_2 \Delta HGF\_SUP_{jst} + \beta_3 \Delta HGF\_CUS_{jst} + \beta_4 FIRM_{it} + \beta_5 ENV_{rst} + j_t + \varepsilon_{it} \quad , \quad (1)$$

$$\Delta LP_{it} = \beta_0 + \beta_1 \Delta SGH\_IH_{rst} + \beta_2 \Delta SGH\_SUP_{jst} + \beta_3 \Delta SGH\_CUS_{jst} + \beta_4 FIRM_{it} + \beta_5 ENV_{rst} + j_t + \varepsilon_{it} \quad , \quad (2)$$

In equation (1) our dependent variable $\Delta EMP_{it}$ represents the year-to-year employment growth of non-HGF (*i*) at time (*t*), while the key explanatory variable $\Delta HGF\_IH_{rst}$ indicates the externalities linked to an increased incidence rate of HGFs in the sector and region at the NUTS 2-digit level and SIC 2-digit level, measured as the growth of the share of HGFs over total employment in region (*r*) and industry (*s*)[11]. Secondly, we consider vertical externalities linked to an increase in the rate of fast-growth firms in the upstream sectors $\Delta HGF\_SUP_{jst}$ and the downstream sectors $\Delta HGF\_CUS_{zst}$ to analyse the spillover effect of an increased incidence rate of fast-growth customers and suppliers.

[11] We also conduct the same analysis using the UK local enterprise partnerships (LEPs) as geographical boundaries. The results are shown in Table A3 in the appendix. LEPs, only available for England, are 39 partnerships between local authorities and businesses set up in 2011 in England by the Department for Business, Innovation and Skills to help determine local economic priorities, and promote economic growth and job creation within the local area.

With equation (2) we estimate the spillover effects of a larger incidence rate of SGHs on the labour productivity growth of non-SGH firms, measured as the ratio between turnover and number of employees. In this case, the dependent variable $\Delta LP_{it}$ measures the year-to-year labour productivity growth of non-SGHs (*s)* at time (*t)*. The key explanatory variables included are $\Delta SGH\_IH_{rst}$, which represents an increase of the share of SGHs over total employment in region (*r)* and industry *(s)* at the NUTS 2-digit level and SIC 2-digit level, and the vertical externalities linked to an increase in the incidence rate of SGHs in the upstream sectors $\Delta SGH\_SUP_{jst}$ and the downstream sectors $\Delta SGH\_CUS_{zst}$ at the SIC 2-digit level.[12] In this way we will be able to estimate the overall industrial externalities of an increased incidence rate of fast-growth firms on the employment and productivity growth of non-fast-growth firms, taking into consideration both the horizontal competition and the vertical industrial integration channels.

In a second set of specifications, we focus on the analysis of the spatial spillovers of the fast-growth firms. In particular, we use an OLS first-difference fixed-effects model in order to identify the causal link between the growth in the incidence rate of fast-growth firms in a specific region, and the employment and labour productivity growth of non-fast-growth firms located in the same region:

$$\Delta EMP_{it} = \beta_0 + \beta_1 \Delta HGF\_GEO_{rst} + \beta_2 FIRM_{it} + \beta_3 ENV_{rst} + j_t + \varepsilon_{it} \qquad (3)$$

$$\Delta LP_{it} = \beta_0 + \beta_1 \Delta SGH\_GEO_{rst} + \beta_2 FIRM_{it} + \beta_3 ENV_{rst} + j_t + \varepsilon_{it} \qquad (4)$$

In equation (3) we estimate the effect of HGFs' spatial spillovers on the year-to-year employment growth of non-HG firms (*i)* at time (*t)*, while $\Delta HGF\_GEO_{rst}$ represents the vector including the main HGF spatial externalities. First, we estimate the impact of an increase in the share of HGFs' employment over the total employment in the same postcode area at the district-level $HGF_{pt}$, regardless of the industrial classification. This is in order to evaluate the effect of Jacobsian externalities that arise from the diversity and variety of the local industrial structure. Secondly, in a separate specification, we analyse the effect of the gravity force between high-growth (j) and non-HGFs (i) $HGF\ Gravity_{ijt}$, measured as the product of their total employment ($E_{it}$, $E_{jt}$) divided by

[12] 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. Results are robust with the main findings presented in this report and are available upon request.

the squares of their distance, in order to estimate the impact on the employment growth of non-HGFs triggered by the nearest HGF. Similarly, in equation (4), we estimate the effect of SGHs' spatial spillovers on the year-to-year labour productivity growth of non-SGHs (i) at time (t). First, we look at the impact of an increase in the share of SGHs' employment over total employment in the same postcode area at the district-level $SGH_{pt}$ on the labour productivity of non-SGHs. We then analyse the effect of the gravity force between SGH (j) and non-SGHs (i) $SGH\ Gravity_{ijt}$ on the labour productivity growth of non-SGHs.

In order to control for firm, region, and industry specific characteristics, we include in all specifications two different sets of control variables at different levels. First, the vector $FIRM_{it}$ includes several firm-level characteristics at time (*t)*; namely employment, labour productivity measured as total revenue per employee, firm age, and two dummy variables equal to 1 if the firm is foreign owned and/or part of a business group. By including these variables, we are able to control for several dimensions of firm heterogeneity. First, firm size and productivity level are included to control for the effect of firms' idiosyncratic capabilities, resources, and peculiarities on their future performance growth. In particular, the level of total employment is used to control for firm size and its capacity for exploiting economies of scale since larger scale generates proportionate savings in costs of production. In addition, one of the key findings of the previous literature predicts a negative relationship between the growth rate of firms and their size, suggesting that small firms grow faster than large companies (Audretsch and Dohse, 2007).

Moreover, by including labour productivity we take into account the different initial levels of firm productive efficiency, measured as output per worker. Due to data limitations, we are not able to include more information about firms' managerial capabilities, labour skills, or the efficiency of the capital invested, but we can use firms' labour productivity as a proxy since all these factors contribute to improvements in the productive efficiency of a company, and have been found to be highly correlated with labour productivity (Bloom and Van Reenen, 2007; Bender et al., 2016).

Firm age is included in order to capture the impact of experience and learning-by-doing, and to allow for the life-cycle and maturity of the company, which previous literature has found to have a negative relationship with further employment and labour productivity growth (Anyadike-Danes et al., 2009; Haltiwanger et al., 2013). Finally, we include

foreign ownership and corporate group dummies in order to control for externalities deriving from being part of a larger business corporation, and the possibility of being exposed to external knowledge, or new production and managerial processes introduced by foreign owners and group affiliates (Baldwin and Gu, 2005; Fons-Rosen et al., 2013). Interestingly, empirical studies suggest that firms that are part of a larger group have greater connections to regional sources of spillovers, such as local businesses, due to their close social connections (Stuart and Sorenson, 2003). Previous literature has also shown that foreign firms are less dependent on resources located in a host country region and might not be familiar with the local environment, suggesting that they may actually be less exposed to local industrial spillovers (Nachum and Keeble, 2003; Osabutey et al. 2014). Unfortunately, due to the limited number of variables available in the BSD database, it has not been possible to include other relevant firm-level variables that could explain the employment and productivity growth of non-fast-growth firms (Barkham et al., 1996). However, the inclusion of firm-level fixed-effects should mitigate this shortcoming by accounting for other firm specific unobserved factors.

Secondly, in each specification, we also include $ENV_{rst}$, representing the different control variables at the industrial and regional level. We control for the overall performance of the sector and region where each single firm operates, including the employment and labour productivity growth at the region-industry level and the net entry rate ratio (always at the NUTS 2-digit and SIC 2 digit-level) in order to take into consideration the level of competition and the dynamism of the local industries. In addition, since many empirical studies have suggested that firm growth, measured in terms of employment or productivity growth, is positively affected by knowledge spillovers (Audretsch and Dohse 2007; O'Mahony and Vecchi 2009) we control for the regional and industrial R&D intensity calculated from the UKIS data. Moreover, since the more productive and faster growing firms might be attracted to those regions that provide a better trained labour force, key knowledge inputs, or a plentiful supply of customers and suppliers (Nachum and Keeble 2003; Osabutey et al. 2014; Combes and Gobillon, 2015), we include in each specification the region-industry specific agglomeration index that measures agglomeration as the combined effect of natural advantages and industry concentration (Ellison and Glaeser, 1997)[13]. We then interact each of the fast-growth externality

[13] 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

metrics with the region-industry Ellison and Glaeser (1997) agglomeration index in order to properly estimate the relationship between fast-growth incidence rate and non-fast-growth firms' employment and productivity growth, while controlling for the self-selection of fast-growth and high-performance firms into industries and regions characterised by high levels of spatial agglomeration and industrial concentration (Autor et al., 2017).

Finally, we include year dummies $j_t$ to account for any specific sources of heterogeneity and to capture possible time-specific macroeconomic dynamics. By using the firm-level fixed-effect first-difference model we are able to identify precisely the causal effect of the fast-growth phenomenon spillovers on the economic performance of non-fast-growth firms, while considering firms' heterogeneity and region-industry specific trends. In fact, the first-difference model allows us to measure the effect of a standard deviation increase in the presence of fast-growth firms within the same industry or region on the employment and labour productivity growth of non-fast-growth firms. In addition, the firm, industry, and regional control variables, together with the firm-level fixed-effects, will make our estimation more precise by considering firm heterogeneity in terms of initial size and productivity, while the industry-region covariates control for specific sectoral trends and spatial agglomeration effects. We do not expect this analysis to be affected by reverse causality between performance growth at the firm-level and the fast-growth phenomenon at the regional and industrial level. In fact, the localization of fast-growth firms and the growth of the incidence rate of fast-growth phenomenon at the regional and industrial level should not be affected by the economic performance growth of individual non-fast-growth firms operating in the same industries and regions. Finally, we control for the role played by agglomeration forces and the self-selection of better performing firms into more agglomerated and concentrated industries-regions by first including in our estimation the level of agglomeration index for each industry-region, and secondly by interacting the different fast-growth externality metrics with the region-industry Ellison and Glaeser (1997) agglomeration index.

All the models are estimated for several sub-samples of firms, focusing specifically on manufacturing, professional services companies, large firms, SMEs, old and young

employment of the industry (s) in the country and by the Herfindhal Index of industrial concentration.

businesses, and low and high-tech firms[14]. As previously stressed, we focus on the manufacturing and professional service sectors since almost a third of all fast-growth firms in the UK belong to either the business services sector or the manufacturing industries. Further, we are interested in evaluating the different impact that fast-growth externalities might have on the employment and productivity growth of these two sectors given their structural differences in terms of labour and capital intensity (Nilsson and Grillitsch, 2016; Du and Bonner, 2017). We distinguish between the impact of fast-growth externalities on large firms and SMEs since recent empirical works suggest that small firms are more likely to rely on spillovers because of their limited ability to invest significant resources in internal capabilities; thus we expect to see a particularly strong influence of industrial and spatial externalities on the performance of small firms (Audretsch and Dohse, 2007; Abubakar and Mitra, 2017). Similarly, we expect to find different effects of fast-growth externalities on younger, entrepreneurial, and more dynamic firms compared to more established companies. Indeed, young firms have a higher probability of experiencing fast-growth episodes, and thanks to their less established structure might be more inclined to take advantage of external spillovers. Finally, we analyse the different impacts on non-fast-growth firms in the low-tech and high-tech sectors in order to test whether fast-growth externalities are stronger in knowledge intensive industries, where collaborations between firms are more developed, and firms can rely on an advanced absorptive capacity to internalize the positive spillovers. An alternative scenario would be if the impact were greater in terms of catch-up for firms in low-tech industries that are less competitive and more distant from the technological frontier (Liu et al., 2010; De Silva et al. 2012; Goya et al. 2012; Sena et al., 2013).

### 3.4 Robustness checks

We run several robustness checks in order to corroborate our findings. First, since both fast-growth categories are defined over a 3-year growth period, we have replicated our

[14] Manufacturing sectors includes all industries with a SIC (2003) code between 15 and 37. The professional services sector includes the industries with a SIC (2003) code from 70 to 74. Firms with more than 250 employees are considered to be large, otherwise they are SMEs. Firms operating for more than 5 years are considered old, young otherwise. Following the Eurostat classification, manufacturing high-tech firms have SIC codes (2003) equal to: (24) chemicals and pharmaceuticals; (29) machinery and engines; (30) computers and office machinery; (31) electrical machinery; (32) IT and communication equipment; (33) medical, precision and optical instruments; (34) motor vehicles; (35) transport equipment.

main estimation models following a "cohort" approach and estimated the spillover effects of a 3-year increase in the incidence rate of fast-growth firms on the 3-year employment and labour productivity growth of non-fast-growth firms. This yields consistent results, as reported in Tables A2, A4, and A5 in the appendix.

Secondly, following an alternative approach to calculating the vertical integration between related industries, we have estimated the vertical industrial integration externalities at the sector-region level, considering the incidence rate of fast-growth suppliers and customers located within the same region at the NUTS 2-digit level.[15]

Third, we have conducted the same analysis using the UK Local Enterprise Partnerships (LEPs) as geographical boundaries rather than the EU NUTS classification. LEPs, only available for England, are 39 partnerships between local authorities and businesses that were set up in 2011 in England by the Department for Business, Innovation and Skills to help determine local economic priorities and promote economic growth and job creation within the local area. The results are shown in Table A3 in the appendix and are again consistent with our main findings.

## 4. THE EXTERNAL ECONOMIC IMPACT OF THE FAST-GROWTH PHENOMENON

This section reports the estimates of the externalities of fast-growth incidence rate in a given region and industry, as modelled in equations (1) and (2). Differentiating between the distinct routes of fast-growth through productivity improvement or employment scale-up, we investigate the fast-growth firms' potential externalities on the rest of the economy in the local region and industry. The externality variables – $FG\_IH_{rst,}$, $FG\_SUP_{jst,}$ *and* $FG\_CUS_{zst}$ – measure respectively the shares of fast-growth firms in terms of employment in the horizontal industrial sector, the upstream sectors, and the downstream sectors. Hence, we interpret the estimates of these spillover variables as the external impact of fast-growth competitors, suppliers, and customers in each manufacturing industry and region.

We first focus on the manufacturing sectors in Section 4.1 and discuss the spillover effects of fast-employment-growth firms (OECD HGFs) on the rest of the firms in a region

[15] Results are consistent with the baseline models, available upon request.

and industry, as reported in Table 2. Section 4.2 focuses on the spillover effects of fast-productivity-growth firms (SGHs), as reported in Table 3. Figure 3 and 4 illustrate the main estimates reported in these tables. In addition to the overall firm estimation, we explore the role of firm heterogeneity in our findings by splitting the sample by sectoral technological specification, firm size, and age. We then discuss the overall externalities and their economic significance in Section 4.3. Section 4.4 discusses the spatial spillover effect of fast-growth firms in the manufacturing sectors. Our findings on the professional service sectors are discussed in Section 4.4.

