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The Effect of New Business Formation on the Productivity of Incumbent Establishments: Evidence from Germany

Michael Fritsch
Friedrich Schiller University Jena
School of Economics and Business Administration
m.fritsch@uni-jena.de

Javier Changoluisa Acuña
Friedrich Schiller University
The DFG Research Training Group 1411 "The Economics of Innov
javier.changoluisa@uni-jena.de

Abstract

The Effect of New Business Formation on the Productivity of Incumbent Firms:
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The Schumpeterian understanding of the effect of new businesses on economic development is usually denoted as ?creative destruction?, a process in which new firms displace incumbents. The reaction of incumbent firms to the entry of new competitors is, however, rather heterogeneous. While some of the established suppliers will experience decreasing sales or will even have to exit the market, others may react to the competitive challenge by improving their performance. Howitt and Mayer-Foulkes (2005) and Acemoglu, Aghion and Zilibotti (2006) have argued that the reaction of incumbent firms to entry of new competitors depends on the distance of a firm to the technological frontier. Based on this argument, Aghion et al. (2009) argued that incumbents that are close to the frontier have higher productivity growth rates and innovate more than more distant firms when they face additional competition by the entry of highly efficient firms. They call this reaction the ?escape-entry effect.? In their empirical study they showed, however, that incumbents that are more distant to the technological frontier show higher productivity growth rates.
At firm level, the above hypothesis has only been tested for entry of established firms that operate close to the technological frontier into a new market (foreign entry). The average entry has, however, considerably lower productivity than the average incumbent and exerts much less competitive threat on the incumbents than the entry of an internationally successful established firm. It is therefore unclear how incumbent firms react to regular entry depending

on their distance to the technological frontier. A further issue that is still rather unclear is the effect of new business formation on the performance of incumbents in the longer run. In particular, it is unclear in how far incumbents attain show improved productivity performance by reducing labor inputs or by product and process innovation.

We analyze the change in productivity of incumbent manufacturing establishments over a two-year period. Fixed-effect panel analysis is applied in order to account for the time invariant characteristics of the firms. The key explanatory variable is the average regional start-up rate of the last ten years. We run alternative specifications with the start-up rate in the same industry, in related industries, etc. Moreover, we account for the characteristics of incumbent firms such as size, distance to the technological frontier, level of human capital, their general development trend and other characteristics. Data to measure the change in productivity of incumbent establishments and the control variables at establishment level are derived from the IAB Establishment Panel. The start-up rates and the regional-level control variables were measured at the level of German Planning Regions.
The main finding of the study is a positive influence of entry on the productivity of incumbents. Additionally, in our case incumbents close to the frontier seem to make bigger jumps in productivity growth. More importantly, we find empirical evidence to claim that entry has a stronger effect on the productivity growth of those incumbents that are further away from the frontier. One advantage of the underlying dataset is that it offers information of the state of the machinery and equipment of the incumbent firms. We used this information as a robustness check for our main findings. Therefore we can argue that apart from the usual understanding of creative destruction that new firms replace incumbents, they may also make incumbents (specially the laggards) stronger!

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The Effect of New Business Formation on the Productivity of Incumbent Establishments: Evidence from Germany

Prof. Dr. Michael Fritsch

School of Economics and Business Administration, Friedrich Schiller University Jena, Carl-Zeiss-Str. 3, D-07743 Jena, Germany (e-mail: m.fritsch@uni-jena.de)

Javier Changoluisa

PhD Candidate, DFG Research Training Group: "The Economics of Innovative Change" Friedrich Schiller University Jena, Bachstr. 18, D-07743 Jena, Germany (e-mail: javier.changoluisa@uni-jena.de).

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Abstract

We analyze the effect of new business formation on the productivity of manufacturing incumbents. There is a significant positive effect of entry into manufacturing as well as of entry into R&-intensive manufacturing sectors in the previous years. However, no robust evidence was found for an effect of entry into knowledge intensive business services. In line with related literature, we found that incumbents that are further away of the technology frontier show higher productivity improvements. Nevertheless, the main finding of the study is that regular new business formation is able to positively influence the productivity growth of incumbents, especially those operating further away the technology frontier.

Keywords: New business formation, productivity, incumbent firms

JEL classification: L26, O12

1. The effects of new business formation on incumbent firms

The Schumpeterian understanding of the effect of new businesses on economic development is usually denoted as “creative destruction”, a process in which new firms displace incumbents. Nonetheless, the reaction of incumbent firms to the entry of new competitors might be rather heterogeneous depending on certain characteristics of the incumbents and on the degree of challenge imposed by the entry firms. In fact, while some of the established suppliers will experience decreasing sales or will even have to exit the market, others may react to the competitive challenge by enhancing their performance.

While a number of analyses have shown a positive effect of new business formation on productivity at the aggregate level of countries or regions[1], still little is known about the effect on incumbents’ productivity. The distinction between the aggregate level and the individual level is important for at least two reasons. First, from the observed increased aggregated productivity it is not possible to identify if entry firms are directly responsible for it or if entry firms indirectly contribute to the aggregated productivity growth by enhancing the productive of the incumbents located in a specific region. Second, aggregate data conceal the heterogeneity of the individual incumbents’ reaction to the entry of new competitors. To the best of our knowledge, we are aware of only one empirical study (Andersson et al., 2012) that has analyzed the effect of new businesses at regional level on incumbent’s productivity at the level of firms. One important limitation of this study is that the time lagged effect of new business formation was addressed only incompletely given that studies about the employment effect of new business formation on growth have found time lags of eight to ten years statistically significant but Andersson et al. (2012) included only lags of the

[1] See for example Callejon and Segarra (1999), Reynolds (1999), Braunerhjelm and Borgman (2004), Carree and Thurik (2008), Bosma (2011), Bosma, Stam and Schutjens (2011).

rate of start-ups of four years due to data limitations. Hence, the longer-term effect of new business formation on incumbents' productivity still remained unclear. More importantly, even though looking at the productivity of incumbents at the firm level, this study pays little attention to the characteristics of the incumbents which might determine differences in their reaction to the threat imposed by start-ups.

Considering these limitations, taking advantage of the availability of long term panel datasets distributed on sectors and planning regions, our paper contributes to the existing literature in three ways. First, it will account for the long term effect of new business formation on the productivity of incumbents. More importantly, we want to find out those firm-level factors that modulate the reaction of incumbents to the effect of new business formation. To do so, different characteristics of incumbents such as size, level of human capital, and more importantly, the individual proximity to the technology frontier, will be considered. Finally, we expect to suggest if new business formation enhances incumbents' productivity by establishing in the same region of the incumbent and competing in the same sector or by supplying knowledge intensive services which appropriated by incumbents allow them to improve their efficiency.

