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New firm formation and employment growth: regional and business dynamics

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Abstract This study examines differences in the effects of start-up rates on subsequent employment change. Two sources of such differences—types of start-ups and types of regions—are analyzed. We find that differences between knowledge-based and other start-ups dominate differences between highly agglomerated and modestly agglomerated regions. In particular, differences in the effects of new start-ups on subsequent employment growth between highly agglomerated and modestly agglomerated regions are greater for knowledge-based start-ups than for other types of start-ups. The results suggest that, while knowledge-based start-ups are likely to impart greater benefits on future employment than other types of start-ups, these benefits are greater when those start-ups locate in more agglomerated regions.

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1 Introduction

Economic analysis has increasingly focused on the economic benefits of entrepreneurship in terms of, for instance, employment generation and innovation (van Praag and Versloot 2007). A recent stream of studies examines whether there is a relationship between increases in new firm formation rates and subsequent employment growth at the regional level. These studies show that the impact of new business formation on regional development is distributed over a relatively long period of time, usually 10 years. Comparable patterns of results are found for Germany (Fritsch and Mueller 2004, 2008), Great Britain (Mueller et al. 2008), the Netherlands (van Stel and Suddle 2008), Portugal (Baptista et al. 2008), Spain (Arauzo-Carod et al. 2008), and the US (Acs and Mueller 2008).

New firms are generally smaller than the average incumbent, and their direct contribution to the stock of jobs in an economy is relatively small (van Stel and Storey 2004). Moreover, new businesses have a greater probability of failure than old businesses. According to Geroski (1995), the survival probability of most entrants is low and successful entrants may take more than a decade to achieve a size comparable to that of the average incumbent. It is therefore striking that a key finding shared by the aforementioned stream of studies for different countries is that there is a positive relationship between new firm formation and subsequent employment growth. These studies found a similar pattern for the lag structure of the effects of new firm formation on employment growth over time. First, the magnitude of direct employment creation in entry cohorts was found to be small. Second, new entrants subsequently crowd out inefficient firms, lowering employment. Third, positive supply-side effects increase overall employment significantly, through the growth of successful entrants and incumbents.

The remarkable similarity in the patterns of results observed across countries suggests that there are three different kinds of impacts of new firm formation on subsequent employment change, and that these impacts do not occur simultaneously, but in different points in time.

i. First, a direct impact of employment creation by firm j in time t is observed;
ii. Second, there is a period when displacement of existing jobs occurs, possibly as a result of increased competition and market selection;
iii. Third, there are positive long term impacts, possibly associated with increased competitiveness and innovation brought about by successful new firms that spills over to the industry.

Even though patterns of effects of new business formation on employment growth are similar across countries, there seem to be pronounced differences in the magnitude and specific timing of these effects. Moreover, differences across regions within countries are also observed (Fritsch and Mueller 2008). Such differences are significant even when one controls for different regional industrial structures.[1] This finding suggests that, even when one controls for economic structure, different regions display different kinds of industrial dynamics, and attract different kinds of new firms.

In particular, the studies by Acs and Mueller (2008) and Fritsch and Mueller (2008) revealed pronounced differences in the magnitude and timing of the effects of new firm creation on subsequent employment growth across regions within countries. In their study for the US, Acs and Mueller (2008) find that large consolidated metropolitan areas are fertile ground for the growth of new businesses, whereas small towns and cities may register high rates of new firm entry but cannot support the expansion of rapidly growing firms.

Similar disparities exist across different countries. Baptista et al. (2008) find that the positive long term impacts of new firm formation on subsequent employment growth in the case of Portugal are smaller and take longer to occur than the same kind of effects in the comparable case of Germany, as found by Fritsch and Mueller (2004). As these studies controlled for differences in regional industrial structures, such disparities are likely due either to differences in business dynamics (i.e. the qualities of the new firms being started) or to differences in regional/national characteristics that may bolster the positive long term impacts of new firm creation on employment growth.

The present paper uses data for Portugal to examine in detail how differences in regional and business dynamics may contribute to generate disparities among regions in the magnitude and timing of employment growth effects. In particular, we examine differences between the long-term effects on employment growth of new firm creation in knowledge-based sectors and in other sectors for regions with different levels of productivity and agglomeration of economic activity.