### 4.1 Fast-employment-growth firms' externalities in manufacturing sectors

First, as reported in column 1 of Table 2, we find negative horizontal externalities of fast employment growth incidence rate on the employment growth of manufacturing firms located within the same region and operating in the same sector. This negative effect on average employment growth may be seen as an indicator of the competition-led crowding-out effect, where competitors that are closely located in the same region struggle to secure a labour force from a limited local labour market when facing a strong expansion of employment-based fast-growth firms.

This is consistent with the theoretical model that explains the trade-off faced by similar firms clustering in the same local labour market; although firms may benefit from labour pooling, enabling them to access workers whose knowledge helps to reduce costs, they also face an increase in costs as a result of labour poaching, defined as the loss of key workers to competition, which also results in higher wages bills for firms as they struggle to retain the remaining employees (Combes and Duranton, 2006). Our results could be related to this trade-off, especially given the problem of the shortage of skills currently experienced in the UK, particularly in some manufacturing industries. This has been exacerbated by migration and housing constraints (Kemeny, 2017) and is considered to be both "the cause and consequence" of the nation's poor economic performance (Finegold and Soskice, 1988; Haskel et al. 2005; Calvo and Coulter, 2017).

In addition, recent theories have predicted the emergence of "superstar firms", where manufacturing industries are increasingly characterised by a "winner takes most" competition. For instance, Andrew et al (2016) show the divergence between a small group of highly productive firms, and the vast majority of laggards that show slow growth and low profits. Autor et al. (2017) have provided evidence from the US showing that industries with larger increases in the concentration of sales among a few superstar firms

exhibit a sharper decline in labour share. The results in Table 2 provide similar evidence for the UK, highlighting how local competition led by fast-growth firms results in an increased competition with other firms for skills and labour, and a concentration of labour for the "happy few".

Turning to the vertical chains, while there is no statistically significant effect linked to the fast-growth incidence rate among suppliers, we do observe strong positive effects in respect of fast-growth customers in both the high- and low-tech sectors. This means the positive employment externalities across sectors can be driven by demand, but not by supply. Consistent with the diverse localization externalities from outside the core industry that have been identified by Jacobs (1969), this indicates that a geographical concentration of different but complementary industries codetermines the growth perspectives of related sectors, together with an overlap of fast-growth spillovers outside of the industry boundaries (Frenken et al. 2007; Boschma and Iammarino, 2009; Cainelli et al., 2016).

In addition, we observe a direct positive agglomeration effect on the average employment growth, mostly among young, small, and low-tech firms. Not surprisingly, all else being equal, young and small firms grow faster in more agglomerated sector and regions, while old firms seem to suffer from increased horizontal competition. Further, the interaction terms of agglomeration and spillover effects suggest a mediating role of agglomeration force in determining firm growth. In particular, the fast-growth customers' spillover effects are more pronounced in the more agglomerated industry-regions; this is in line with the previous literature (Audretsch and Dohse, 2007). This evidence shows a mediating role of agglomeration force in stimulating firm growth, through market creation along the value-chain of related industries by fast-growth firms in the region. In particular, an increase of fast-growth episodes in the most agglomerated downstream sectors will lead to a larger increase in the employment growth of non-fast-growth firms in the upstream sectors. Moreover, we find that the fast-growth customers' positive spillover effects on the supplier sectors in the high-tech manufacturing sectors are more pronounced in more agglomerated areas. Consistent with the localisation externalities theory, these findings corroborate the predictions of non-knowledge spillover effects due to co-locating sectors that share similar production inputs and facilities (Lichtenberg 1960; Henderson 1986; Arthur 1989; Rotemberg and Saloner 1990; Glaeser et al 1992). Market-creating effects generated by fast-growth customers are more likely to occur in

agglomerated locations where the sharing of production inputs and labour is more readily available and less costly.

Furthermore, by comparing the results among firms of different age and size, we find that small and old firms mostly drive the overall results. More specifically, the employment externalities of fast-growth firms in the horizontal sectors and the moderating effects of agglomeration are stronger for small firms, suggesting that small firms are more affected in their employment growth than their larger peers. We also observe that old non-fast-growth firms benefit more from the fast-growth customers' spillovers, but also suffer more from competition within the same sector in agglomerated areas, showing the comparative advantage of a stronger customer base, but at the same time a degree of technological weakness compared to young firms.

The estimates of the control variables are largely consistent with the literature, finding a positive and significant relationship between employment growth at the regional and firm level, and a negative relationship between employment and labour productivity growth, as expected. Being part of a larger business group is positively associated with employment growth of non-fast-growth firms, while older firms tend to increase their size at a slower pace.

The results in the main specification in column 1 are consistent with the robustness checks reported in Table A2 in the appendix measuring the region-industry spillover effect of fast-growth firms by cohort, and with the results presented in Table A3 in which regions are defined using LEP boundaries instead of NUTS classification for England.

### 4.2 Fast-productivity-growth firms' externalities in manufacturing sectors

Turning to the spillover effects of the fast-productivity-growth incidence rate reported in Table 3, we find a positive and highly statistically significant impact of SGHs on the labour productivity growth of other firms, irrespective of firm age and size, and particularly in the low-tech sectors. Consistently, higher rates of fast productivity growth incidence seem to spill labour productivity growth to other non-fast-growth firms both within the same sector and along the vertical industrial chain. Overall, a 1% increase in the incidence rate of SGHs within the same industry and region would prompt a 1.4% increase in the average labour productivity of non-fast-growth manufacturers. Interestingly, we find that the marginal effect of the spillovers is higher for low-tech firms at 1.9%, while being statistically insignificant for high-tech firms. This may suggest that there is more scope

for productivity catching up in low-tech sectors, or possibly, that the demonstration effect of productivity highflyers is more effective due to the low-tech nature of the sector.

Along the industrial vertical chains, an increase in the incidence rate of fast-growth suppliers seems to stimulate a strong positive effect for local firms' productivity growth for old and young firms, and across the low-tech and high-tech sectors (albeit with a stronger effect for the latter), and especially for SMEs. These results confirm the Marshall-Arrow-Romer (MAR) knowledge spillover prediction about within-sector effects, and Jacobs' theory predicting externalities between different but related sectors (Jacobs, 1969). The positive spillover effect of fast-growth firms incidence rate along the supply chain is also consistent with recent evidence in the innovation literature, suggesting that knowledge externalities derive from an increased incidence rate of fast-growth suppliers on the productivity growth of non-fast-growth firms in the downstream sectors (Isaksson et al 2016).

There could be multiple channels through which more productive suppliers could transmit productivity and efficiency to downstream customers. In addition to the knowledge spillover effect, the existing industrial organization literature explains well the potential stimuli of positive productivity externalities within the same sector, driven by competition-led efficiency improvements. Research refers to the pressures from perceived or actual competitors, which could affect productivity levels within the same industry. In addition, Syverson (2011) summaries the several mechanisms identified in the literature through which product-market competition enhances the productivity of an industry, such as through the Darwinian selection process (Forster, Haltiwanger and Krizan 2001), or via within-organization efficiency improvements that are frequently analysed by the trade literature (Schmitz 2005). Our findings seem to corroborate within-effect efficiency improvements in particular, highlighting productivity improvements associated with the impact of local fast-growth competitors (Abubakar and Mitra, 2017).

Similar to the employment growth externalities discussed in the previous section, we find a positive and significant moderating effect of agglomeration in the fast productivity growth suppliers' externalities to non-fast-growth companies. This result suggests that higher fast-growth firms among suppliers more effectively stimulate productivity improvement in other firms in more agglomerated industries-regions. Interestingly, our results highlight different externalities deriving from the industrial vertical integration of fast-growth firms. On the one hand, employment growth externalities are linked to agglomeration economies and fast-growth incidence rate in customer sectors, where

non-knowledge spillovers such as customer-base and localisation externalities are at play. On the other hand, productivity spillovers through agglomeration economies seem more likely to be knowledge and technology driven when they originate and flow from suppliers to customers. Furthermore, urbanisation externalities may also play a role, since fast-productivity-growth firms are more likely to spill over their knowledge and technology in more agglomerated urban areas where ideas and resources are more conveniently shared (Glaeser et al 1992).

Finally, analysing the fast-productivity-growth spillovers for different samples of firms, we do not find statistical differences in the spillover effects between large and small firms, or between old and young firms. However, the magnitudes of these effects range widely across the different samples, with a larger impact for large firms compared to SMEs. This indicates that firms may need to achieve a sufficiently large size that enables them to exploit economies of scale in order to be able to assimilate knowledge gained from fast-growth competitors (Cohen and Levinthal, 1990; Kotha et al., 2011). Despite this, spillovers from fast-growth suppliers and customers seem to be more relevant for SMEs rather than for large firms, probably due to the possibility of implementing learning-by-doing strategies, and the opportunity of setting up lasting industrial relationships between suppliers and customers; something that may not be as relevant for established and large companies (Isaksson et al 2016).

The results in the main specification in column 1 of Table 3 are consistent with the robustness checks reported in Table A2 in the appendix measuring the region-industry spillover effect of fast-growth firms by cohort, and with the results presented in Table A3 in which regions are defined using LEP boundaries instead of NUTS classification for England. The control variables are largely consistent with the previous literature, finding a positive and significant relationship between labour productivity growth at the region and firm level, and a negative relationship between employment and labour productivity growth, as expected. In addition, competition at the region-industry level measured by the net entry rate is positive and statistically significant, highlighting the positive association between a competitive environment and firms' productivity enhancement.

### 4.3 The overall fast-growth firms' externalities in the manufacturing sectors

In this section, we discuss the overall externalities of the fast-growth incidence rate in the manufacturing sectors, paying particular attention to the economic significance of the estimated average marginal effects of fast-growth incidence rate on employment growth

and productivity growth of non-fast-growth firms. Based on the estimates of the main model specifications previously reported in the first columns of Tables 2 and 3, we calculate the model prediction of the average employment and productivity growth effects, for both the horizontal and vertical industrial sectors. Further, by aggregating at the different levels, we discuss the overall spillover effects at the regional and industrial levels respectively, as illustrated in Figures 3 and 4. [16]

Overall, according to our estimates, increasing the fast-growth incidence rate by 1% leads to an overall slower employment growth by 0.35% in the same manufacturing industry in the same region, *ceteris paribus*. This translates to almost 122,000 jobs across the UK regions. This adverse impact appears quite significant, compared with what we know about new job creation due to fast growth firms.[17]

Geographically, a diverse picture of the national average negative spillover effects on employment growth emerges at the regional level. It appears that the strongest negative externalities on employment growth take place in relatively peripheral areas, with the highest negative effects being seen in the Highlands (-7.5%), Cheshire (-6.2%), north-east England (-2.6%), east Scotland (-2.4%), Lincolnshire (-2.3%), Devon (-1.7%) and Lancashire (-1.5%). In contrast, the major urban areas experience a positive spillover effect from fast-growth episodes in terms of employment growth, especially in Surrey (+1.7%), London (+1.05%), Kent (+0.5%), Leeds (+0.3%), Oxfordshire (+0.25%), and the West Midlands (+0.1%). This pattern further confirms our hypothesis that the negative externalities on the employment growth of non-fast-growth firms are stronger in peripheral areas, where local labour markets are less developed, and the costs of labour poaching are higher due to the particularly fierce competitive pressure exerted by fast-growth firms.

Turning to labour productivity effects, considering the horizontal sector and the vertical chains of customers and suppliers, the overall impact of a 1% increase in fast-growth incidence rate would result in a 1.5% increase in the average labour productivity of non-

[16] The discussion in this section is based on results at NUTS2 regional level, SIC2 industrial level. We also estimate the predicted effects by NUTS3 regional and SIC3 industrial level, as provided in Figure A1 in the Appendix.

[17] The existing evidence suggests that fast-employment-growth firms (OECD HGFs) generate the majority of all new jobs in the UK. Out of the 2.4 million all new jobs that were created by established businesses employing ten or more people in the past three years, about 1.3 million were created during a fast growth period, equating to roughly 54 per cent (NESTA, 2009).

fast-growth manufacturers. This indicates how both horizontal competition and vertical interactions with fast-growth firms induce a productivity improvement for non-fast-growth firms.

As was seen with employment growth, this spillover effect is fairly heterogeneous across regions and industries. But contrary to the employment growth patterns, we find that the effects are strong for non-fast-growth manufacturing firms based near metropolitan areas such as the Greater London area (-5.2%), and also in peripheral areas such as Cheshire (-5.2%), the South East (-4.3%), and Cornwall (-4.2%). Similarly, the areas in which the positive externality is stronger for the labour productivity of non-fast-growth firms are evenly scattered across the country, including eastern and western Scotland (+12%), London (+9%), Northern Ireland (+8.2%), Liverpool (+7%), Wales (+6%), and the West Midlands (+4.5%). The analysis at the LEP level in Figure A2 in the appendix confirms these findings, highlighting that the positive relationship between fast-growth spillovers and the productivity growth of non-fast-growth firms is evenly distributed across LEPs, with negative effects being seen only in the south-east and south-west LEPs.

Comparing employment growth spillovers and productivity growth spillovers, we find that the latter are more evenly distributed across the country. Interestingly, productivity spillovers are strong and positive in most of the regions that experience larger than average negative employment spillovers, mainly in the south of England. This evidence suggests that both employment and productivity growth externalities seem to be mainly driven by the increased competitive pressure and knowledge spillovers generated by fast-growth firms.

It is worth noting that these results are consistent with the predicted spillover effects measured at the LEP level in England (reported in Figure A1 in the appendix). These figures corroborate an overall negative impact of fast-growth on the employment growth of non-fast-growth firms; this is especially the case in Cornwall, Heart of the South West, and Cumbria. Positive employment growth as a result of an increased incidence rate of fast-growth firms is experienced by non-fast-growth firms in London, Cheshire, Liverpool, Buckinghamshire, and Oxfordshire.

Turning to the industrial sector aggregation, Figure 4 reports the ranked overall spillover effects of fast-growth firms on the employment and productivity growth of non-fast-growth firms for all SIC2 level industries in terms of magnitude. The industries that are mostly negatively affected in terms of employment growth by fast-growth spillovers are

the fuel (-8.2%), leather and apparel (-3.5%), mineral products (-1.6%), and food processing (-1.5%) sectors. The sectors positively affected in terms of employment by fast-growth spillovers are the automotive industry (+0.6%), the sector that produces medical and precision instruments (+0.5%), the publishing industry (+0.4%) and the electric machinery industry (+0.3%). The trend emerging from these results seems to point to an overall negative spillover effect, especially on the employment growth in the medium-low tech sectors, possibly suggesting a concentration of the labour share in these sectors to a smaller number of fast-growth companies, as suggested by Autor et al. (2017). The medium-high tech manufacturing sectors, on the other hand, seem to experience the positive externalities from fast-growth firms in terms of employment growth, suggesting an overall job-pooling spillover effect of fast-growth firms in these industries.