The reminder is organized in the following way. Section two explains different ways how new business formation is expected to influence the productivity of incumbent firms. Section three explains the methodology applied in this research paper, a description of the variables, and the data used to measure them. Section four presents the main findings and interpretations. Finally, section five concludes and presents some possible ideas for further research.

2. New business formation and the productivity of incumbents

Early contributions by Schumpeter (1934) stated that the distinctive characteristic of entrepreneurs is to carry out new combinations and employ means of production in more advantageous ways. Thanks to the introduction of these novel and more efficient methods, innovative entrepreneurs may achieve higher productivity levels than incumbents which allow them to obtain the entrepreneurial profit (Schumpeter, 1934). According to the Schumpeterian argument, innovative entry firms enforce incumbents to adapt to the higher efficiency levels settle by entries or to leave the market. Competition, then, is one possible mechanism how new business formation influence variations in the productivity of incumbents. In order to strictly capture the idea of entrepreneurship from the Schumpeterian perspective, previous studies, such as Aghion et al. (2009) focused on the relation of foreign firm entry and productivity growth and innovativeness of incumbent firms. The mentioned study considered foreign firm entry since it is characterized for being very innovative and advanced representing very well the entrepreneurial idea from the Schumpeterian perspective.

The focus in our paper is rather different in the sense that we are interested in the relation of regular new business formation in a certain region and the productivity growth of incumbents located in that region. We are aware of the fact that within regular new business formation innovative as well as non innovative, less challenging start-ups should be found. Nevertheless, we consider that regular new business formation deserves attention not only because previous literature has already investigated the effect of advanced entry on incumbents' productivity but also because regular new business formation is the most commonly observed in the markets being, therefore, of special interest for policy makers.

Even though in this paper we do not focus our attention exclusively on frontier, advanced entry, we still expect a positive relation of regular new

business formation and incumbents' productivity growth. We consider that the positive relation of new business formation and regional or country level productivity growth, identified in the studies mentioned in the previous section, suggests that regular new business formation probably contributes to that increased aggregated productivity in an indirect manner by enhancing the productivity of the incumbents located in a certain region. Besides, following Bosma et al. (2011), we expect that the effect of regular regional new business formation represents a competitive threat to incumbent firms, as entrepreneurs by narrowing their market scope to the local or regional area are able to take advantage of the specific knowledge they posses of the market environment (Bosma et al., 2008). This argument is in line with Schutjens and Stam (2003) who argued that during their first three years, firms tend to narrow their spatial scope. In line with these arguments and considering that for this study we focus on the productivity change of manufacturing incumbents, hypothesis 1 states:

Hypothesis 1: The productivity growth of manufacturing incumbents is positively related to new business formation taking place in the same sector and region of the incumbent as a result of the competition it represents.

Entrepreneurship has been claimed to be a channel for new knowledge to come to the market which might be appropriated by incumbents resulting in productivity gains. In fact, Aghion and Howitt (1992) stated that entrepreneurs are expected to develop more efficient production methods than incumbents thanks to the new knowledge they posses or/and by the combination of existing knowledge in different ways. In line with this argument, Audretsch and Keilbach (2004) argued that entrepreneurship plays an important role in selecting specific knowledge from the general available body of knowledge, namely the scientific knowledge developed due to R&D activities, and turning it to economic knowledge. The new knowledge or the new combinations of existing knowledge brought to the market by entrepreneurs may also be appropriated by incumbent firms.

Among the different existing sectors, new entry firms in the knowledge intensive business services (KIBS) sector are by definition expected to bring new knowledge and diffuse it in the markets as argued by Muller and Zenker (2001) and Wood (2002). Additionally, these authors also consider that KIBS, due to their consultancy service, support firms to exploit their own knowledge potential. Similarly, the capability of KIBS to combine new knowledge gained from the interaction with clients has been claimed by Bettencourt et al. (2002). More importantly, there is a clear interaction between the KIBS and the manufacturing sector. For example, Mankun and MacPherson (1997) and Den Hertog (2000) argued that manufacturing industries require KIBS in close proximity to advance their product development and innovation activities. The result of new entry firms in the KBIS sector, bringing new knowledge and getting involved in the innovation activities of manufacturing incumbents might be reflected in productivity growth.

Therefore, hypothesis 2 states:

Hypothesis 2: There is a positive relation of new business formation in the KIBS sector and manufacturing incumbent's productivity growth as entry in the KIBS sector bring and diffuse knowledge in the market which can be appropriated by those incumbents.

As we are also interested in identifying those firm-level factors that are conducive or that impede the reaction of incumbents to the challenge of entry, we focus on the individual proximity of the incumbents to the technology frontier as previous literature has found it to be a decisive factor in determining the reaction of incumbents to entry firms. In this sense, Howitt and Mayer-Foulkes (2005) and Acemoglu, Aghion and Zilibotti (2006) introduced in the Schumpeterian growth theory the variation of innovation activity of incumbents according to the distance to the technology frontier. Following these arguments, the threat of advanced entry firms is expected to encourage incumbents in sectors close to the technology frontier to innovate

more which leads to productivity growth as frontier incumbents know that they can escape and survive entry by reacting with intensive, successful innovations (escape-entry effect). On the other hand, frontier entry is expected to discourage innovation in incumbents operating in sectors further away from the frontier as there is little hope for these firms to survive entry and because they forecast decreasing profits from innovative activities. In line with this theoretical background, Aghion et al. (2009), aiming to empirically determine if greenfield foreign entry affects the innovation incentives of incumbent firms in the UK, found that the reaction of these firms to the threat of entry depends on the distance to the technology frontier of the industries in which the incumbent is active. In a first stage they found that incumbents in industries far from the frontier show higher labor productivity growth rates. In a second stage, they addressed the effect of entry on incumbents' productivity conditional on the distance to the frontier of the industry in which they operate. They found that "…incumbent productivity growth responds more positively to technologically advanced entry in industries close to the technology frontier than in industries farther below the frontier." (Aghion et al. 2009, p. 27).

Since the reaction of incumbents to entry conditional on their proximity to the frontier has been tested for the competition imposed by advanced entry, it is unknown how incumbents' proximity to frontier will influence their reaction to the threat of regular new business formation. Nevertheless, the argument that incumbents in frontier industries have better conditions to react to entry still holds in our case and, therefore, we will expect that being close to the technology frontier will also favor the reaction of incumbents to regular new business formation.