The paper proceeds as follows. The next section provides a brief exploration of the regional and business dynamics that may lead to differences in the magnitude and timing of the long term effects of new business formation on employment growth within and across regions. Section 3 focuses on the empirical analysis. Section 4 presents and discusses the results, and Sect. 5 provides some concluding remarks.

[1] Economic activities in different regions differ accordingly to their composition in terms of sectors; therefore, regions with greater proportions of firms in declining sectors should display lower impacts of new firm formation on employment growth than regions with a greater proportion of firms in growing sectors. A shift-share procedure was used to correct for this kind of difference in, for instance, the studies by Baptista et al. (2008); and Mueller et al. (2008). Differences across regions in the effects of new firm formation on employment growth remained significant.

2 Effects of new firm formation on employment growth: regional and business dynamics

The relationship between new firm entry and economic growth has been addressed by recent theory and empirical work. Acs et al. (2004) argue that entrepreneurship (i.e. new firm creation) contributes to economic growth by penetrating the "knowledge filter" that prevents new knowledge from spilling over to economic agents. In this way, new firm creation facilitates the working of the fundamental mechanism behind sustained economic growth (Romer 1986, 1990). Recent empirical studies find a positive relationship between new firm entry and productivity growth (Disney et al. 2003; Aghion et al. 2004).

While the creation of new firms may play a significant role in spawning regional economic growth, the extent of the effects of entrepreneurial activity on subsequent growth should vary across regions according to the pools of innovative opportunities and human capital available in each region (Shane 1996; Baptista and Mendonça 2009). Business and regional dynamics are strongly inter-related, and play an important role in determining the impact of new firm entry on economic development and employment growth. Regions may differ considerably with regard to the characteristics of new and incumbent businesses as well as with regard to their ability to absorb the positive effects of new business formation. In order to analyze such differences, they distinguish between types of regions according to different criteria, including the degree of agglomeration and the average labor productivity. Acs and Mueller (2008) look at differences in levels of business dynamics (i.e. proportion of rapidly growing firms) between regions; not surprisingly, they find that most rapidly growing firms are located in the larger (i.e. more agglomerated) metropolitan regions[2] It seems therefore reasonable to assume that there is a positive relationship between the degree of regional agglomeration and business dynamics levels.[3]

The role played by agglomeration effects—or externalities—in promoting supply-side spillovers is widely addressed in the literature (see for instance Baptista 1998; and Audretsch 2003). There is a general belief that location matters to the development and growth of industries. Much literature has been developed around the notion that firms tend to concentrate in certain regions so they can benefit from co-location. Feldman (1994) argues that spillovers associated with innovation are stronger within relatively restricted geographical regions due to agglomeration externalities that increase the capacity of firms to tap into the local pool of new ideas, while Jaffe et al. (1993) provide evidence of geographical concentration of spillovers on innovative (patenting) activity; Baptista (2000) finds that the probability of a firm adopting an innovation depends positively on the local presence of other adopters.

Other studies have argued that agglomeration externalities influence business dynamics directly through the process of displacement that determines which firms survive and grow, and which firms fail (Acs and Mueller 2008). Agglomeration externalities influence firm competitiveness and growth through mechanisms that involve both concentration and diversity of industries (Glaeser et al. 1992; Blien et al. 2006), and may also result from efficiency gains due to increased competition: several empirical studies support the conjecture of a relatively high level of competition in agglomerations. These studies find higher rates of start-ups (Fritsch and Falck 2007) and a lower probability of survival (Fritsch et al. 2006) in more agglomerated regions.

Baptista et al. (2008) suggest that a substantial part of the differences across regions and countries in the size and structure of lagged effects of entry on employment change are likely to be due to differences in types and/or qualities of start-ups. The size of negative (market selection) and positive (supply-side spillovers) effects and the lag time for those effects to ensue should vary according to the type of entrant, as not all entrants are equally efficient and/or innovative, and, therefore, not all have the same impact. While it is acknowledged that the emergence of positive supply-side effects from new firm formation does not require that newcomers are successful,[4]

[2] According to Acs and Mueller (2008), 40% of all the rapidly growing firms are located in only 20 metropolitan regions, which are mostly the largest cities in the United States.