It is notable that the distribution of the most affected industries in terms of productivity growth differs widely across the country. In Figure 4 we notice that the non-fast-growth firms that benefited the most from the fast-growth externalities in terms of productivity growth are those producing metals and metal products (+6.8% on average), the producers of machinery (+3.1%), IT equipment (+3%) and those in the paper industry (+3%). On the contrary, only a limited number of manufacturing industries experience negative productivity externalities linked to the fast-growth incidence rate, mainly in the fuel sector (-15%), the leather and apparel industries (-3.5% on average), and the transport equipment sector (-2.1%).

In addition, the wider economic impact of fast-growth firms in a region also hinges on its industrial structure, which can vary considerably from region to region. We find that some industries benefit more from fast-growth firms in the region than do others. Examples are the apparel industry in the East Midlands, the computers industry in the West Midlands, the chemicals sector in Greater Manchester, and the leather industry in Hampshire. Other sectors experience stronger negative productivity spillover effects, such as the chemical sector in Devon, the leather sector in Shropshire, and the plastics industry around Liverpool.

Similarly, the largest negative externalities on the employment growth of the region are found in the plastics industry in Scotland, the transport equipment sector in Merseyside and Yorkshire, the textile industry in Lincolnshire, and the machinery sector in Wales. The strongest positive spillover for employment growth are registered in the leather industry around Bristol and Gloucestershire, the transport equipment sector in the East-

Midlands, and the sector for electric machineries around Liverpool. These results highlight that the regional/local labour market and industrial structure are crucial to explaining the complexity of the externalities of the fast-growth phenomenon.

### 4.4 Spatial externalities of fast-growth firms in manufacturing sectors

Next, we analyse the effect of spatial externalities originating from the geographical proximity of fast-growth firms. Here we estimate HGF spillovers on the employment and productivity growth of non-fast-growth firms located in the same region regardless of their industrial sector. This is in order to test Jacobs' theory (1969) that externalities are independent from firms' industry characteristics but arise instead from the diversity and variety of the local economic structure. Hence, we might expect that the population of fast-growth firms would impact other non-fast-growth firms located in the same region, regardless of the industrial activity (Sena et al., 2013).

As previously explained above in the methodological section, we adopt two of the most common measures of spatial externalities. The first is the share of local fast-growth firms over total employment at the postcode district level[18] in order to estimate the possible externalities linked to the agglomeration of firms at the most disaggregated geographical level. The second measure takes into consideration the one-to-one geographical distance between a non-fast-growth firm and its most proximate fast-growth firm, estimating the gravitational force between each pair of fast-growth and non-fast-growth companies. This Newtonian measure of gravity allows us to estimate the possible proximity-specific spillover effect, possibly capturing demonstration effects, knowledge spillover, and local market creation effects, as well as the competition effect in action.

The spatial analysis at the district level in columns 1 and 3 of Table 4 corroborates the previous findings for the industrial horizontal externalities. In particular, column 1 shows the negative effect of an increase in the fast-growth incidence rate on the employment growth of non-fast-growth firms located in the same district area. Overall, an increase of 1% in the incidence rate of fast-growth firms within the same postcode district area translates to a decrease of almost 0.3% in the employment of non-fast-growth manufacturers, regardless of their industry. In addition, the results in column 3

[18] According to the Royal Mail classification, postcode districts are defined by the first 4 digits of a postcode (e.g., CV23).

corroborate the previous finding of a positive and statistically significant impact of a higher incidence rate of fast-growth firms on the productivity growth of non-fast-growth companies, estimating a 0.2% increase in the average labour productivity of non-fast-growth firms as a consequence of a 1% increase of fast-growth manufacturers within the same district. These findings suggest again a crowding-out spillover effect of fast-growth firms on the employment growth of non-fast-growth firms, through increased competitive pressure on a constrained local labour market. This pressure may generate a labour poaching effect on non-fast-growth firms located in the same district area even though they do not operate in the same industry. At the same time, a larger incidence rate of fast-growth firms in the same district area has a positive impact on the productivity growth of non-fast-growth firms located in the same area, regardless of their sector. This evidence demonstrates how a larger geographical agglomeration of fast-growth firms can enhance pro-competitive effects, generating positive demonstration effects and knowledge spillovers regardless of the industrial specialization, with an overall positive impact on the productivity growth of non-fast-growth firms. This is consistent with the findings in the previous literature (Graham et al. 2010; Martin et al. 2011).

Columns 2 and 4 of Table 4 also report the results of the spatial analysis concerning fast-growth firms' gravity force on the employment and productivity growth of the closest located non-fast-growth firms. By using this more refined one-to-one relationship measure, we find that the closest located fast-growth firm has a strongly positive spillover effect on both the employment and productivity growth of non-fast-growth firms, boosting their employment growth by 0.5% and their productivity growth by almost 0.2%. These positive externalities are linked to possible demonstration effects and a new local demand for services and products originated by the closest fast-growth firm. However, the results indicate that where one-to-one localisation externalities exist, they tend to attenuate fairly rapidly with increased distance, as suggested in the previous literature (Graham, 2008). Moreover, this spillover measure also considers the size of both fast-growth and non-fast-growth companies in order to evaluate the role of economies of scale in order for the one-to-one relationship to work. The results suggest that both fast-growth and non-fast-growth firms need to be of a critical size in order to be able to attract each other and to generate a connection that enables them to mutually exploit the positive benefits deriving from it (Griffith et al. 2004; Abubakar and Mitra, 2017). The existing literature has established that firms with greater levels of absorptive capacity are more likely to receive possible spillovers and are better able to internalize the externalities deriving from fast-growth companies (Escribano et al. 2009).

The robustness checks reported in Tables A4 and A5 in the appendix corroborate the main results of our spatial analysis. Here, we estimate the spillover effects using a cohort approach (3 years growth period) based on a cohort-to-cohort increase in the incidence rate of fast-growth firms on the cohort-to-cohort employment and labour productivity growth of non-fast-growth firms.

### 4.5 Fast-growth firms' externalities in the professional services sectors

Finally, we turn to the professional services sector in the UK, which includes a range of different occupations providing support to businesses of all sizes and in all sectors. This sector includes real estate activities, renting services, IT related services, research and development, and other professional services such as legal, accounting, engineering, and business administration services. Professional services are considered to be critical to the success of the UK economy, representing 15% of UK GDP, 14% of employment, and 14% of exports.[19] As previously stressed, the professional service sectors registered the highest rate of fast-growth firms among the UK service sectors. The interactive nature of the professional service sectors with the other sectors in the economy also augurs the likely wider economic impact of these fast-growth firms on the other sectors.

In Table 5, we notice immediately a different pattern for the spillover effect of fast-growth firms in contrast to the manufacturing sectors. First, we find in column 1 a positive and statistically significant spillover effect of HGFs on the employment growth of non-fast-growth companies operating within the same region and industry. A 1% increase of fast-growth firms' incidence rate in the professional services sector would lead to a 0.3% employment growth for other non-fast-growth companies operating within the same industry and region. This reflects a market-creating effect of fast employment growth firms within the same sector and is characteristic of the professional services industries. One of the most important factors that may explain this finding is the fast, continuing, and accelerating trend of the increasing prominence of knowledge-based, service-oriented activities (OECD, 2000), which stimulate higher consumer and business demand, triggering an outsourcing of service-related activities from manufacturing firms and an increased emphasis on the role of IT. Hence fast-growth incidence rate, capturing increased service scope and capacity, may spur further growth of related sub-sectors within the professional service sectors. Further, the chain of growth may happen as a

[19] See for instance http://www.pwc.co.uk/assets/pdf/professional-services-factsheet.pdf.

result of service sectors outsourcing services to each other since this sector is broad and includes several related and complementary subdivisions.

We also find a small negative effect due to increased fast employment growth firms among suppliers, implying a market-replacing effect. This is not surprising since the same SIC2 professional service industries, such as legal and accounting activities and the IT service sectors, are the major suppliers to other sectors within the same broad industry.[20] In response to growing price-based competition and toughened regulation and compliance rules, many firms undercut prices in order to attract customers and seek ways of cost-saving, for example by investing in tailored computer software instead of purchasing services from the IT sectors. Labour mobility is made possible because some of the professional service sectors share similar skill requirements.

We find that agglomeration plays a mediating role in directing the spillover effects of fast growth. Not only do the previously discussed negative spillover effects of fast-growth suppliers turn out to be stronger in agglomerated areas, we also find strong positive spillovers on the average firm employment growth from fast-growth customers.

The more prominent role of agglomeration in professional services compared with manufacturing reflects the differences between the productive structures and labour skills required in the two industries. Unlike production in the manufacturing industries, which is embodied in machinery and organizational processes, services rely more on human capital and skills, which implies a stronger reliance on knowledge-based agglomeration externalities (Raspe and Van Oort 2008; Vega-Jurado et al. 2009; Grillitsch and Nilsson, 2017). In addition, some argue that the labour skills needed in some service sectors, especially in the professional services sector, are quite similar and hence may be easier to acquire in local labour markets, in contrast to some very specific skills that are needed in the manufacturing sectors. For this reason, we might expect to find labour pooling in the service sectors rather than labour poaching effects, given its more flexible and adaptable labour market and the larger availability of skills needed (Hidalgo et al. 2007; WEC, 2016; Neffke et al. 2016). This sector has expanded quickly

[20] For example, according to our data, for Legal and Accounting activities (74), the top suppliers are Legal and Accounting activities (74), and Scientific and Research Development (73). For Real estate (70), the top suppliers are Legal and Accounting activities (74), Restaurant (55), and so on.

since 2000, particularly in the UK, and enjoys advantages in terms of access to the open market, a flexible labour regime, and an innovative approach to business practices (BIS, 2013).

Analysing the vertical industrial integration of non-fast-growth firms, just as for the manufacturing industries, we find positive spillovers on employment growth originating from a higher incidence rate of fast-growth customers for firms operating in particularly agglomerated industrial districts. The investigation of the spatial externalities in columns 2 and 3 confirms the main result that fast-growth externalities, even from different industries, have a positive impact on the employment growth of non-fast-growth firms in the professional services sector. However, this positive relation holds only for particularly agglomerated region-industries or in the presence of a strong one-to-one gravity force between fast-growth and non-fast-growth companies. This result is in line with the evidence provided by the previous literature which, by investigating the localisation externalities in the manufacturing and service industries, has identified a weak impact from spatial spillovers for the services sector that attenuates fairly rapidly as the distance increases (Graham, 2008).

Columns 4, 5 and 6 in Table 5 report the fast-growth externalities for the productivity growth of non-fast-growth firms in the professional service sector at the industrial and spatial level. In contrast to the manufacturing sectors, the region-industry horizontal productivity spillover effect for the professional services sector is negative, indicating that an increased presence of SGFs by 1% leads primarily to competition-driven crowding-out effects, with an overall decrease in productivity growth for non-fast-growth firms of almost 5.6%. This is consistent with the recent evidence that an above-average number of UK firms reported skills availability as a constraint on investment (CBI Service Sector Survey, 2015) and the UK is particularly suffering from the lack of labour supply for high-skilled and technology-related jobs (The UK Employer Skills Survey, 2017).[21] In addition, the ramping competition faced by professional services sectors in the recent years means the service contracts may concentrate to top performers, especially in the rising demand and expectations from customers and increasingly prevalent external talent

21 The report can be seen at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/746493/ESS_2017_UK_Report_Controlled_v06.00.pdf.

networks as a resourcing model that professional service firms adopt, such as contractors and service providers.

Our results in column 4 show that spillover effects across the vertical chain are positive, comparative to the manufacturing sectors. It indicates a degree of market creating or knowledge spillover effects for downstream and upstream fast-growth firms. Such negative externalities from the horizontal competition of fast-growth firms is confirmed by the gravity force analysis in column 6, where the close location of another professional service fast-growth firm increases the competitive pressure on non-fast-growth companies, with negative impacts felt in terms of productivity and even survival. This is particularly the case when professional services are highly clustered in specific areas, as suggested by the negative and significant coefficient of the agglomeration interaction. Finally, in column 5 we find a positive impact of fast-growth firms from different industries that are spatially located in the same district on the productivity growth of non-fast-growth firms operating in the professional services industry. This result corroborates the Jacobsian theory of localization externalities for the professional services industry, since the positive spillovers in terms of productivity come from outside the core industry and arise from the diversity and variety of the regional economic structure. These localization externalities could originate from several sources, such as tacit spillovers originating from social interactions, partnerships, and the exploitation of new business opportunities created in the local markets. This evidence stresses once more how local specialization could bring about static competition in the professional services industry whereas encouraging diversity could bring dynamic and evolving advantages for non-fast-growth firms, improving their productivity through interaction with fast-growth firms from different industries (Imbes and Wacziarg, 2003).

### 4.6 Discussion

The results presented so far shed a new light on the fast-growth phenomenon. The previous literature on fast-growth firms has mainly focused on investigating the triggers and characteristics of fast-growth firms, and their direct contribution to employment and productivity growth, without considering their spillover effects on other firms in the economy. We show in this study that these external impacts may strengthen or weaken firms' performance by promoting the growth of other firms located within regional and industrial boundaries or, conversely, crowding them out. However, the findings of the manufacturing sectors differ noticeably from that of the professional service sectors. In

addition, the external impacts may spread over a broad range of sectors vertically integrated in production value chains.

These findings of the manufacturing sectors taken together suggest, on the one hand, that an increased incidence rate of fast-growth firms within an industry-region results in increased pressure on the labour market, making it more difficult for competitors to attract skills and labour. On the other hand, an increased incidence rate of fast productivity growing firms exercises competition-led externalities of productivity growth that are, overall, positive. Interestingly, these contrasting effects suggest that simultaneously promoting employment growth and productivity growth may generate incompatible results.

This study also investigates the consequences of having a larger incidence rate of fast-growth firms in various regions and industries. By identifying the external impacts of fast-growth firms, we can better understand the overall fast-growth phenomenon at the regional and sectoral level. More specifically, we have analysed both the fast-growth phenomenon's beneficial effects of market-creating and knowledge spillovers, and its adverse employment impact. From a policy perspective, it is important to separately consider the drivers at regional and sectoral level of the fast-growth phenomenon, and the factors that facilitate or moderate the externalities of fast-growth. To this end, further analysis needs to be conducted in greater detail and at a more disaggregated level. As Storey and Greene (2010) argue, ultimately the ability of a country to nurture its fast-growth businesses is probably the most important element in enterprise development.

Finally, one of the main findings of our analysis is that in many UK regions, the negative externalities of the fast-growth phenomenon within the same industrial sectors could suggest that there is intense competition for labour and skills. This is consistent with the existing evidence that a skills deficiency is one of the primary reasons the UK's productivity lags behind that of other nations (Leitch, 2006). Our finding shows that this problem could be exacerbated in less agglomerated regions and peripheral areas, where fast-growth firms could further increase the competition pressure on the limited local labour markets.

Turing to the patterns of professional service sectors, we find marked differences from the manufacturing sectors. Higher HGF incidence rate has market-creating impact on other firms within the same region and industry, and market-replacing effects from suppliers in the value chains. Further, fast-productivity-growth firm incidence rate has

negative spillovers on other firms in the same region and sector, and positive spillovers along the value chains. These interesting contrasts feature the distinct characteristics of the professional services sectors from the manufacturing, for consisting of closely related subsectors, highly competitive, requiring highly skilled labour and frequently experiencing business model disruptions, all of which are driving significant transformation in the sector, demanding professional services providers deliver quality, speed and agility while stay lean, specialised and digitally capable.