Hence, hypothesis 3 states:

Hypothesis 3: The influence of new business formation on the productivity growth of incumbents is conditional on the proximity of the

incumbents to the technology frontier. Incumbents close to the frontier and faced with the competition of start-ups are expected to show a more positive reaction in terms of productivity growth.

3. Methodology

The spatial framework of our analysis corresponds to German planning regions. Abundant research on new business formation and economic growth has been conducted within this spatial framework which might be useful to interpret, relate and contrast those findings to the ones of this research paper. Additionally, the availability of reliable long-term data on start-ups for German regions makes this spatial framework especially convenient. German Planning Regions represent functional spatial units containing at least one core city and the surrounding area. The analysis is restricted to West Germany for the following reasons. First, the transformations occurred in East Germany during the 1990s influenced severely the economic processes of this part of the country (see Fritsch, 2004; Kronthaler, 2005), making it a special case difficult to include in the analysis. Second, there are differences in the availability of data, while data on new business formation for West Germany is available since 1976, for East Germany it is only available since 1992 which would represent an undesired restriction for the study in terms of the time framework.

a. Data

The data for the productivity of manufacturing incumbent establishments was derived from the IAB Establishment Panel. This is a survey conducted by the Institute for Employment Research (Nuremberg), a research unit of the German Federal Employment Agency. The survey covers the 71 planning regions in West Germany and contains establishment level information for a representative sample of firms from 1992 to 2011. Public sector is excluded

from the analysis. We decided to focus on incumbents of the manufacturing sector (2-digit, based on the WZ 2003 classification) trying to avoid the problems related to measuring the productivity in the service sector. The condition for an establishment to be considered an incumbent is to be operating in the market for at least 10 years. Based on the availability of data, we were able to track the productivity change of incumbent establishments in the period 1993 to 2011. Due to fluctuations of the firms participating in the survey the panel is unbalanced. This dataset was also used to articulate the control variables at establishment and industry level that will be described later on. One limitation of the data refers to the fact that it does not allow us to know if incumbents closed down being this also a possible effect of competition and threat imposed by start-ups. Nevertheless, according to Audretsch and Keilbach (2004), it is likely that entry firms drive out incumbents when new markets substitute existing markets, such as digital cameras replacing analogue cameras. Based on this argument, we do not expect that many of the incumbent firms in our data were driven out of the market by the challenge of start-ups.

Data for the start-ups in the different sectors at regional level was obtained from the Establishment History File of the German Social Insurance Statistics. This dataset contains regional panel data of the number of establishments in Germany with at least one employee liable to social security. The data originate from the notification process of the social security system and the internal procedures of the Federal Employment Agency. This database only contains establishments with at least one employee. Therefore, businesses that are only run by the founder with no dependent employee (solo self-employment) are not included. This situation does not represent a problem for the aims of the present study; it rather represents a convenient way to exclude non-innovative entry.

b. Measure of variables

The *dependent variable* is the *growth in productivity* (log transformed productivity) of manufacturing incumbents at establishment level over a two-year period. A two-year period is chosen in order to avoid disturbances by short-term fluctuations.

Hence, productivity change is given by

$$\Delta P = \ln \mathrm{P}_{\mathrm{t}=0} - \ln \mathrm{P}_{\mathrm{t}-2} \ .$$

Productivity is defined as value added per employee. Value added is the incumbent' sales after subtracting intermediate inputs, wages, and external costs of the corresponding period.

Because our main interest is to identify the effect of new business formation on incumbent s' productivity, the *average start-up rate* is the *main explanatory variable* in our study. The start-up rate is calculated as the number of new businesses in the region in a certain period divided by the regional workforce (number of employees) according to the labor market approach. Since empirical research has shown that the effect of new business formation emerges over a period of eight to ten years (Fritsch, 2013), we calculated the averages start-up rate as a moving average of the start-up rates of the previous ten years before the incumbents' productivity growth. This variable is intended to be an indicator of the intensity of new business formation taking place in a respective planning region and sector.

In accordance to the hypotheses stated in section two, we considered for our regressions start-ups in the manufacturing sector as we expect that they will represent competition to manufacturing incumbents. Besides, we considered R&D intensive manufacturing start-ups which despite the fact of not being direct competitors to manufacturing incumbents, their condition of R&D intensive give them a challenging, threatening characteristic that might

push incumbents to improve efficiency. Besides, manufacturing incumbents might be able to appropriate and benefit from the knowledge developed by R&D intensive start-ups. We also considered start-ups in the knowledge intensive business service (KIBS) sector as they might benefit manufacturing incumbent firms by providing them with new knowledge or new combinations of knowledge necessary to update processes and improve efficiency.

The *control variables at establishment level* we considered in the analysis are the following. First, to control for *path dependency* we included in the regression an average of the absolute levels of productivity of period t-2 and period t-3. We also controlled for the possibility that productivity change is the result of a drastic investment in the near past. To do so we considered the *change in investments* over the last two periods before the start of the change in productivity, namely, period t-4 to t-2. We considered change in investment before the base year of the productivity as the benefits of investments might need some time to realize and be reflected in productivity growth. We are concern about drastic investments as in manufacturing incumbents they would most probably correspond to investments in machinery that can directly influence the productivity of these firms. We also controlled for the *size* of the incumbents which is measured by the total number of employees in the respective period. Larger firms are expected to have more resources or more facilities to access to resources and implement productivity changes in comparison to smaller firms. To capture the level of *human capital* of the incumbent establishments, we considered the share of highly qualified employees, namely, employees with tertiary education in reference to the total number of employees. As we argued that incumbents may enhance their productivity based on the knowledge they can appropriate from the start-ups, human capital is expected to play a positive role in this process as it enhances the absorptive capacity of incumbents which is a decisive factor for knowledge spillovers (Cohen and Levinthal, 1990). Since the level of productivity is the valued added per employee, the growth in

productivity may also be the result of a reduction of the number of employees. To account for this, we included as an additional control variable the *change in the number of employees* at the same time of the productivity growth (t-2 to t=0). By doing so we can identify if the productivity growth we observe is the result of a simultaneous reduction in the number of employees or a genuine increase in value added.