[3] Glaeser et al. (1992) find a positive correlation between agglomeration externalities and firm growth levels.

[4] Hoetker and Agarwal (2007) find that significant diffusion of knowledge may occur after an innovative firm exits an industry if other firms are able to use that firm's activities as a template to successfully replicate and extend its innovative knowledge.

it is expected that different kinds of start-ups will have different impacts on the industrial re-structuring process according to the "quality" of new entrants with regard to innovation, efficiency, and product differentiation.[5] New firms provide a vehicle for the introduction of innovations into an economy, therefore being a source of both industry turbulence (Beesley and Hamilton 1984) and productivity growth (Aghion et al. 2004).[6]

Even though, as pointed out by van Stel and Storey (2004), innovation in new firms seems to be not as frequent as expected, a significant contribution by new entrants to employment growth occurs through increased competitiveness and enhanced efficiency of incumbents. In a recent study for Germany, Fritsch and Noseleit (2009) find that the employment effects of new businesses on the incumbents are significantly positive and considerably larger than the employment that is directly generated in the start-ups.

When discussing the transition from the managed economy to the entrepreneurial economy, Audretsch and Thurik (2004) stress the role played by the increasing pace of technological progress. In the managed economy technological trajectories were relatively well-defined and firms were subject to relatively low uncertainty, while in the entrepreneurial economy product life-cycles are short and competitive conditions change rapidly. In a meta-analysis of the empirical evidence that net employment growth is generated by only a few rapidly growing firms, Henrekson and Johansson (2009) do not find that these firms are disproportionately high tech. However, the large majority fits in the less restricted qualification of knowledge-based enterprises (KBEs).[7] A greater presence of knowledge-based entrants is likely to boost the introduction of innovations in the market. Knowledge-based industries tend to have shorter product and technology life-cycles and, being less focused on operational economies of scale, provide more opportunities for new, small firms to induce market re-structuring and change through innovation and efficiency improvements. It can therefore be argued that both employment destruction (due to increased competition and displacement) and employment creation (due to positive supply-side spillovers) will be greater the higher is the rate of entry in knowledge-based sectors.

3 Empirical analysis

Our study investigates whether there is a significant relationship between new firm start-up rates and subsequent employment growth at the regional level using longitudinal data for Portuguese regions. Following Fritsch and Mueller (2004, 2008), we look at the lag structure of these effects and at the total effect over time. Based on the discussion in the previous section, as well as on the works by Fritsch and Mueller (2008), and Acs and Mueller (2008), two main hypotheses are tested:

Hypothesis 1 Start-ups will have stronger impacts on subsequent employment change in regions with relatively high levels of agglomeration.

Hypothesis 2 Start-ups of knowledge-based enterprises will have a greater impact on subsequent employment change than start-ups of other firms, regardless of the regional level of agglomeration.

3.1 Data and measurement issues

Data on entry and employment come from the longitudinal matched employer-employee micro-data set *Quadros de Pessoal* (QP), which was built based on information gathered in annual mandatory surveys by the Portuguese Ministry of Labor and Social Solidarity. These surveys cover all business units

[5] Baptista and Preto (2009) seek to examine the effects on employment growth of start-up rates according to different types of entrants (e.g. small vs. large start-ups and domestics vs. foreign start-ups).

[6] Disney et al. (2003) find that in the UK between 1980 and 1992 about half of productivity gain was because of internal factors, such as introducing new technology and organisational changes. The remaining half was because of external factors, most notably that the entrants were more productive than those exiting. However amongst single plant independent firms almost all the gains were attributable to external factors.

[7] This classification includes high technology and medium–high technology industries, post and communications, finance and insurance and business services (OECD 2002).

with at least one wage-earner in the Portuguese economy.[8]

Following Fritsch and Mueller (2004) and Baptista et al. (2008) we use as indicator of regional development the relative change over a 2-year period of employment in the private sector. By using changes over a 2-year period we attempt to avoid disturbances due to short-run fluctuations. The specific form in which the data set was built enables us to distinguish between true start-ups and entry of new plants/business units. New firm formation is measured by yearly regional start-up rates. Start-ups were assigned to the 30 standardized (NUTS III) regions of Portugal for the period 1983–2000. Start-ups in the agricultural sector are excluded.