It is worth noting that our findings offer mainly a short-term view on the competition-led crowding-out effect due to the fast-growth firms (superstar firms). This means that we cannot exclude the possibility that in the longer term, this process could lead to industrial structural change and the reallocation of resources to more productive firms/sectors. Partially, the ultimate outcomes also depend on the industrial/regional responses to the competition and crowding-out effects, which could be shaped by a pro-active industrial strategy.

## 5. CONCLUSIONS

Building upon the previous fast-growth and externality literatures, this study has investigated the external impact of fast-growth firms on productivity and job creation of the rest non-fast-growth firms in the UK. This is the first study that looks at the impact of fast-growth firms' spillovers, linking high-growth and industrial externality theories to identify the externalities of the fast-growth phenomenon on the surrounding firms and integrated industries.

Using comprehensive firm-level data on UK firms, and adopting different measures of fast-growth, our econometric analysis shows that in the manufacturing sectors, fast-growth externalities within the same industry and region have opposite effects on employment and productivity. A higher proportion of fast-employment-growth firms in the manufacturing sectors has a negative spillover effect on overall employment growth in the same industry-region, while a higher proportion of SGHs drive up competition and generate positive spillover effects in terms of labour productivity.

Further, there are positive inter-industry externalities for both fast-growth in employment and productivity. Specifically, more high-employment-growth firms in the downstream sectors have positive market-creating spillover effects on employment in the upstream sectors. In addition, the positive inter-industry productivity externalities from fast-growth

firms are more prevailing, both from the supply and demand sides, as a result of knowledge spillovers and demonstration effects.

The gravity and spatial analyses corroborate our main findings, highlighting closer distance intensifies these effects, while these findings are more pronounced among small, old firms, and especially in the low-tech sectors. In addition, agglomeration plays an important role in mediating the externalities, with the strongest negative externalities on employment growth taking place in peripheral areas, whereas the major urban areas experience a positive spillover effect from the fast-growth episodes both in terms of employment and productivity growth.

There are several policy implications. First, achieving job creation and promoting productivity at the same time may prove challenging. National and subnational policy-makers need to be mindful of this tension, and may require prioritising one over the other given specific circumstances in an industry-regional economic and social context.

Second, the externalities of fast growth firms in the manufacturing sectors seem to show that in the short run, more fast-productivity-growth firms are beneficial to other firms, potentially due to competition effects and knowledge spillovers, while more fast-employment-growth firms may put a strain on other firms' abilities to attract skills and labour. This suggests that targeted growth policies can be compounded in their impacts by maximising positive spillovers through a focus on industrial clusters (to exploit the benefits of geographical agglomeration) and vertical integration, whilst at the same time taking in to account regional limitations which could lead to negative spillovers arising due to competition-led crowding-out.

Our analysis on the professional service sectors yields different patterns from the manufacturing sectors. We find positive, market-creating impact of high-employment-growth firms on employment growth within the same region and industry, and market-replacing effects from suppliers in the value chains, while negative spillovers of high-productivity-growth firms on other firms in the same region and sector, and positive spillovers along the value chains. These different patterns highlight the distinct features of these sectors and the specific challenges faced by the firms in the context of rising competitive pressure, digital economy and disruptions of business models.

We need to account for the strengths and limitations of our analysis. Firm-level population data from the ONS Business Structure Database (BSD) allow us to build a full representation of the economic growth patterns of UK firms in the whole economy over the examined period at aggregate, sector, and regional level, and among heterogeneous groups. But it does not contain sufficient information about firm operation, for example capital, intermediate input use, or value-added. These data would have enabled us to construct a measure of total factor productivity or other, more robust, measures of productivity, especially for the service sector. In addition, it does not provide any indicators of firms' innovation and internationalization which would have been useful for capturing both the drivers of fast-growth firms and how non-fast-growth firms might be affected by externalities. Finally, labour productivity may not reflect on the true productive performance of the professional service sectors.

While this paper achieves to establish the evidence of the wider economic impact of fast growth phenomena, it provides limited insights on the mechanisms through which fast-growth firms affect others in the region and industry, and across industry and space. Further research about the mechanisms through which fast growth externalities occur will deepen our understanding about these important effects and help design appropriate measures to promote long-term balanced growth. Possible mechanisms of knowledge spillovers, market structure and competition, labour market conditions and skills provision, as well as infrastructure and connectivity issues, should be on the top of future research agenda.

## TABLES and FIGURES

### Table 1: Characteristics of UK fast-growth firms in the manufacturing and professional services sectors, 1997-2013

| **Manufacturing** | **Overall** | | **SGHs** | | **HGFs** | |
|---|---|---|---|---|---|---|
| *No. of observations and ratio* | 2,823,945 (100%) | | 153,339 (5.4%) | | 120,690 (4.3%) | |
| | ***Mean*** | ***S.D.*** | ***Mean*** | ***S.D.*** | ***Mean*** | ***S.D.*** |
| *Tot. Employment* | 21.13 | 202.14 | 74.15 | 467.30 | 54.33 | 280.80 |
| *Turnover* | 2,948.95 | 77,105.55 | 16,232.44 | 179,711.20 | 6,756.48 | 51,204.58 |
| *Lab. Productivity* | 90.11 | 1,967.61 | 174.75 | 731.81 | 162.92 | 1,239.06 |
| *Av. Age* | 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 |
| **Prof. Services** | **Overall** | | **SGHs** | | **HGFs** | |
| *No. of observations and ratio* | 11,204,171 (100%) | | 367,708 (3.3%) | | 374,114 (3.4%) | |
| | ***Mean*** | ***S.D.*** | ***Mean*** | ***S.D.*** | ***Mean*** | ***S.D.*** |
| *Tot. Employment* | 7.62 | 128.91 | 20.87 | 225.78 | 46.02 | 350.57 |
| *Turnover* | 4,535.42 | 15,257.11 | 6,412.50 | 1,572.94 | 6,258.90 | 2,120.70 |
| *Lab. Productivity* | 107.70 | 2,240.24 | 247.36 | 1609.91 | 201.73 | 5806.35 |
| *Av. Age* | 8.64 | 7.33 | 9.34 | 6.93 | 9.52 | 7.19 |
| *Foreign Ownership* | 1.25% | 0.11 | 4.71% | 0.21 | 4.74% | 0.21 |
| *Group* | 50.62% | 0.50 | 52.55% | 0.50 | 68.22% | 0.47 |
| *SMEs* | 99.76% | 0.05 | 99.05% | 0.10 | 97.60% | 0.15 |
| *Young* | 52.65% | 0.50 | 45.24% | 0.50 | 44.42% | 0.50 |

***Notes:*** *Statistics based on the Business Structure Database (BSD) between 1997 and 2013. Turnover expressed in thousands of pound. Super Growth Heroes (**SGH**): firms that have experienced a positive labour productivity growth over a 3-year period with both turnover and employment growth and labour productivity it's above 3-years average labour productivity of its sector at the SIC 3-digit level. High Growth Firms (**HGF**): the total employment of firms with more than 10 employees grows by more than 20% over a 3 years period, or if the total employment of firms with less than 10 employees grows by more than 8 new employees over a 3 years period. Manufacturing firms: SIC (2003) sectors between code 15 and code 37. Prof. Services: SIC (2003) sectors between code 70 and code 74. High-Tech: firms with a SIC code (2003) equal to 35, 24, 30, 32, 33, 31, 34 and 29.*

**Table 2: Region-Industry Spillover Effect of High Growth Firms (HGFs) on the Employment Growth of non-fast-growth firms in the Manufacturing Sectors.**

| | Employment Growth | | | | | | |
|---|---|---|---|---|---|---|---|
| | (1) Manufacturing Overall | (2) Large | (3) SME | (4) Old | (5) Young | (6) Low-Tech | (7) High-Tech |
| *FG_IH$_{rst}$* | -0.00351** | -0.0024 | -0.104*** | -0.00721*** | 0.00058 | -0.00367 | -0.0029 |
| | (0.0018) | (0.002) | (0.017) | (0.002) | (0.003) | (0.002) | (0.003) |
| *FG_CUS$_{zst}$* | 0.0152*** | 0.0201 | 0.0155*** | 0.0149*** | 0.0149*** | 0.0160*** | 0.0154*** |
| | (0.0024) | (0.0199) | (0.0024) | (0.0029) | (0.0039) | (0.0028) | (0.005) |
| *FG_SUP$_{jst}$* | 0.0005 | 0.0078 | 0.0005 | 0.0003 | 0.0015 | 0.0014 | 0.0002 |
| | (0.0017) | (0.0088) | (0.0011) | (0.0014) | (0.0019) | (0.0015) | (0.0017) |
| *FG_IH#Aggl.* | -0.909 | 1.378 | -0.879 | -1.474** | -0.0717 | -0.733 | -1.434 |
| | (0.593) | (4.971) | (0.596) | (0.733) | (0.941) | (0.710) | (1.064) |
| *FG_CUS#Aggl.* | 0.355* | 1.778 | 0.385* | 0.819*** | 0.423 | 0.158 | 1.252*** |
| | (0.203) | (2.440) | (0.203) | (0.262) | (0.323) | (0.224) | (0.550) |
| *FG_SUP#Aggl.* | 0.146 | -0.705 | 0.142 | -0.333 | 0.405* | 0.174 | 0.258 |
| | (0.162) | (2.132) | (0.162) | (0.225) | (0.235) | (0.181) | (0.455) |
| *Agglom. Index$_{rst}$* | 0.224 | -0.457 | 0.304** | -0.0534 | 0.605*** | 0.345** | -0.144 |
| | (0.150) | (1.127) | (0.151) | (0.193) | (0.231) | (0.166) | (0.370) |
| *Employment$_{it}$* | 0.209*** | 0.0596*** | 0.216*** | 0.157*** | 0.278*** | 0.219*** | 0.201*** |
| | (0.001) | (0.003) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| *Lab. Productivity$_{it}$* | -0.0222*** | -0.0418*** | -0.0217*** | -0.0189*** | -0.0262*** | -0.0234*** | -0.0167*** |
| | (0.000) | (0.003) | (0.001) | (0.001) | (0.006) | (0.001) | (0.001) |
| *Age$_{it}$* | -0.0833*** | 0.0265*** | -0.0852*** | -0.0776*** | -0.065*** | -0.0863*** | -0.0738*** |
| | (0.001) | (0.009) | (0.001) | (0.003) | (0.002) | (0.001) | (0.002) |
| *Foreign Own.$_{it}$* | 0.00276 | 0.00232 | -0.00047 | 8.04E-05 | 0.00650* | 0.002 | 0.00021 |
| | (0.002) | (0.004) | (0.002) | (0.002) | (0.003) | (0.002) | (0.002) |
| *Group$_{it}$* | 0.0168*** | -0.00714 | 0.0124*** | 0.0114*** | 0.0210*** | 0.0142*** | 0.0187*** |
| | (0.001) | (0.013) | (0.001) | (0.001) | (0.002) | (0.001) | (0.001) |
| *D.Employment$_{rst}$* | 0.00312*** | 0.0493*** | 0.00255*** | 0.00385*** | 0.00249*** | 0.00278*** | 0.00372*** |
| | (0.000) | (0.004) | (0.001) | (0.0010) | (0.001) | (0.001) | (0.007) |
| *D.Lab. Prod$_{rst}$* | -0.00461*** | 0.00181 | -0.0047*** | -0.0039*** | -0.0052*** | -0.0044*** | -0.0048*** |
| | (0.001) | (0.004) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| *Net Entry Rate$_{rst}$* | 0.00201*** | 0.0133** | 0.00167** | 0.00281*** | 0.000104 | 0.00198** | -0.00041 |
| | (0.001) | (0.007) | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) |
| *R&D Intensity$_{rst}$* | 0.00949** | 0.0671 | 0.00900* | 0.0161*** | 0.00146 | 0.00672 | 0.00856 |
| | (0.005) | (0.045) | (0.005) | (0.006) | (0.008) | (0.005) | (0.010) |
| *Observations* | 1,680,139 | 20,429 | 1,659,710 | 855,552 | 824,587 | 1,305,685 | 374,454 |
| *No. Firms* | 318,862 | 2,920 | 315,942 | 118,488 | 200,374 | 246,886 | 77,754 |

***Notes:*** *Estimation based on the Business Structure Database (BSD), 1997-2013. Fast Growth defined as High Growth Firms (**HGFs**): total employment of more than 10 and grow by more than 20% over a 3-year period, or if the total employment of firms with less than 10 employees and grow by more than 8 new employees over a 3-year period. Manufacturing firms: SIC code (2003) sectors 15-37. SMEs: firms with less*

*than 250 employees in their first period in the BSD. Young: firms less than 5 years old in their first period in the BSD. High-Tech: firms with a SIC code (2003) equal to 35, 24, 30, 32, 33, 31, 34 and 29.*