A large body of literature has claimed that *export* activities lead to productivity growth mainly because of two mechanisms. First, based on evidence from China and measuring export activities as the share of sales to foreign countries, Kraay (1999) argued that firms operating in international markets are in an advantageous position to capture knowledge and technological spillovers from their international contacts favoring learning and efficiency gains. Second, export orientation is expected to improve firms' efficiency as it allows firms to exploit economies of scale (World Bank, 1993). Nevertheless, the argument that export orientation leads to productivity gains by means of learning processes has not been free of controversy. In fact, Bernard and Jensen (1999) and Bernard and Wagner (1997) in a sample of U.S. and German manufacturing firms did not find evidence for learning processes attributed to exports. These two referred studies use a dichotomous measure of export activities which only tells if firms are involved in international sales. Based on these controversial findings, Castellani (2002) conducted a study on export behavior and productivity growth which found that if exports are measured as the share of foreign sales on total sales it has a positive effect on productivity growth. On the other hand, considering only if a firm has foreign participation by a dummy variable leads to no impact in productivity. Therefore, Castellani (2002) claimed that in order to capture the benefits of internationalization it is not enough to enter a foreign market but rather it is necessary a significant participation in international activities, investments and knowledge accumulated through time. Castellani (2002) concluded that the higher the export orientation, the higher the firm´s

productivity growth. As we are trying to control for the possibility that the productivity growth of the incumbents in our sample may be driven by export activities of the incumbents, we consider an export intensive measure, namely, the share of foreign sales on total sales.

Finally, *proximity to the technology frontier* was captured in two different ways. In the first way, we identified for each period and manufacturing subsector the incumbent with the highest level of productivity. In reference to this highest level of productivity we calculated the proximity to the frontier for all other incumbents of our sample by dividing their levels of productivity by the highest productivity level. The second measure for proximity to frontier uses the information about the overall technical state of the plant and machinery of the incumbents available in the IAB Establishment Panel dataset. This measure corresponds to a Likert scale from 1 (state of the art) to 5 (obsolete). We used this measure as a categorical variable to check for robustness of the findings obtained by the continuous variable measuring proximity to frontier.

The study also considers *control variables at regional level* to account for regional specific characteristics which might affect the productivity growth of incumbents. Following Fritsch and Mueller (2004), we included population density as a control variable since agglomerations are characterized by a relative higher degree of competition which should act as an intrinsic pressure for increasing performance among the existing incumbents in the region. Bosma et al. (2011) also considers that regions with higher population density might stimulate competitiveness and offer the possibility of benefiting from economies of scale because of the larger demand they represent. Population density is a ‘catch all’ variable calculated as the total population over area size in squared kilometers. We also controlled for the possibility that productivity growth is influenced by the spatial proximity of other regions. To do so we included a Harris-type market potential function to account for spatial dependencies among regions. This variable is measured as the

distance weighted sum of total population in all other regions (see Redding and Sturm 2008; Südekum 2008). Data to measure population density and market potential was obtained from the Federal Statistical Office.

Finally, incumbent's productivity growth might also be influenced by industry specific characteristics. For example, developments in a certain industry offer, for example, technology opportunities which could possibly influence the productivity of incumbent firms. In order to capture these kinds of opportunities we considered the *change in the sales of an industry* over a two year period. Using the IAB Establishment Panel data, we aggregated the micro data of the individual sales of all the establishments corresponding to each of the subsectors to obtain a proxy for the total sales of the industry in each period. Once obtained the aggregated sales of each subsector, the change corresponds to the difference in the sales from t-2 to t=0. This variable is also considered at the same time of the productivity growth as it is also intended to control for the fact that productivity growth is the results of a simultaneous general growth of the specific industry in which the incumbent operates.

The third hypothesis of our study conditions the reaction of incumbents to the threat of entry on the individual distance of the incumbent to the technology frontier. To test this hypothesis, we included in a second stage of the analysis an interaction term. This interaction variable is the multiplication of our main explanatory variable *average start-up rates* and the *proximity to the technology frontier* of the incumbent establishments. This interaction variable would allow us to identify if the effect of entry on the productivity of incumbents depends on the proximity of the incumbents to the frontier.

A summary of the variables included in the analysis are presented next.

Table 1: Definition of variables

Variable	*Definition*
Regional-sector level variables	
Average start-up rate t-2−t-11 (log)	Average number of start-ups in a region-sector over the regional workforce (10-year moving average) [b]
Establishment level variables	
Productivity change in incumbents t=0−t-2 (log)	Productivity change in incumbents. [a] $\Delta P = \ln \mathrm{P}_{\mathrm{t=0}} - \ln \mathrm{P}_{\mathrm{t-2}}$
Average level of productivity t-2−t-3 (log)	Average level of productivity (2-year moving average). [a]
Change in investments t-2−t-4 (log)	Difference of investments over a two year period before the change in productivity. [a]
Number of employees (log)	Number of employees on the current year. [a]
Highly qualified employees (log)	Share of employees in the establishment with a tertiary degree. [a]
Change number of employees t=0−t-2 (log)	Difference in the number of employees over a two year period. [a]
Proximity to the technology frontier (log)	Relative percentage proximity to the leader of the industry. [a]
Exports (log)	Share of the total sales corresponding to foreign countries. [a]
Industry level variables	
Change in the sales of the industry t=0−t-2 (log)	Difference in the total sales of the industry over a two year period. [a]
Regional level variables	
Population density (log)	Total population per km^2. [c]
Market potential (log)	Distance weighted sum of total population in all other regions. [c]

Interaction variable	
Start-up rate x Proximity (log)	Interaction of start-up rates and proximity to the technology frontier of the incumbent establishments. [a] and [b]
Data sources: [a] Establishment Panel; [b] Establishment History File; [c] Federal Statistical Office.	

c. Estimation of the effects of entry on incumbent's productivity

To assess the relationship between the productivity growth of incumbent establishments and new business formation, we applied an OLS regression with panel fixed-effects to control for unobserved heterogeneity of time-invariant factors of our entities– in this case the time invariant characteristics of manufacturing incumbent establishments.

We regress incumbents' productivity growth on the average start-up rate, distinguishing by the different sectors which are manufacture, R&D intensive manufacture and KIBS.

The expected relationship is specified as follow.

$$\Delta lnP_{i,r,s,t}^{inc} = \alpha + \beta_1 start\text{–}up\ rate_{r,t} + X_{i,t-2} + Z_{r,t-2} + W_{s,t-2} + \mu_r + \lambda_t + \varepsilon_{r,t}$$

Where:

- $\Delta lnP_{i,r,s,t}^{inc}$ is the respective productivity growth at establishment level (from t-2 to t=0), *i* indexes incumbent establishments, *r* indexes regions, *s* indexes subsectors within the manufacture sector to which the incumbents belong, and *t* indexes years.

- $\beta_1 Startup - rate_{r,t}$ is the lagged start-up rate calculated as a moving average over a period of 10 years (from t-2 to t-11) in region r.
- $X_{i,t-2}$ are a set of control variables at establishment level
- $Z_{r,t-2}$ are a set of control variables at regional level
- $W_{s,t-2}$ is a control variable at industry level
- μ_i are incumbent establishments specific fixed effects
- λ_t are time dummies to control for common macro shocks.
- $\varepsilon_{r,t}$ is the error term.