**Table 3: Region-Industry Spillover Effect of Fast-growth Firms (SGHs) on the Productivity Growth of non-fast-growth firms in the Manufacturing Sectors.**

| | Productivity Growth | | | | | | |
|---|---|---|---|---|---|---|---|
| | (1) Manufacturing overall | (2) Large | (3) SME | (4) Old | (5) Young | (6) Low-Tech | (7) High-Tech |
| *FG_IH$_{rst}$* | 0.0144*** | 0.144*** | 0.0131*** | 0.0149*** | 0.0144** | 0.0187*** | 0.00787 |
| | (0.004) | (0.034) | (0.004) | (0.005) | (0.007) | (0.006) | (0.007) |
| *FG_CUS$_{zst}$* | 0.0124*** | 0.0168 | 0.0116** | 0.004 | 0.0213*** | 0.00246 | 0.0386*** |
| | (0.0047) | (0.0338) | (0.0047) | (0.0057) | (0.0077) | (0.0064) | (0.0093) |
| *FG_SUP$_{jst}$* | 0.0417*** | 0.0350 | 0.0414*** | 0.0457*** | 0.0361*** | 0.0363*** | 0.0687*** |
| | (0.0034) | (0.0310) | (0.003) | (0.0042) | (0.0055) | (0.0036) | (0.0127) |
| *FG_IH#Aggl.* | 0.0615 | 3.178 | -0.0396 | -0.0481 | 0.24 | 0.825 | -1.379 |
| | (1.266) | (11.270) | (1.274) | (1.666) | (1.916) | (1.549) | (2.246) |
| *FG_CUS#Aggl.* | 2.331** | -1.317 | 2.304** | 4.055*** | 0.849 | 1.489 | 5.158* |
| | (0.932) | (9.951) | (0.936) | (1.164) | (1.501) | (1.007) | (2.775) |
| *FG_SUP#Aggl.* | 4.421*** | 6.841 | 4.352*** | 6.389*** | 2.112 | 3.950*** | 5.686* |
| | (0.954) | (10.421) | (0.959) | (1.223) | (1.480) | (1.014) | (3.178) |
| *Agglom. Index$_{rst}$* | 1.388*** | 1.68 | 1.322*** | 1.403*** | 1.504*** | 1.649*** | -0.526 |
| | (0.353) | (2.287) | (0.356) | (0.456) | (0.543) | (0.387) | (0.926) |
| *Employment$_{it}$* | -0.0358*** | 0.0121** | -0.0390*** | -0.0191*** | -0.0605*** | -0.0404*** | -0.0262*** |
| | (0.001) | (0.005) | (0.001) | (0.001) | (0.002) | (0.001) | (0.002) |
| *Lab. Productivity$_{it}$* | 0.399*** | 0.328*** | 0.399*** | 0.370*** | 0.424*** | 0.404*** | 0.395*** |
| | (0.001) | (0.001) | (0.006) | (0.001) | (0.001) | (0.001) | (0.002) |
| *Age$_{it}$* | 0.0650*** | -0.091*** | 0.0661*** | 0.0441*** | 0.151*** | 0.0697*** | 0.0495*** |
| | (0.002) | (0.018) | (0.002) | (0.006) | (0.004) | (0.002) | (0.005) |
| *Foreign Own.$_{it}$* | -0.0175*** | -0.00841 | -0.0130*** | -0.0124*** | -0.0256*** | -0.0133** | -0.0216*** |
| | (0.004) | (0.010) | (0.004) | (0.004) | (0.008) | (0.006) | (0.006) |
| *Group$_{it}$* | -0.0221*** | -0.00062 | -0.0175*** | -0.0263*** | -0.0150*** | -0.0189*** | -0.0359*** |
| | (0.002) | (0.025) | (0.002) | (0.002) | (0.004) | (0.002) | (0.004) |
| *D.Employment$_{rst}$* | -0.00397*** | -0.052*** | -0.0034*** | -0.0044*** | -0.00339** | -0.0036*** | -0.0045*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) | (0.0010) | (0.001) |
| *D.Lab. Prod$_{rst}$* | 0.0271*** | 0.0219*** | 0.0272*** | 0.0228*** | 0.0315*** | 0.0289*** | 0.0215*** |
| | (0.001) | (0.008) | (0.001) | (0.002) | (0.002) | (0.002) | (0.002) |
| *Net Entry Rate$_{rst}$* | 0.00552*** | 0.00565 | 0.00575*** | 0.00261 | 0.00908*** | 0.00740*** | 0.000286 |
| | (0.002) | (0.013) | (0.002) | (0.002) | (0.003) | (0.002) | (0.004) |
| *R&D Intensity$_{rst}$* | -0.00182 | -0.0542 | -0.00189 | -0.0108 | 0.00477 | 0.0096 | -0.0358 |
| | (0.011) | (0.100) | (0.011) | (0.014) | (0.017) | (0.012) | (0.024) |
| *Observations* | 1,668,802 | 17,227 | 1,651,575 | 847,358 | 821,444 | 1,294,986 | 373,816 |
| *No. Firms* | 319,992 | 2,809 | 317,183 | 117,904 | 202,088 | 247,856 | 78,195 |

***Notes:*** *Estimation based on the Business Structure Database (BSD), 1997-2013. Fast Growth defined Super Growth Heroes (**SGH**): firms that have experienced a positive labour productivity growth over a 3-year period with both turnover and employment growth and labour productivity it's above 3-years average labour productivity of its sector at the SIC 3-digit level. Manufacturing firms: SIC code (2003) sectors 15-37. SMEs: firms with less than 250 employees in their first period in the BSD. Young: firms less than 5 years old*

*in their first period in the BSD. High-Tech: firms with a SIC code (2003) equal to 35, 24, 30, 32, 33, 31, 34 and 29.*

**Table 4: Spatial Spillover Effect of Fast-growth Firms on the Employment and Productivity Growth of non-fast-growth firms in the Manufacturing Sectors.**

| | Employment Growth | | Productivity Growth | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | *District Level* | *Gravity Force* | *District Level* | *Gravity Force* |
| *FG Spat. Spillover$_{rt}$* | -0.00289*** | | 0.00210*** | |
| | (0.000) | | (0.000) | |
| *FG Spat. Spill.#Aggl.* | -0.31 | | 0.26 | |
| | (0.208) | | (0.210) | |
| *FG Gravity Force$_{it}$* | | 0.00535*** | | 0.00192*** |
| | | (0.000) | | (0.000) |
| *FG Gravity#Aggl.* | | -0.0526*** | | -0.00943 |
| | | (0.016) | | (0.0145) |
| *Agglom. Index$_{rst}$* | 0.631*** | 0.760*** | 0.599*** | 0.651*** |
| | (0.121) | (0.11) | (0.116) | (0.133) |
| *Employment$_{it}$* | 0.389*** | 0.394*** | -0.0108*** | 0.00676*** |
| | (0.0018) | (0.001) | (0.001) | (0.001) |
| *Lab. Productivity$_{it}$* | -0.0416*** | -0.0296*** | 0.598*** | 0.600*** |
| | (0.0009) | (0.000) | (0.001) | (0.002) |
| *Age$_{it}$* | -0.157*** | -0.120*** | 0.0280*** | 0.0513*** |
| | (0.0020) | (0.001) | (0.001) | (0.001) |
| *Foreign$_{it}$* | -0.00212 | 0.00230* | -0.00527*** | -0.00577*** |
| | (0.0013) | (0.001) | (0.000) | (0.001) |
| *Group$_{it}$* | 0.000492 | 0.00910*** | -0.00916*** | -0.00815*** |
| | (0.0006) | (0.000) | (0.000) | (0.000) |
| *D.Employment$_{rt}$* | 0.0210*** | 0.0103*** | -0.00831*** | -0.0105*** |
| | (0.0018) | (0.001) | (0.001) | (0.001) |
| *D.Lab.Productivity$_{rt}$* | -0.0481*** | -0.0318*** | 0.0506*** | 0.0489*** |
| | (0.0021) | (0.001) | (0.001) | (0.002) |
| *Net Entry Rate$_{rt}$* | 0.00021 | 0.000350* | 0.000457*** | 0.000539** |
| | (0.0001) | (0.000) | (0.000) | (0.000) |
| *R&D Intensity$_{rt}$* | -0.0128* | -0.0196*** | -0.00315 | -0.00218 |
| | (0.0073) | (0.006) | (0.006) | (0.008) |
| *Observations* | 1,550,780 | 1,525,169 | 1,614,133 | 1,451,442 |
| *No. Firms* | 302,116 | 310,291 | 307,452 | 303,877 |

***Notes:*** *Estimation based on the Business Structure Database (BSD) between 1997 and 2013. Fast Growth defined as High Growth Firms (**HGF**) for employment growth models and as Super Growth Heroes (**SGH**) for labour productivity growth models. Manufacturing firms: SIC (2003) sectors between code 15 and code 37.*

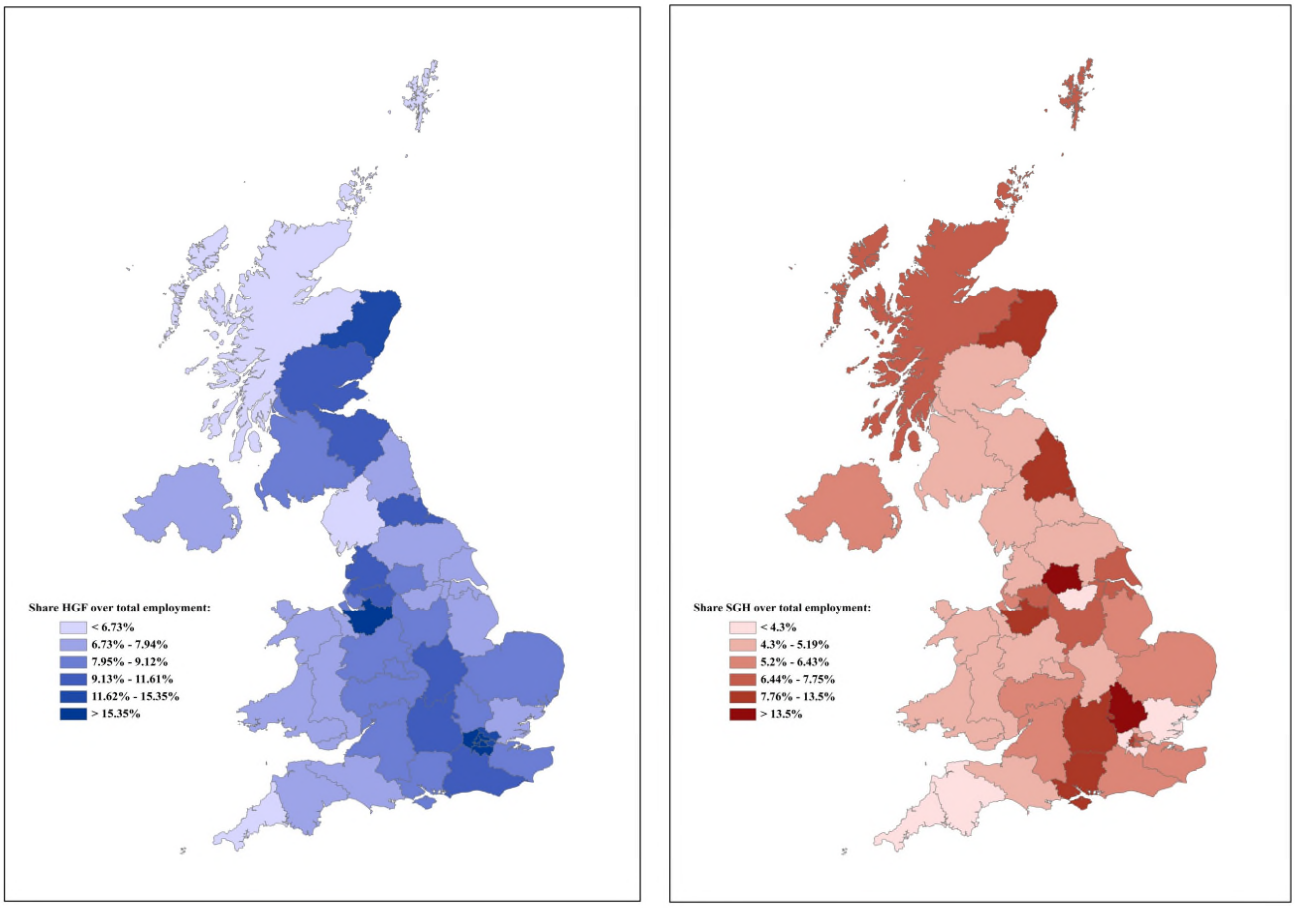
**Table 5: Region-Industry and Spatial Spillover Effects of Fast-growth Firms on the Employment and Productivity Growth of non-fast-growth firms in the Professional Service Sectors.**

| | Employment Growth | | | Productivity Growth | | |
|---|---|---|---|---|---|---|
| | (1) *Region-Industry* | (2) *District Level* | (3) *Gravity Force* | (4) *Region-Industry* | (5) *District Level* | (6) *Gravity Force* |
| *FG_IH* | 0.00371** | -0.00181 | 0.00266*** | -0.0556*** | 0.0164*** | -0.00594*** |
| | (0.001) | (0.001) | (0.000) | (0.006) | (0.004) | (0.000) |
| *FG_IH#Aggl* | -0.0347 | 0.146*** | 0.114 | 0.1099 | -0.745*** | -0.0556*** |
| | (0.0604) | (0.052) | (0.151) | (0.247) | (0.149) | (0.007) |
| *FG_SUP* | -0.0056*** | | | 0.120*** | | |
| | (0.1381) | | | (0.0057) | | |
| *FG_CUS* | -0.01059 | | | 0.0865*** | | |
| | (0.0155) | | | (0.006) | | |
| *FG_CUS# Aggl.* | 0.3994*** | | | 0.9753*** | | |
| | (0.100) | | | (0.285) | | |
| *FG_SUP# Aggl.* | -0.262* | | | -1.805*** | | |
| | (0.108) | | | (0.298) | | |
| *Agglom. Index$_{rst}$* | 0.0316*** | -0.033 | -0.00524 | -0.137*** | -0.335*** | 0.257*** |
| | (0.008) | (0.022) | (0.013) | (0.027) | (0.047) | (0.043) |
| *Employment$_{it}$* | 0.270*** | 0.435*** | 0.318*** | -0.0152*** | 0.00166 | -0.0124*** |
| | (0.000) | (0.001) | (0.000) | (0.001) | (0.001) | (0.001) |
| *Lab. Prod$_{it}$* | -0.0113*** | -0.0220*** | -0.0100*** | 0.428*** | 0.639*** | 0.469*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.001) | (0.000) |
| *Age$_{it}$* | -0.0687*** | -0.115*** | -0.0712*** | 0.112*** | 0.125*** | 0.127*** |
| | (0.000) | (0.001) | (0.000) | (0.001) | (0.002) | (0.002) |
| *Foreign Own$_{it}$* | 0.000813 | -0.0224*** | 0.00329* | -0.00753** | -0.0170*** | 0.0071 |
| | (0.001) | (0.003) | (0.002) | (0.003) | (0.005) | (0.006) |
| *Group$_{it}$* | -0.00285*** | -0.0308*** | -0.00427*** | 0.0340*** | -0.0230*** | 0.0399*** |
| | (0.000) | (0.001) | (0.001) | (0.001) | (0.002) | (0.002) |
| *D.Employment$_{rst}$* | -0.000321* | 0.00045 | -0.00101*** | 0.00565*** | -0.00031 | 0.000242 |
| | (0.000) | (0.000) | (0.000) | (0.001) | (0.001) | (0.001) |
| *D.Lab. Prod$_{rst}$* | 0.000171 | -0.0015*** | -0.00033 | 0.0136*** | 0.0199*** | 0.0245*** |
| | (0.000) | (0.000) | (0.000) | (0.001) | (0.001) | (0.001) |
| *Net Entry Rate$_{rst}$* | -7.61E-06 | 5.22E-05 | -3.60E-06 | -3.90E-06 | -8.83E-05 | -0.00034 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| *R&D Intensity$_{rst}$* | -0.0520*** | -0.0003*** | -7.17E-05 | 0.659*** | -0.0012*** | -0.0009*** |
| | (0.019) | (0.000) | (0.000) | (0.059) | (0.000) | (0.000) |

| | | | | | | |
|---|---|---|---|---|---|---|
| *Observations* | 7,493,913 | 6,702,937 | 5,264,427 | 7,424,195 | 6,566,906 | 4,619,256 |
| *No. Firms* | 1,631,410 | 1,497,515 | 1,271,597 | 1,636,994 | 1,483,295 | 1,183,748 |