We decided to use the logarithm of all the variables in order to interpret the coefficients of the regressors as quasi-elasticities and thus allow easy comparisons between the regressions. The coefficient of our main explanatory variable, namely, the lagged start-up rate, represents the relative productivity growth that can be attributed to changes in the long-term start-up activity in a specific sector in a certain region.

One additional issue we tried to take into account is minimizing the danger of reverse causality which refers to the fact that low productive incumbents may attract start-ups to enter the market. In fact, in regions where it is possible to find inefficient incumbents, potential entries will see an opportunity to enter the market. This reverse causality is more likely to happen at the same time of the observed low productivity, namely at t-2, the base year of the productivity growth. To avoid this issue we further lagged the main explanatory variable, namely, we calculated the average start-up rate from t-5 to t-11 instead of t-2 to t-11 as it is less probable that entrepreneurs will decide to start a firm now to take advantage of the opportunities left by low productive incumbents only three years later. We consider this to be a less likely scenario as entrepreneurs would know that the opportunities they observe now would most probably change three years later as this is what characterizes today's very dynamic markets. By further lagging the main explanatory variable we also create a time gap between start-up activity and

the reaction of incumbents. If there is really a reaction of incumbents to the competition and threat of start-ups, setting this time gap would give incumbents more time to react and show that reaction in terms of productivity growth. Therefore, we expect a higher coefficient and significance of the further lagged average start-up rate (t-5–t-11) as this allows observing the productivity growth after giving the incumbents time to react. The results of this further lagged average start-up rate can be observed in models III and IV of tables 2, 3 and 4.

4. Results

Our analysis shows that regular new business formation in the manufacturing sector has on average a positive effect on the productivity growth of manufacturing incumbents (Please see Model I and II in Table 2). This finding suggests that regular start-ups are also able to represent competition and threat to incumbents which react enhancing their productivity. Baumol et al. (1988) argued that not only actual entry but sometimes just the threat of entry can force incumbents to perform more efficiently. In our case, we can say that not only entry from the Schumpeterian point of view, namely very advanced innovative entry, but also regular start-ups represent threat and competition that leads incumbents to work more efficiently.

While the size of the incumbent represented by the number of employees is not significantly related to productivity growth in any model, human capital represented by the share of highly qualified employees appears to be significantly related to productivity growth. This finding suggests that the mere increase in the number of employees does not contribute to productivity growth but the increase of highly qualified employees does. Even though we considered a measure of the intensity of export activities, no significant relationship was found between exports and

productivity growth. This finding is supported by Clerides et al. (1998) who considered lagged export volumes and did not find evidence of export activities contributing to productivity growth by means of learning effects.

It is important to remark that no significant relationship was found between productivity growth and change in the number of employees over the same periods of analysis. Therefore, it can be argued that the observed growth in productivity is not the result of a mere decrease of the number of employees but rather a genuine improvement in value added.

No significant relationship was found between productivity growth and the variation in sales of the industry which allows us to argue that the observed productivity change was not driven by general growth of a specific sub sector as a result of some kind of opportunity.

In regards to the proximity of the incumbents to the technology frontier, it has a significant negative relation to their productivity growth. This finding suggests that incumbents further away the frontier show higher productivity growth rates than incumbents closer to the frontier. This finding is in line with previous findings by Aghion et al. (2009). In our case, we confirmed this finding by using the second measure of proximity to frontier, namely, the Likert scale (Please see Model II in Table 2). In fact, firms with machinery and equipment “1: state of the art” have a negative significant relation to productivity growth.

Results of the further lagged average start-up rate can be found in Models III and IV of Table 2. We observe a more significant, higher coefficient which suggests that in fact setting a time gap allows observing an increased productivity growth as incumbents have more time to react. The control variables remain stable compared to Model I and II.

Table 2. *The effect of new business formation in the manufacturing sector on the productivity growth of manufacturing incumbents*

	Productivity growth in manufacturing incumbents (log), t-2-t=0			
	Model I	Model II	Model III	Model IV
Average start-up rate in manufacturing (t-2−t-11) (log), t-2	0.895**	1.050**		
	(-0.385)	(-0.461)		
Average start-up rate in manufacturing (t-5−t-11) (log), t-2			1.090***	1.261***
			(-0.373)	(-0.429)
Path dependency (log), *t*-2	-0.833***	-1.040***	-0.843***	-1.051***
	(-0.0612)	(-0.0663)	(-0.0611)	(-0.0665)
Size (log), *t*-2	0.0597	-0.0467	0.0759	-0.0228
	(-0.108)	(-0.124)	(-0.108)	(-0.124)
Human capital (log), *t*-2	0.0522*	0.0734**	0.0452	0.0626*
	(-0.0305)	(-0.0358)	(-0.0302)	(-0.0359)
Export intensity (log), *t*-2	-0.0325	-0.011	-0.0331	-0.013
	(-0.0474)	(-0.0421)	(-0.0472)	(-0.0417)
Change in investments t-4−t-2 (log), *t=0*	0.00499	0.00875	0.00274	0.00621
	(-0.0101)	(-0.0111)	(-0.0103)	(-0.0114)
Change in number of employees t-2-t=0 (log), *t*=0	-0.0971	-0.135	-0.0854	-0.127
	(-0.112)	(-0.123)	(-0.11)	(-0.12)
Change sales industry t-2-t=0 (log), *t=0*	0.0556	0.0216	0.044	0.00218
	(-0.0366)	(-0.0444)	(-0.0373)	(-0.0461)
Population density (log), *t*-2	-3.557*	-3.482*	-3.261*	-3.072
	(-1.902)	(-1.971)	(-1.869)	(-1.935)
Market potential (log), *t*-2	5.316	10.06	8.233	13.1
	(-10.54)	(-11.64)	(-10.31)	(-11.1)
Proximity to technology frontier *t-2*	-0.185***	1 -0.165***	-0.185***	1 -0.176***
	(-0.0308)	(-0.0558)	(-0.0306)	(-0.0552)
		2 -0.0703**		2 -0.0835**
		(-0.0316)		(-0.0344)
		4 -0.101		4 -0.131
		(-0.0801)		(-0.082)
		5 -0.0161		5 -0.0847
		(-0.0902)		(-0.0906)
Year dummies	Yes	Yes	Yes	Yes
R-squared (within)	0.393	0.381	0.393	0.381
Adjusted R-squared (within)	0.388	0.375	0.388	0.375
Number of observations	2247	1976	2262	1987

Notes: Fixed effects panel regressions. Robust standard errors in parentheses. *** Statistically significant at the 1 percent level; ** statistically significant at the 5 percent level; * statistically significant at the 10 percent level. Model I: Continuous proximity to frontier (log transformed). Model II: Scale proximity to frontier (1 state of the art; 5 obsolete). Model III: Further lagged average start-up rate and continuous proximity to frontier (log transformed). Model IV: Further lagged average start-up rate and scale proximity to frontier (1 state of the art; 5 obsolete).