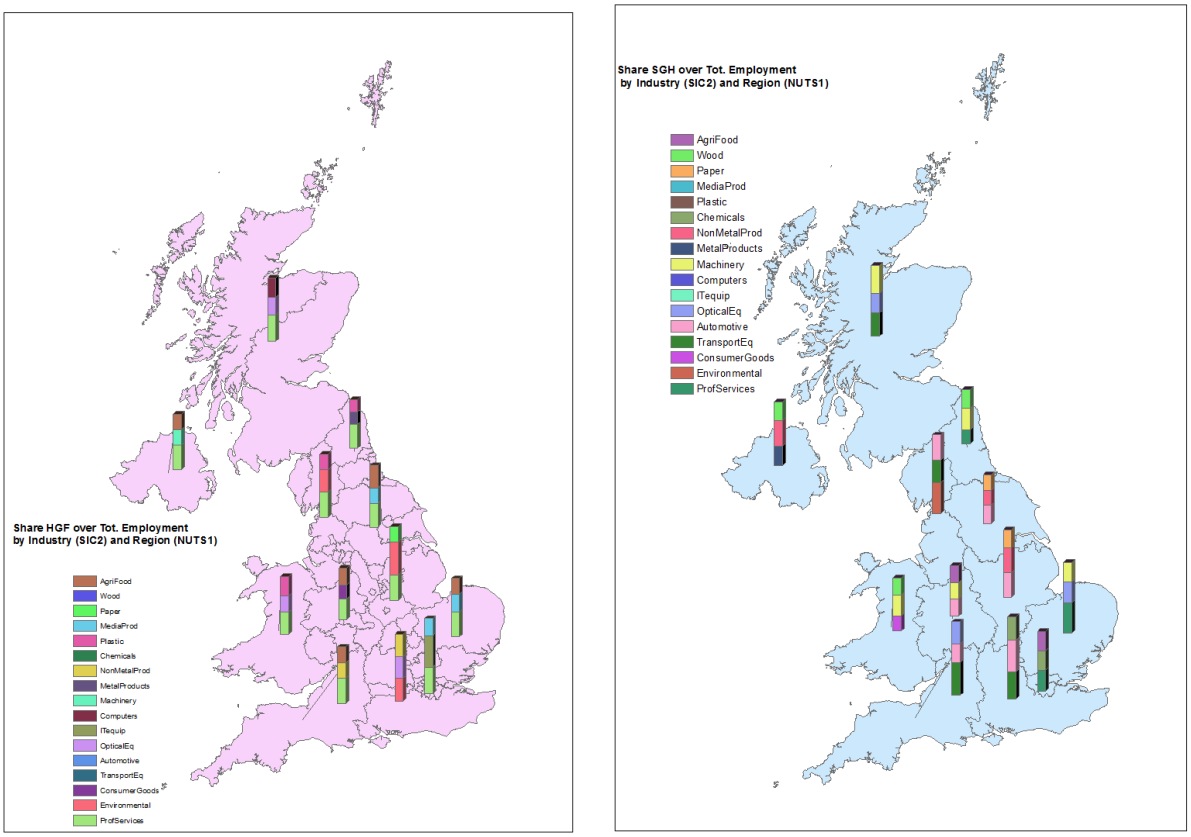
***Notes:*** *Estimation based on the Business Structure Database (BSD) between 1997 and 2013. Fast Growth defined as High Growth Firms (**HGF**) for employment growth models and as Super Growth Heroes (**SGH**) for labour productivity growth models. Prof. Services: SIC (2003) sectors between code 70 and code 74. Fast Growth Spillover at the Region-Industry level measured as the growth of the share of employment of HGFs or SGHs over the total employment in each industry (SIC 2-digit) and region (NUTS 2-digit). At the district level Fast Growth Spillover measured as the growth of the share of employment of HGFs or SGHs over the total employment in each postcode area at the district level. FG Spillover in the gravity force specification measured as gravity force between each pair of fast-growth firms (j) and non-fast-growth firm (i) dividing the product of their employment by the squared of their distance.*

**Figure 1: Share of HGFs and SGHs over total employment per region (NUTS 2-digit level)**



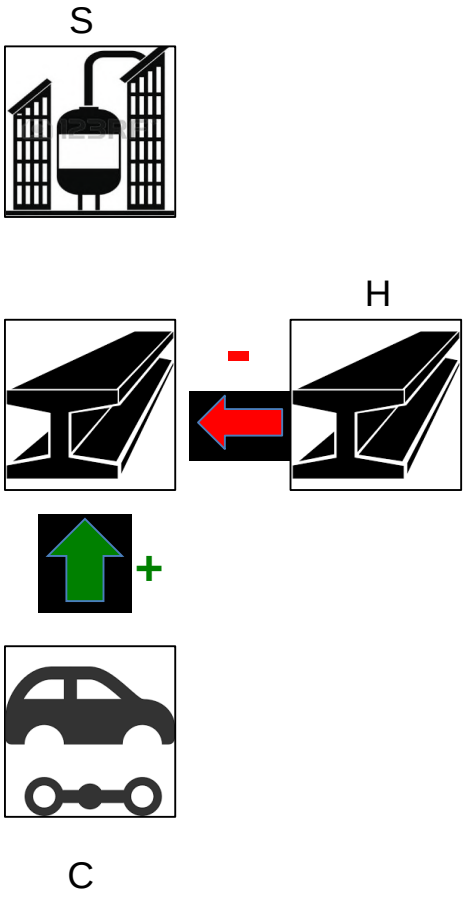

***Notes:*** *Statistics based on the Business Structure Database (BSD) between 1997 and 2013. Super Growth Heroes (**SGH**): firms that have experienced a positive labour productivity growth over a 3-year period with both turnover and employment growth and labour productivity it's above 3-years average labour productivity of its sector at the SIC 3-digit level. High Growth Firms (**HGF**): the total employment of firms with more than 10 employees grows by more than 20% over a 3 years period, or if the total employment of firms with less than 10 employees grows by more than 8 new employees over a 3 years period.*

**Figure 2: Share of HGFs and SGHs over total employment by industry (SIC 2-digit) and region (NUTS 1-digit)**




***Notes:*** *Statistics based on the Business Structure Database (BSD) between 1997 and 2013. Super Growth Heroes (**SGH**): firms that have experienced a positive labour productivity growth over a 3-year period with both turnover and employment growth and labour productivity it's above 3-years average labour productivity of its sector at the SIC 3-digit level. High Growth Firms (**HGF**): the total employment of firms with more than 10 employees grows by more than 20% over a 3 years period, or if the total employment of firms with less than 10 employees grows by more than 8 new employees over a 3 years period.*

**Figure 3: Region-Industry High-growth Firms (HGF) externalities on Employment Growth of non-fast-growth firms in the Manufacturing Sectors: estimates illustrated**




| **Manufacturing** | OECD HGFs |
|---|---|
| *Upstream sectors (Suppliers)* | |
| *Horizontal sector* | ↓★★ |
| *Downstream sectors (Customers)* | ↑★★★ |

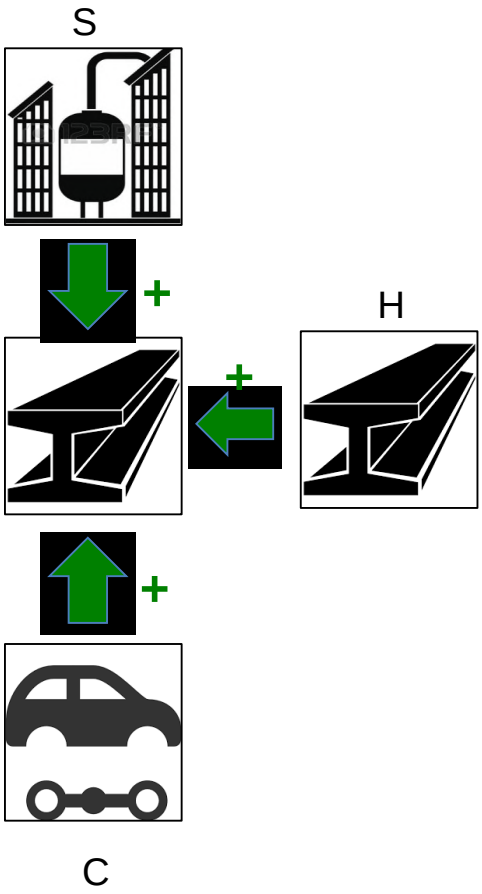
| **Professional services** | OECD HGFs |
|---|---|
| *Upstream sectors (Suppliers)* | ↓★★★ |
| *Horizontal sector* | ↑★★★ |
| *Downstream sectors (Customers)* | |

Note: In this study, we construct the fast growth externality measures coming from the same industry and cross industrial sectors along the supply chains. We estimate the growth outcome of non-fast-growth firms in a region-industry, given a higher incidence rate of fast-growth firms in the same industrial sector (also called horizontal sector), in the upstream sectors (i.e. suppliers) and in the downstream sectors (i.e. customers), *ceteris paribus*. This illustration shows the estimates of the effects derived from our analysis.

In this case, suppose our central concern is the growth of non-fast-growth firms in the steel-manufacturing sector, and we want to know what happen to it when there are more fast growth firms in the steel-manufacturing sector, when there are more fast growth suppliers in the petroleum industry, and when there are more fast growth customers in the car-making industry.

We find positive employment externalities in steel-making sectors, given a higher incidence rate of high-growth firms in employment (HGFs) in the car manufacturing sector. So, more high-employment-growth firms in the downstream sectors that demand for services and products have market-creating spillover effect on employment in the upstream sectors. Further, there is no effect on growth of steel-making firms due to a higher HGF incidence rates in the petroleum industry.

**Figure 4: Region-Industry Fast-growth Firms (FGF) externalities on Productivity Growth of non-fast-growth firms in the Manufacturing Sectors: estimates illustrated**




| **Manufacturing** | SGHs |
|---|---|
| *Upstream sectors (Suppliers)* | ↑★★★ |
| *Horizontal sector* | ↑★★★ |
| *Downstream sectors (Customers)* | ↑★★★ |

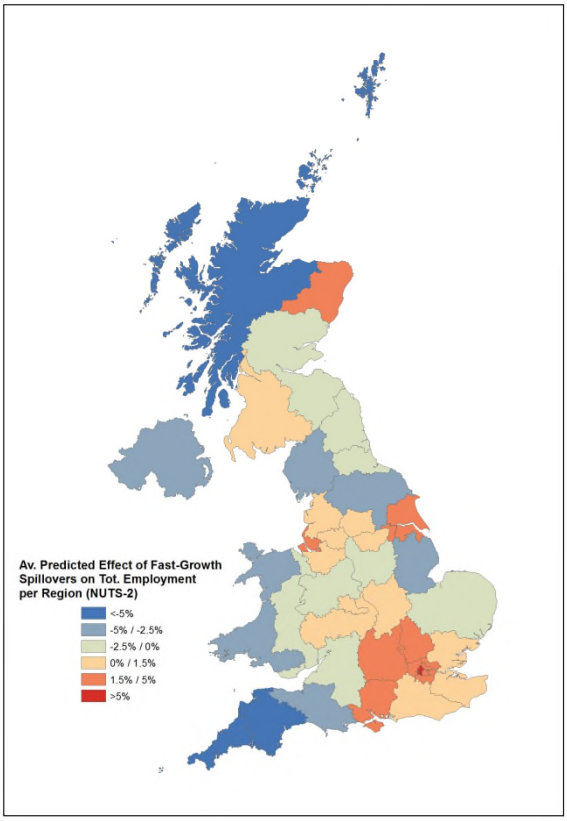
| **Professional services** | SGHs |
|---|---|
| *Upstream sectors (Suppliers)* | ↑★★★ |
| *Horizontal sector* | ↓★★★ |
| *Downstream sectors (Customers)* | ↑★★★ |

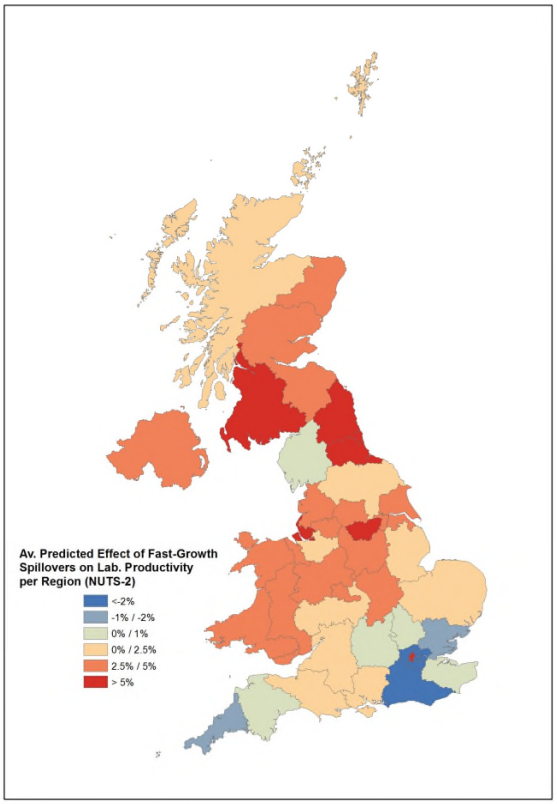
Note: In this study, we construct the fast growth externality measures coming from the same industry and cross industrial sectors along the supply chains. We estimate the growth outcome of non-fast-growth firms in a region-industry, given a higher incidence rate of fast-growth firms in the same industrial sector (also called horizontal sector), in the upstream sectors (i.e. suppliers) and in the downstream sectors (i.e. customers), *ceteris paribus*. This illustration shows the estimates of the effects derived from our analysis.

In this case, suppose our central concern is the growth of non-fast-growth firms in the steel-manufacturing sector, and we want to know what happen to it when there are more fast growth firms in the steel-manufacturing sector, when there are more fast growth suppliers in the petroleum industry, and when there are more fast growth customers in the car-making industry.

We find positive inter-industry productivity externalities due to fast-growth firms both from the supply and demand sides, as a result of knowledge spillovers and demonstration effects. Put differently, the evidence suggests positive productivity externalities in steel-making sectors, given a higher incidence rate of Super-growth heroes (SGHs) in both the car manufacturing sector and the petroleum industry.

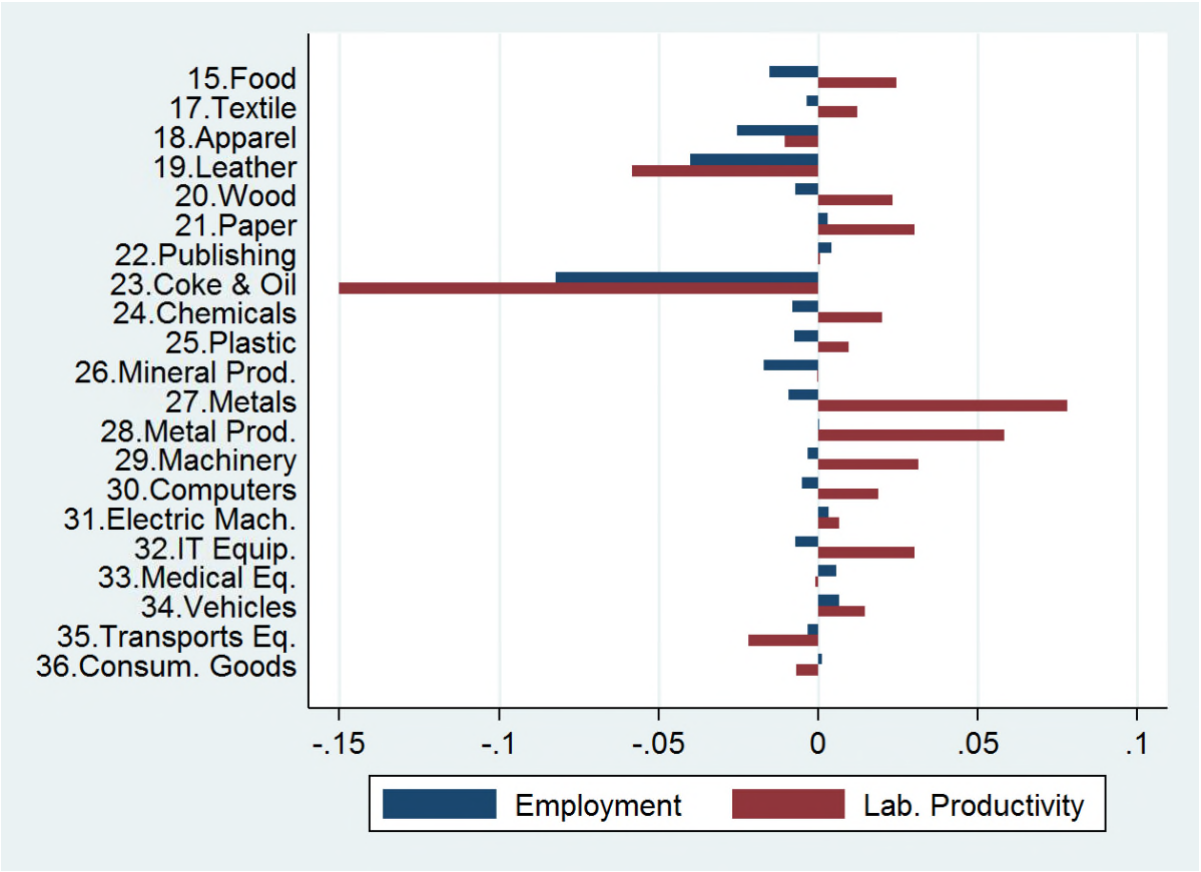
**Figure 5: Average marginal effect of Region-Industry Fast-Growth Spillovers on Employment and Productivity Growth per Region (NUTS 2-digit level)**




***Notes:*** *Predicted values of the impact of fast growth industry-region spillovers aggregated at the NUTS 2-digit level. Fast Growth firms defined as Super Growth Heroes (SGH) for the productivity growth models and as High Growth Firms (HGF) for the employment growth models.*

**Figure 6: Average marginal effect of Industry Fast-Growth Spillovers on Employment and Productivity Growth per Industry (SIC 2-digit level)**



# APPENDIX

**Table A1: Definitions of all the variables used in this analysis.**

| | |
|---|---|
| *Super Growth Heroes (SGH)* | Dummy variable equal to 1 if firm experienced positive labour productivity growth over a 3-year period whereby both turnover and employment have grown relative to the base year, and with labour productivity level above the SIC 3-digit level industry average, and 0 otherwise (estimated from BSD). |
| *High Growth Firms(HGF)* | Dummy variable equal to 1 if the total employment of firms with more than 10 employees grows by more than 20% over a 3 years period, or if the total employment of firms with less than 10 employees grows by more than 8 new employees over a 3 years period, and 0 otherwise (estimated from BSD). |
| *Turnover(it)* | Log of total turnover per firm (i) per year (t) (BSD) |
| *Employment(it)* | Log of total employment per firm (i) per year (t) (BSD) |
| *Age(it)* | Log of age of firm (i) (BSD) |
| *Foreign Ownership(it)* | Dummy variable equal to 1 if the firm is owned by a foreign company and 0 otherwise |
| *Group(it)* | Dummy variable equal to 1 if the firm is part of a business group and 0 otherwise |
| *Tot.Employment(rst)* | Log of total employment per industry-region-year (rst) at the NUTS 2-digit and SIC 2-digit level (Eurostat) |
| *Turnover(rst)* | Log of total turnover per industry-region-year (rst) at the NUTS 2-digit and SIC 2-digit level (Eurostat) |
| *Labour Productivity(rst)* | Log of total labour productivity (turnover/employment) per industry-region-year (rst) at the NUTS 2-digit and SIC 2-digit level (Eurostat) |
| *Net Entry Rate (rst)* | Measure of sector-region openness to new businesses measured as the difference between entries and exits in each year divided by the total number of firms operating in the sector-region (estimated from BSD). |
| *R&D Intensity (st)* | Industrial R&D intensity measured as the ration between total expenditure in R&D and total turnover in each industry and year (estimated from CIS survey). |
| *Agglomeration Index (rst)* | Ellison and Glaeser (1997) index of region-industry agglomeration measured as the difference between the squared share of employment of an industry in a given region and the squared share of employment of a region in the country, divided by the squared share of employment of the industry in the country, divided by the Herfindhal Index of industrial concentration (estimated from BSD). |
| *FG_IH (rst)* | Annual share of fast-growth firms employment (SGH and HGF definitions) over the total employment in each industry-region at the NUTS 2 digit and SIC 2 digit level (Estimated from BSD). |
| *FG (pt)* | Annual share of employment created by fast-growth firms (SGH and HGF definitions) over the total employment in each postcode area at the 3-digit level (Estimated from BSD). |
| *FG_SUP (jst)* | Share of employment created by fast-growth firms (SGH and HGF definitions) in the upstream sectors (j) for each industry (s), weighted by the share of inputs of production purchased from each sector (j) over the total consumption of sector (s) (Estimated from BSD and ONS Input-output tables). |
| *FG_CUS (zst)* | Share of employment created by fast-growth firms (SGH and HGF definitions) in the downstream sectors (z) for each industry (s), weighted by the share of total sales to sector (z) over the total demand of sector (s) (Estimated from BSD and ONS Input-output tables). |
| *FG Gravity (it)* | Gravity force between pairs of fast-growth (SGH and HGF definitions) and non-fast-growth firms calculated as the product of their size (in terms of employment) divided by the square of the distance between them (based on their geo-coordinates) (estimated from BSD). |
| *Manufacturing* | Dummy variable equal to 1 for all firms in the SIC (2003) sectors between code 15 and code 37, and 0 otherwise. |
| *Prof. Services* | Dummy variable equal to 1 for all firms in the SIC (2003) sectors between code 70 and code 74, and 0 otherwise. |
| *SMEs* | Dummy variable equal to 1 for all firms with less than 250 employees in their first period in the BSD dataset, and 0 otherwise. |
| *Young* | Dummy variable equal to 1 for all firms less than 5 years old in their first period in the BSD dataset, and 0 otherwise. |
| *High-Tech* | Dummy variable equal to 1 for all firms with a SIC code (2003) equal to 35, 24, 30, 32, 33, 31, 34 and 29, and 0 otherwise. |
| *Industry Dummy (s)* | SIC 2-digit level |
| *Region Dummy (r)* | NUTS 2-digit level |

**Table A2: Region-Industry Spillover Effect of Fast-growth Firms on the Employment and Productivity Growth of non-fast-growth firms by cohort – Manufacturing and Professional Services sectors.**

| | Employment Growth | | Productivity Growth | |
|---|---|---|---|---|
| | ***Manufacturing*** | ***Prof. Services*** | ***Manufacturing*** | ***Prof. Services*** |
| $Employment_{it}$ | 0.0485*** | -0.0786*** | -0.0170*** | 0.0664*** |
| | (0.000299) | (0.000390) | (0.000528) | (0.00112) |
| $Lab.\ Productivity_{it}$ | -0.00433*** | 0.00585*** | 0.0871*** | -0.0578*** |
| | (0.000197) | (0.000183) | (0.000390) | (0.000580) |
| $Age_{it}$ | -0.00263*** | -0.0183*** | -0.00179*** | 0.0289*** |
| | (0.000116) | (0.000455) | (0.000213) | (0.00138) |
| $Foreign\ Own._{it}$ | 0.00151* | -0.00328*** | -0.00314** | -0.00337 |
| | (0.000803) | (0.00127) | (0.00154) | (0.00385) |
| $Group_{it}$ | -0.00441*** | -0.00755*** | 0.00975*** | 0.00222 |
| | (0.000352) | (0.000511) | (0.000663) | (0.00155) |
| $D.Employment_{rst}$ | 0.00528*** | -0.00055** | -0.00234* | -0.00176** |
| | (0.000636) | (0.000261) | (0.00120) | (0.000812) |
| $D.Lab.\ Productivity_{rst}$ | -0.00229*** | 0.00859* | 0.0210*** | 0.287*** |
| | (0.000701) | (0.00506) | (0.00135) | (0.0156) |
| $Net\ Entry\ Rate_{rst}$ | 0.00128*** | -1.71e-05 | 0.000878** | 8.41e-05 |
| | (0.000229) | (2.12e-05) | (0.000432) | (6.36e-05) |
| $R\&D\ Intensity_{rst}$ | -0.0615 | 0.0226 | 1.289*** | 0.226** |
| | (0.0446) | (0.0335) | (0.0802) | (0.108) |
| $Agglomeration\ Index_{rst}$ | 0.632*** | -0.00656 | -0.810*** | -0.283*** |
| | (0.0775) | (0.0137) | (0.146) | (0.0426) |
| $FG\_IH_{rst}$ | -0.00309** | 0.00306 | 0.00395** | -0.00761 |
| | (0.00116) | (0.00189) | (0.00159) | (0.00553) |
| $FG\_SUP_{jst}$ | 0.318 | -2.955*** | 1.179*** | 44.55*** |
| | (0.460) | (0.605) | (0.312) | (2.054) |
| $FG\_CUS_{zst}$ | 0.679*** | -9.563*** | 0.271 | -78.32*** |
| | (0.186) | (0.728) | (0.325) | (2.978) |
| *FG_IH#Aggl.* | -0.914** | 0.00522 | 0.0475 | 2.372*** |
| | (0.402) | (0.0744) | (0.540) | (0.269) |
| *FG_SUP#Aggl.* | 80.64 | 51.62 | 320.6*** | 326.9*** |
| | (86.40) | (35.87) | (99.15) | (90.88) |
| *FG_CUS#Aggl.* | -31.00 | 2.306 | -85.90 | 127.5 |
| | (26.51) | (43.33) | (58.82) | (97.28) |
| *Observations* | 1,576,246 | 7,109,239 | 1,583,578 | 7,028,406 |
| *No. Firms* | 306,064 | 1,614,477 | 307,277 | 1,606,701 |

***Notes:*** *Estimation based on the Business Structure Database (BSD) between 1997 and 2013. Fast Growth firms defined as Super Growth Heroes (**SGH**) for the productivity growth models and as High Growth Firms (**HGF**) for the employment growth models. Manufacturing firms: SIC (2003) sectors between code 15 and code 37. Prof. Services: SIC (2003) sectors between code 70 and code 74. For the cohort approach (3 years growth period) we estimate the spillover effects based on a cohort-to-cohort increase in the incidence rate of fast-growth firms on the cohort-to-cohort employment and labour productivity growth of non-fast-growth firms.*

**Table A3: Region-Industry Spillover Effect of Fast-growth Firms on the Employment and Productivity Growth of non-fast-growth firms by LEP – Manufacturing and Professional Services sectors.**

| | Employment | | Productivity | |
|---|---|---|---|---|
| | ***Manufacturing*** | ***Prof. Services*** | ***Manufacturing*** | ***Prof. Services*** |
| *Employment$_{it}$* | 0.199*** | 0.709*** | -0.0348*** | -0.274*** |
| | (0.000530) | (0.000723) | (0.00112) | (0.00203) |
| *Lab. Productivity$_{it}$* | -0.0217*** | -0.0265*** | 0.389*** | 1.425*** |
| | (0.000261) | (0.000368) | (0.000700) | (0.00136) |
| *Age$_{it}$* | -0.0811*** | -0.162*** | 0.0612*** | 0.320*** |
| | (0.000848) | (0.000922) | (0.00200) | (0.00288) |
| *Foreign Own.$_{it}$* | 0.00418*** | 0.00217* | -0.0177*** | -0.0105*** |
| | (0.00161) | (0.00117) | (0.00397) | (0.00362) |
| *Group$_{it}$* | 0.0164*** | -0.000577 | -0.0235*** | 0.0483*** |
| | (0.000796) | (0.000498) | (0.00190) | (0.00154) |
| *D.Employment$_{rst}$* | 0.00244*** | -0.000407** | -0.00167 | 0.00390*** |
| | (0.000466) | (0.000194) | (0.00110) | (0.000630) |
| *D.Lab. Productivity$_{rst}$* | -0.00225*** | 0.000548* | 0.0147*** | 0.0146*** |
| | (0.000573) | (0.000291) | (0.00138) | (0.000940) |
| *Net Entry Rate$_{rst}$* | 0.000119 | -1.11e-05 | 0.000596 | 2.51e-06 |
| | (0.000189) | (9.83e-06) | (0.000451) | (2.97e-05) |
| *R&D Intensity$_{rst}$* | 0.0116* | 0.000337*** | -0.0261 | -0.0038*** |
| | (0.00688) | (9.86e-05) | (0.0164) | (0.000311) |
| *Agglomeration Index$_{rst}$* | 0.414*** | 0.0373*** | 1.079*** | -0.197*** |
| | (0.110) | (0.00871) | (0.263) | (0.0284) |
| *FG_IH$_{rst}$* | -0.00639*** | -0.000655 | 0.00693** | -0.0485*** |
| | (0.00210) | (0.00147) | (0.00386) | (0.00620) |
| *FG_CUS$_{zst}$* | 6.163*** | -2.123*** | 5.196*** | 38.41*** |
| | (0.795) | (0.417) | (1.369) | (2.694) |
| *FG_SUP$_{jst}$* | 0.0272 | -0.190 | 8.014*** | 19.91*** |
| | (0.305) | (0.429) | (0.956) | (2.750) |
| *FG_IH#Aggl.* | -1.238** | 0.132* | -2.282* | -1.695*** |
| | (0.601) | (0.0678) | (1.358) | (0.340) |
| *FG_CUS#Aggl.* | 281.8*** | 111.8*** | 135.4 | -1,332*** |
| | (85.61) | (27.45) | (344.0) | (126.7) |
| *FG_SUP#Aggl.* | 33.89 | -71.04** | 738.7** | 1,106*** |
| | (40.10) | (27.73) | (294.4) | (148.6) |
| *Observations* | 1,712,018 | 6,696,805 | 1,669,502 | 6,628,614 |
| *No. Firms* | 310,553 | 1,470,512 | 309,291 | 1,475,596 |