Table 3 shows that there is a positive relation of the average start-ups in the R&D intensive manufacturing sector and manufacturing incumbents' productivity growth. Notice that this relation is smaller in coefficient and significance compared to the relation of manufacturing incumbent's productivity growth and start-ups in the manufacturing sector. As R&D intensive manufacture start-ups do not operate in the specific market of manufacturing incumbents, this finding suggest that the direct threat and competition of start-ups plays a more relevant role in the productivity growth of incumbents rather than knowledge incumbents can gain from R&D intensive start-ups. I could also be argued that the condition of R&D intensive start-ups of being highly competitive does represent a thread which leads incumbents or other related sectors to work more efficiently.

As in the relation of manufacturing start-ups and manufacturing incumbents presented in Table 2, also in the case of R&D intensive manufacturing start-ups and manufacturing incumbents it is possible to see that in Models III and IV, the relation is more significant and higher. This finding suggests again that setting a gap to allow incumbent to appropriate and benefit from the knowledge of R&D intensive start-ups, or to react to their thread is important to identify a relationship.

Table 3. The effect of new business formation in the R&D intensive manufacture sector on the productivity growth of manufacturing incumbents

	Productivity growth in manufacturing incumbents (log), t-2-t=0			
	Model I	Model II	Model III	Model IV
Average start-up rate in R&D intensive manufacturing (t-2−t-11) (log), t-2	0.175	0.247*		
	(-0.132)	(-0.139)		
Average start-up rate in R&D intensive manufacturing (t-5−t-11) (log), t-2			0.287*	0.375**
			(-0.152)	(-0.164)
Path dependency (log), *t*-2	-0.829***	-1.035***	-0.835***	-1.044***
	(-0.0615)	(-0.0661)	(-0.0612)	(-0.0663)
Size (log), *t*-2	0.0564	-0.0468	0.0702	-0.0273
	(-0.108)	(-0.126)	(-0.107)	(-0.125)
Human capital (log), *t*-2	0.0518*	0.0724**	0.0475	0.0662*
	(-0.0307)	(-0.0363)	(-0.0305)	(-0.0363)
Export intensity (log), *t*-2	-0.0271	-0.00316	-0.0267	-0.00273
	(-0.0469)	(-0.0412)	(-0.0467)	(-0.041)
Change in investments t-4−t-2 (log), *t=0*	0.0056	0.00943	0.00302	0.00644
	(-0.0101)	(-0.0111)	(-0.0103)	(-0.0114)
Change in number of employees t-2-t=0 (log), *t*=0	-0.111	-0.141	-0.0932	-0.129
	(-0.113)	(-0.124)	(-0.113)	(-0.122)
Change sales industry t-2-t=0 (log), *t=0*	0.0538	0.0183	0.0414	0.000994
	(-0.0366)	(-0.0445)	(-0.0374)	(-0.0463)
Population density (log), *t*-2	-2.402	-2.227	-2.799	-2.606
	(-1.692)	(-1.729)	(-1.748)	(-1.802)
Market potential (log), *t*-2	-4.507	-0.769	-1.892	1.974
	(-8.661)	(-9.029)	(-9.06)	(-9.389)
Proximity to technology frontier *t-2*	-0.184***	1 -0.166***	-0.185***	1 -0.176***
	(-0.0308)	(-0.0561)	(-0.0304)	(-0.0552)
		2 -0.0732**		2 -0.0835**
		(-0.032)		(-0.0344)
		4 -0.0828		4 -0.131
		(-0.0855)		(-0.082)
		5 -0.00906		5 -0.0847
		(-0.0949)		(-0.0906)
Year dummies	Yes	Yes	Yes	Yes
R-squared (within)	0.39	0.379	0.389	0.377
Adjusted R-squared (within)	0.385	0.372	0.384	0.37
Number of observations	2247	1976	2262	1987

Notes: Fixed effects panel regressions. Robust standard errors in parentheses. *** Statistically significant at the 1 percent level; ** statistically significant at the 5 percent level; * statistically significant at the 10 percent level. Model I: Continuous proximity to frontier (log transformed). Model II: Scale proximity to frontier (1 state of the art; 5 obsolete). Model III: Further lagged average start-up rate and continuous proximity to frontier (log transformed). Model IV: Further lagged average start-up rate and scale proximity to frontier (1 state of the art; 5 obsolete).

We complement our analysis by investigating whether new business formation in the KIBS sector is related to the productivity growth of manufacturing incumbents. Table 4 shows that the average start-up rate in the KIBS sector is only slightly significant in model I. For the rest of the models, even though the relation is positive it is not significant. Therefore, there is no robust evidence to suggest a relationship between new business foramtion in the KIBS sector and the productivity of manufacturing incumbents. Even though this finding contradicts our second hypothesis, it does not mean that we deny the argument that start-ups in the KIBS sector are responsible for bringing new knowledge or new combinations of existing knowledge that could be gained by manufacturing incumbents. Actually, our finding that R&D intensive manufacturing start-ups has a positive, significant relation to incumbent's productivity growth suggests that incumbent manufactures might benefit from the knowledge those innovative R&D intensive start-ups bring to the market. For the case of KIBS start-ups, we consider that one possible reason for not finding the expected relationship is that incumbents do not necessarily establish interactions with newly established KIBS which would allow such a knowledge interaction process and a consequent significant relationship. Incumbents might prefer to interact with incumbent KIBS as they might be already acknowledged in the market. Besides, considering that empirical evidence has showed that local manufacturing sector has no effect on KIBS start-up activity (Andersson and Hellerstedt, 2009), it suggest that there is not much interaction between newly established KIBS and manufacturing incumbents or that the relation go beyond the borders of the region. Therefore, it still remains to be tested if new business formation in the KIBS sector of adjacent regions of the location of the incumbent is related to the incumbent productivity growth.