***Notes:*** *Estimation based on the Business Structure Database (BSD) between 1997 and 2013. Fast Growth firms defined as Super Growth Heroes (**SGH**) for the productivity growth models and as High Growth Firms (**HGF**) for the employment growth models. Manufacturing firms: SIC (2003) sectors between code 15 and code 37. Prof. Services: SIC (2003) sectors between code 70 and code 74. FG Competitors measured at the industry (SIC 2-digit) and LEP level for the 39*

*partnerships between local authorities and businesses set up in 2011 in England by the Department for Business, Innovation and Skills.*

**Table A4: Spatial Spillover Effect of Fast-growth Firms on the Employment and Productivity Growth of non-fast-growth firms by cohort– Manufacturing and Professional Services sectors.**

| | Employment Growth | | Productivity Growth | |
|---|---|---|---|---|
| | ***Manufacturing*** | ***Prof. Services*** | ***Manufacturing*** | ***Prof. Services*** |
| *Employment$_{it}$* | 0.0551*** | -0.0785*** | -0.0152*** | 0.0659*** |
| | (0.000377) | (0.000390) | (0.000619) | (0.00111) |
| *Lab. Productivity$_{it}$* | 0.00147*** | 0.00590*** | 0.0902*** | -0.0579*** |
| | (0.000269) | (0.000183) | (0.000471) | (0.000577) |
| *Age$_{it}$* | -0.00369*** | -0.0183*** | -0.00151*** | 0.0286*** |
| | (0.000146) | (0.000455) | (0.000251) | (0.00138) |
| *Foreign$_{it}$* | 0.000638 | -0.00309** | -0.00248 | -0.00435 |
| | (0.000960) | (0.00127) | (0.00171) | (0.00384) |
| *Group$_{it}$* | -0.00589*** | -0.00769*** | 0.00955*** | 0.00353** |
| | (0.000439) | (0.000511) | (0.000753) | (0.00154) |
| *D.Employment$_{rst}$* | 0.00133*** | 0.00124*** | -0.000249 | 0.00516*** |
| | (0.000258) | (0.000262) | (0.000417) | (0.000798) |
| *D.Lab.Productivity$_{rst}$* | -0.00109*** | -0.0385*** | 0.00309*** | 0.168*** |
| | (0.000401) | (0.00258) | (0.000681) | (0.00786) |
| *Net Entry Rate$_{rst}$* | 0.00158*** | -1.55e-05 | 6.32e-05 | 9.41e-05 |
| | (0.000306) | (2.12e-05) | (0.000514) | (6.36e-05) |
| *R&D Intensity$_{rt}$* | -0.0291 | 0.0257 | 0.889*** | 0.314*** |
| | (0.0419) | (0.0306) | (0.0664) | (0.0928) |
| *Agglomeration Index$_{rst}$* | 1.193*** | -0.00237 | -1.498*** | -0.448*** |
| | (0.106) | (0.0137) | (0.173) | (0.0416) |
| *FG Spat. Spillover$_{rt}$* | -0.00188* | 0.000376 | 0.00193 | 0.0450*** |
| | (0.00109) | (0.00332) | (0.00139) | (0.0128) |
| *FG Spat. Spillover#Aggl. Index* | -0.636** | 0.0342 | 0.324 | 0.201 |
| | (0.263) | (0.117) | (0.370) | (0.438) |
| *Observations* | 1,062,260 | 7,118,521 | 1,176,346 | 7,065,477 |
| *No. Firms* | 254,494 | 1,614,645 | 267,822 | 1,609,735 |

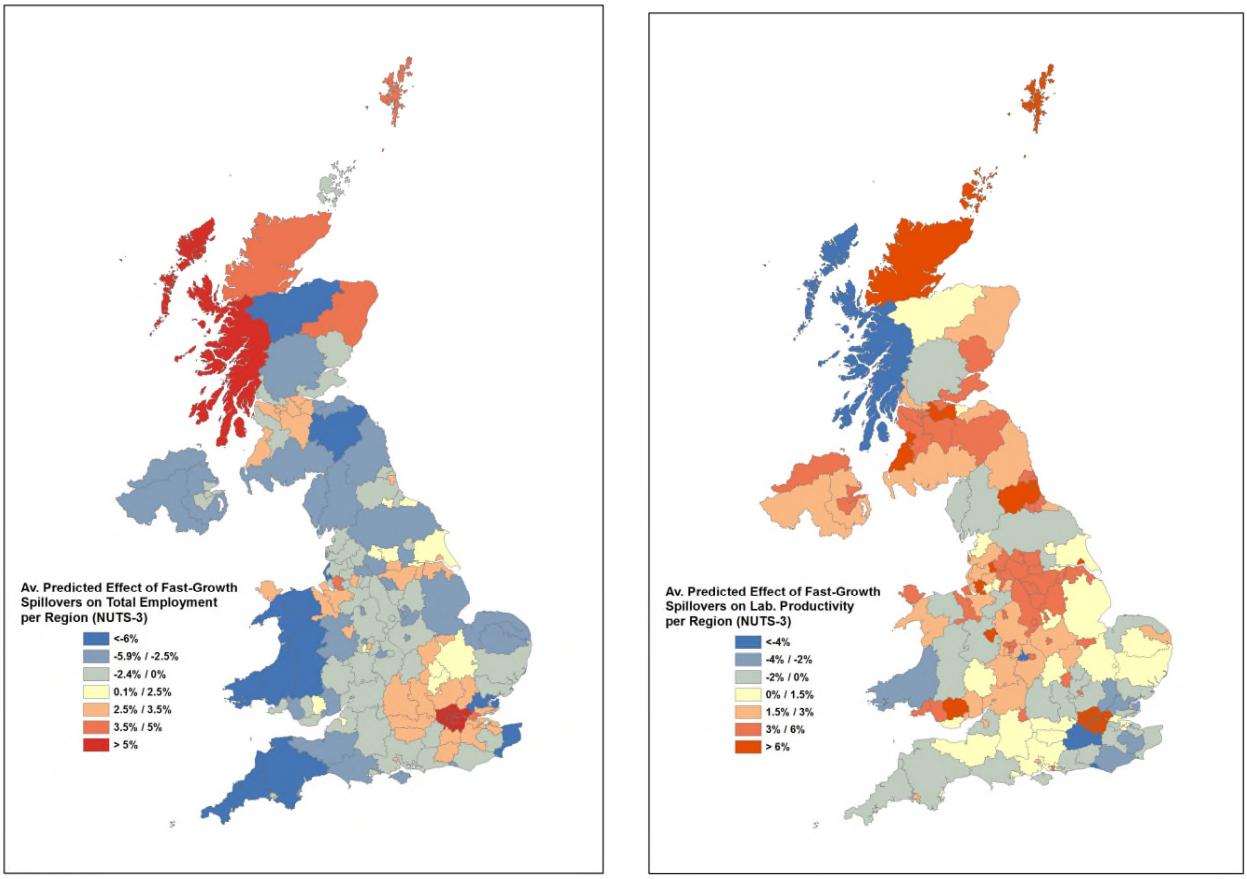
***Notes:*** *Estimation based on the Business Structure Database (BSD) between 1997 and 2013. Fast Growth firms defined as Super Growth Heroes (**SGH**) for the productivity growth models and as High Growth Firms (**HGF**) for the employment growth models. Manufacturing firms: SIC (2003) sectors between code 15 and code 37. Prof. Services: SIC (2003) sectors between code 70 and code 74. For the cohort approach (3 years growth period) we estimate the spillover effects based on a cohort-to-cohort increase in the incidence rate of fast-growth firms on the cohort-to-cohort employment and labour productivity growth of non-fast-growth firms.*

**Table A5: Gravity Force Effect of Fast-growth Firms on the Employment and Productivity Growth of non-fast-growth firms by cohort – Manufacturing and Professional Services sectors.**

| | Employment Growth | | Productivity Growth | |
|---|---|---|---|---|
| | ***Manufacturing*** | ***Prof. Services*** | ***Manufacturing*** | ***Prof. Services*** |
| *Employment$_{it}$* | 0.0461*** | -0.0834*** | -0.0131*** | 0.0830*** |
| | (0.000304) | (0.000482) | (0.000552) | (0.00134) |
| *Lab. Productivity$_{it}$* | -0.00270*** | 0.00715*** | 0.0900*** | -0.0617*** |
| | (0.000190) | (0.000205) | (0.000398) | (0.000665) |
| *Age$_{it}$* | -0.00272*** | -0.0142*** | -0.00229*** | 0.0419*** |
| | (0.000120) | (0.000502) | (0.000229) | (0.00156) |
| *Foreign$_{it}$* | 0.00239*** | -0.000654 | -0.00123 | 0.00173 |
| | (0.000801) | (0.00163) | (0.00163) | (0.00506) |
| *Group$_{it}$* | -0.00154*** | -0.00517*** | 0.0104*** | 0.00149 |
| | (0.000352) | (0.000606) | (0.000700) | (0.00185) |
| *D.Employment$_{rst}$* | 0.00154*** | -0.00122*** | -0.00192** | -0.00132 |
| | (0.000482) | (0.000276) | (0.000960) | (0.000868) |
| *D.Lab.Productivity$_{rst}$* | -0.00236*** | 0.00865 | 0.0221*** | 0.230*** |
| | (0.000639) | (0.00560) | (0.00127) | (0.0175) |
| *Net Entry Rate$_{rst}$* | 0.00129*** | -3.54e-06 | 0.00111** | -1.46e-05 |
| | (0.000245) | (3.15e-05) | (0.000480) | (9.57e-05) |
| *R&D Intensity$_{rt}$* | -0.0596** | 0.000323*** | 0.846*** | -0.00204*** |
| | (0.0286) | (0.000116) | (0.0574) | (0.000359) |
| *Agglomeration Index$_{rst}$* | 0.665*** | -0.00194 | -0.757*** | -0.330*** |
| | (0.0725) | (0.0151) | (0.147) | (0.0476) |
| *FG Gravity Force$_{it}$* | 0.00668*** | 0.00389*** | 0.00679*** | 0.00618*** |
| | (7.16e-05) | (5.87e-05) | (0.000137) | (0.000339) |
| *FG Gravity Force#Aggl. Index* | -0.0130 | -0.00407** | -0.178*** | -0.0419*** |
| | (0.0177) | (0.00166) | (0.0367) | (0.0131) |
| *Observations* | 1,590,099 | 5,782,792 | 1,544,416 | 5,652,089 |
| *No. Firms* | 308,223 | 1,334,868 | 307,697 | 1,295,840 |

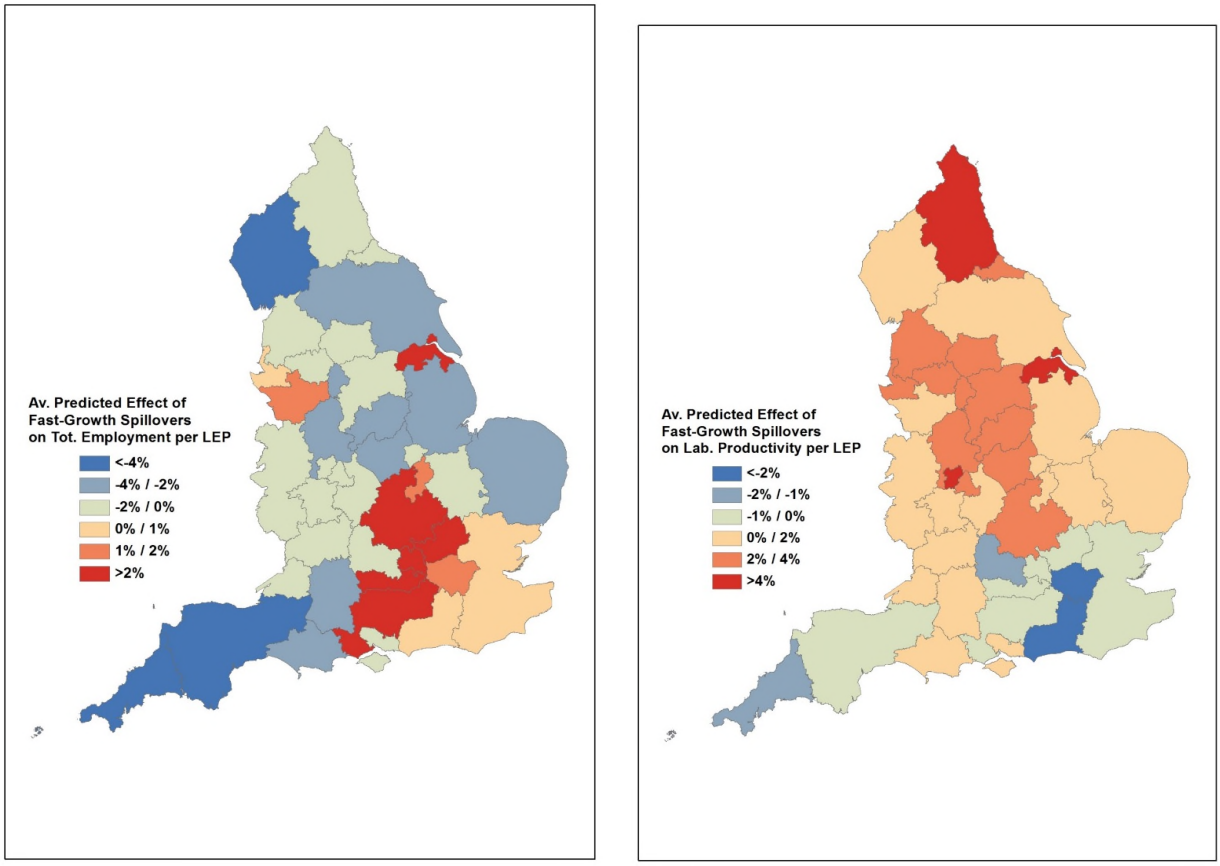
***Notes:*** *Estimation based on the Business Structure Database (BSD) between 1997 and 2013. Fast Growth firms defined as Super Growth Heroes (**SGH**) for the productivity growth models and as High Growth Firms (**HGF**) for the employment growth models. Manufacturing firms: SIC (2003) sectors between code 15 and code 37. Prof. Services: SIC (2003) sectors between code 70 and code 74. For the cohort approach (3 years growth period) we estimate the spillover effects based on a cohort-to-cohort increase in the incidence rate of fast-growth firms on the cohort-to-cohort employment and labour productivity growth of non-fast-growth firms.*

**Figure A1: Average predicted effect of Region-Industry Fast-Growth Spillovers on Employment and Productivity Growth per Region (NUTS 3-digit level)**




***Notes:*** *Predicted values of the impact of fast growth industry-region spillovers aggregated at the NUTS 3-digit level. Fast Growth firms defined as Super Growth Heroes (SGH) for the productivity growth models and as High Growth Firms (HGF) for the employment growth models.*

**Figure A2: Average predicted effect of Region-Industry Fast-Growth Spillovers on Employment and Productivity Growth per LEP**




***Notes:*** *Predicted values of the impact of fast growth industry-region spillovers aggregated at the LEP level. Fast Growth firms defined as Super Growth Heroes (SGH) for the productivity growth models and as High Growth Firms (HGF) for the employment growth models.*

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