Table 4. The effect of new business formation in the KIBS sector on the productivity growth of manufacturing incumbents

	Productivity growth in manufacturing incumbents (log), t-2-t=0			
	Model I	Model II	Model III	Model IV
Average start-up rate in KIBS sector (t-2−t-11) (log), t-2	1.041*	0.846		
	(-0.408)	(-0.517)		
Average start-up rate in KIBS sector (t-5−t-11) (log), t-2			0.524	0.369
			(-0.352)	(-0.381)
Path dependency (log), *t*-2	-0.835***	-1.040***	-0.835***	-1.043***
	(-0.0614)	(-0.0681)	(-0.0618)	(-0.0677)
Size (log), *t*-2	0.0434	-0.0663	0.0546	-0.0516
	(-0.107)	(-0.124)	(-0.107)	(-0.125)
Human capital (log), *t*-2	0.0518*	0.0722**	0.0443	0.0623*
	(-0.0311)	(-0.0365)	(-0.0305)	(-0.0362)
Export intensity (log), *t*-2	-0.0222	0.000248	-0.0272	-0.00379
	(-0.046)	(-0.0406)	(-0.0463)	(-0.0408)
Change in investments t-4−t-2 (log), *t=0*	0.00617	0.00971	0.00341	0.00658
	(-0.01)	(-0.0111)	(-0.0103)	(-0.0116)
Change in number of employees t-2-t=0 (log), *t*=0	-0.108	-0.154	-0.099	-0.144
	(-0.111)	(-0.123)	(-0.112)	(-0.123)
Change sales industry t-2-t=0 (log), *t=0*	0.0548	0.0206	0.0426	0.00324
	(-0.036)	(-0.0444)	(-0.0369)	(-0.0461)
Population density (log), *t*-2	-3.150*	-2.696	-3.042*	-2.619
	(-1.801)	(-1.826)	(-1.835)	(-1.845)
Market potential (log), *t*-2	-1.409	-0.426	-3.63	-2.039
	(-9.396)	(-9.947)	(-9.334)	(-9.763)
Proximity to technology frontier *t-2*	-0.186***	1 -0.155***	-0.187***	1 -0.170***
	(-0.0308)	(-0.0552)	(-0.0306)	(-0.0553)
		2 -0.0676**		2 -0.0840**
		(-0.0321)		(-0.0351)
		4 -0.0659		4 -0.0924
		(-0.086)		(-0.0887)
		5 0.0242		5 -0.0173
		(-0.101)		(-0.101)
Year dummies	Yes	Yes	Yes	Yes
R-squared (within)	0.394	0.38	0.389	0.374
Adjusted R-squared (within)	0.389	0.373	0.383	0.367
Number of observations	2247	1976	2262	1987

Notes: Fixed effects panel regressions. Robust standard errors in parentheses. *** Statistically significant at the 1 percent level; ** statistically significant at the 5 percent level; * statistically significant at the 10 percent level. Model I: Continuous proximity to frontier (log transformed). Model II: Scale proximity to frontier (1 state of the art; 5 obsolete). Model III: Further lagged average start-up rate and continuous proximity to frontier (log transformed). Model IV: Further lagged average start-up rate and scale proximity to frontier (1 state of the art; 5 obsolete).

Turning to the third hypothesis of our study which referred to the effect of new business formation on incumbents' productivity growth conditional on their proximity to the technology frontier, we tested this hypothesis only for the relation of manufacturing start-ups and incumbents' productivity as this is the most robust relation found in our analysis. Results of this estimation are presented in Table 5, where it is possible to observe that the interaction term "Average start-up rate x Proximity to frontier", is negatively correlated with incumbents' productivity growth. This result suggests that incumbents' productivity growth responds less positively to regular new business formation if the incumbent is close to the technology frontier. On the other hand, incumbents further away from the frontier seem to react more positively to regular new business formation in the same sector.

Aghion et al. (2009) found that incumbents' productivity growth in industries close to the technology frontier responds more positively to technologically advanced entry. We contribute to this field of literature by testing the reaction of incumbents to regular new business formation conditional on the proximity of incumbents to the technology frontier. By doing so, we identify that the reaction of incumbents is quite different if they are faced with regular start-ups or with technologically advanced entry. In fact, in our case incumbents away from the frontier are the ones responding more positively. This suggests that regular new business formation is able to represent a greater challenge to incumbents further away from the frontier while frontier incumbents (highly productive) do not seem to be considerably affected by regular start-ups. As we considered that the relation identified between start-ups in the manufacture sector and manufacturing incumbents' productivity growth is the result of the competition and threat start-ups impose, we interpret our results suggesting that this competition is taking place mostly among entry firms and incumbents away from the frontier. On the other hand, regular new business formation is not challenging enough to strongly influence the productivity of frontier incumbents.

Table 5. *The effect of new business formation in the manufacturing sector on the productivity growth of manufacturing incumbents conditional on their distance to the technology frontier*

	Productivity growth in manufacturing incumbents (log), t-2-t=0
Average start-up rate in manufacturing x Proximity to technology frontier	-0.0503
	(-0.073)
Average start-up rate in manufacturing (t-2−t-11) (log), t-2	0.794*
	(-0.427)
Path dependency (log) *t*-2	-0.832***
	(-0.0616)
Size (log) *t*-2	0.0573
	(-0.11)
Human capital (log), *t*-2	0.0519*
	(-0.0305)
Export intensity (log) *t*-2	-0.0332
	(-0.0474)
Change in investments t-4−t-2 (log) t=0	0.00504
	(-0.01)
Change in number of employees t-2-t=0 (log) *t*=0	-0.0984
	(-0.113)
Change sales industry t-2-t=0 (log) t=0	0.0578
	(-0.0367)
Population density (log), *t*-2	-3.527*
	(-1.913)
Market potential (log), *t*-2	4.918
	(-10.59)
Proximity to technology frontier (log), *t-2*	-0.168***
	(-0.0327)
Year dummies	Yes
R-squared (within)	0.393
Adjusted R-squared (within)	0.388
Number of observations	2247

Notes: Fixed effects panel regressions. Standard errors in parentheses. *** Statistically significant at the 1 percent level; ** statistically significant at the 5 percent level; * statistically significant at the 10 percent level.

Figure 1. shows the marginal effect of the average start-up rate in manufacture on the productivity growth of manufacturing incumbents. It is possible to observe that the closer the incumbent to the frontier, the lower the positive effect on its productivity growth. The technology frontier is 0 as it is the logarithm of 1 which represents the most productive firm. On the other hand, -8.32 is the incumbent furthest away the frontier.

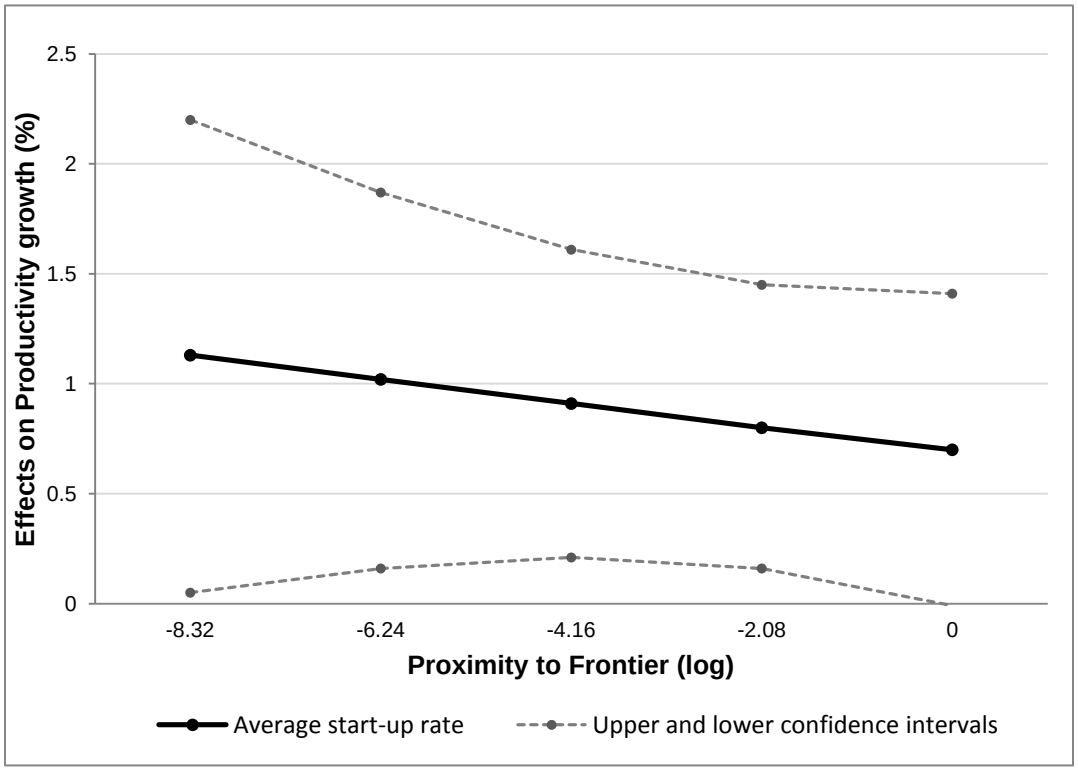

Fig. 1. *The marginal effect of new business formation in the manufacturing sector on the productivity growth of manufacturing incumbents.*

5. Conclusions

In our analysis we moved from the extend literature about the relation of new business formation and productivity growth at the regional or national level and focused on the effect of start-ups on the productivity growth of

incumbent establishments. While previous studies have found a positive effect of frontier, advanced entry on the growth of productivity of frontier incumbents, we identified that regular new business formation is also capable of imposing a positive effect on the productivity of incumbents. This positive relation seems to be the result of the competition and threat start-ups represent when they enter the same sector of the incumbent. More importantly, incumbents faced with new start-ups in the same sector show genuine productivity growth and not simply a change in the number of employees.

We also investigated the firm level factors that modulate the effect of start-ups on the productivity growth of incumbents. In this regard, we determined that the individual proximity of the incumbents to the technology frontier is a decisive factor. While previous studies empirically showed that frontier incumbents respond more positively to the threat imposed by frontier entry, we identified that incumbents further away the frontier are more responsive to regular new business formation. We interpret this finding by considering the fact that the average entry has usually lower productivity than advanced, frontier entry and exerts much less competitive threat on frontier incumbents than on incumbents away from the frontier. Therefore, we can argue that apart from the usual understanding of creative destruction that new firms replace incumbents, regular new business formation makes incumbents, especially those further away the frontier, stronger.

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Appendix

Table A1: Descriptive statistics

Variable	*Mean*	*Standard deviation*	*Minimun*	*Maximum*
Incumbents' productivity growth	0.0233689	0.5976042	-7.296067	5.710388
Average start-up rate in Manufacture	-6.539773	0.2502897	-7.406254	-5.738553
Average start-up rate in KIBS	-4.154187	0.2817525	-4.968325	-3.456145
Average start-up rate in R&D intensive manufacture	-6.972135	0.4115686	-8.45439	-5.925693
Path dependency	10.89183	0.7201107	4.39006	14.35585
Size	4.554549	1.958464	0	11.0121
Human Capital	-1.970455	1.054707	-6.626718	2.399107
Change in the number of employees	0.0001739	0.1322392	-1	2.807355
Proximity to the technology frontier	-2.21065	1.06739	-8.320173	0
Exports	3.22166	1.023383	0	4.60517
Population density	5.670765	0.6242671	4.277382	7.125517
Change in the sales of the industry	0.0050921	0.0514123	-0.1414174	0.4202671
Start-up Manufacture x Proximity to Frontier	-0.7923061	0.7768387	-7.828298	2.026343

Table A2. Correlation between variables

	Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Incumbents' productivity growth	1													
2	Average start-up rate in Manufacture	0.0284	1												
3	Average start-up rate in KIBS	0.0347	0.4185	1											
4	Average start-up rate in R&D intensive manufacture	0.0117	0.8367	0.3763	1										
5	Path dependency	0.3519	-0.035	-0.082	-0.05	1									
6	Size	0.0341	-0.069	-0.007	-0.099	0.1691	1								
7	Human Capital	0.0373	0.0302	-0.067	-0.025	0.3241	0.0753	1							
8	Change in the number of employees	0.0835	-0.003	0.023	0.0058	0.0937	-0.127	0.1023	1						
9	Proximity to the technology frontier	0.1998	-0.098	-0.203	-0.086	0.6130	0.1009	0.2645	0.0871	1					
10	Exports	0.0033	-0.006	-0.031	-0.044	0.188	0.3226	0.3037	0.0133	0.206	1				
11	Population density	0.039	-0.089	-0.468	-0.194	0.0936	0.0378	0.1165	-0.064	0.057	0.117	1			
12	Change in the sales of the industry	0.0032	0.0549	0.0967	0.0737	-0.009	0.0058	-0.132	-0.028	0.07	-0.043	0.0146	1		
13	Change in investment	0.0677	-0.024	-0.024	-0.022	0.101	0.007	0.03	0.107	0.054	0.039	-0.023	-0.011	1	
14	Start-up Manufacture x Proximity to Frontier	0.1846	-0.822			0.295	0.1055	-0.082	0.0284	0.275	0.1124	0.1892	-0.039	-0.02	1