In order to control for differences in regional size, regional entry levels are not gauged in absolute terms, but as rates measured relative to regional size (Ashcroft et al. 1991). Following Garofoli (1994), and Audretsch and Fritsch (1994), regional start-up rates are measured using the size of the regional workforce as denominator ("labor market" approach). This methodology has advantages over the use of the total number of firms in a region as the denominator ("business stock" approach) since the latter might be misleading in regions with a few large firms (in such case, small numbers of new firms would provide an artificially high birth rate, primarily because of the small denominator).

3.2 Knowledge-based start-ups, regional agglomeration, and economic performance

In our analysis, we follow the OECD classification of knowledge-based sectors, aggregated by technology level (OECD 2002). This is a very wide definition of technology-intensive sectors, encompassing high and medium technology industries, as well as knowledge-based services. Using this wide definition of technology intensity provides a more adequate measure of the business dynamics in a region than merely including entry in high tech industries, as these firms represent a very small share of the Portuguese industrial structure, and are therefore unlikely to impact significantly on regional innovation and efficiency levels.

In order to measure regional agglomeration effects and business dynamics, we follow Fritsch and Mueller (2008). These authors use population density as a proxy for the level of agglomeration externalities in German planning regions, classifying these into "highly agglomerated;" "moderately congested;" and "rural." The classification by Fritsch and Mueller is linked with the perspective taken by Acs and Mueller (2008), who look at levels of business dynamics in American metropolitan regions by measuring the shares of fast growing and slow growing firms. These authors revisit one of the main insights of David Birch's (1981) seminal contribution about the role played by small firms in employment creation: the perception that a small number of rapidly growing establishments (so-called "gazelles") are responsible for most of the employment growth in regional economies. These authors find that some regions—the more agglomerated metropolitan areas—have most of the rapidly growing companies. By contrast, less agglomerated regions have a predominance of slow growing companies.

Table 8 in the Appendix to this paper shows that, in the particular case of Portugal, it is easy to identify highly agglomerated regions as the ones generating greater entry. Only the large metropolitan regions of Greater Lisbon and Greater Oporto (NUTS III codes 10104 and 10302 in Table 8) display agglomeration levels that are susceptible of ranking in the German "highly agglomerated" group defined by Fritsch and Mueller (2008). Moreover, these two regions are also the ones that display higher entry rates. Hence, we start by classifying the 30 Portuguese NUTS III regions into two groups:

i. Highly agglomerated regions, corresponding to the metropolitan regions of Greater Lisbon and Greater Oporto, which are highly agglomerated and display high proportions of rapidly growing new firms (i.e. high levels of business dynamics);
ii. Modestly agglomerated regions, corresponding to all other 28 NUTS regions, which display below average levels of agglomeration and business dynamics.

The QP database allows us to use start-up and incumbent sizes to determine the proportions of rapidly growing start-ups per region. In order to compute regional population density, additional data on NUTS regions was gathered from the Portuguese National Institute of Statistics (INE).

[8] The database is property of the Portuguese government and can be accessed on-site at the Observatory of the Ministry of Labor and Social Solidarity.

In order to look closer at the business dynamics of modestly agglomerated regions—i.e. the ones displaying relatively low levels of agglomeration and start-up rates, and lower than average proportions of rapidly growing firms, we again follow Fritsch and Mueller (2008) and look at differences in labor productivity, as measured by GDP per working population. When drawing a distinction between regions according to their economic performance (i.e. labor productivity), these authors find that the differences between the effects of new business formation on employment are much more pronounced between higher and lower productivity regions than when regions are differentiated on the basis of agglomeration only. However, Fritsch and Schroeter (see this Special Issue) find that the main determinant of this effect is population density rather than labor productivity. Many of the German high productivity regions have high levels of population density while most of the low productivity regions are rural areas.

Figure 7 in the Appendix displays the Portuguese modestly agglomerated regions by labor productivity levels. By examining the differences in the effects of new business formation on employment between regions with high and low labor productivity, we observe whether entries in regions with relatively high levels of economic performance (as measured by labor productivity) have a greater impact on subsequent employment change than entries in regions with low economic performance. While regions with high economic performance may be dominated by efficient incumbents in mature industries which have relatively highly qualified employees (from which the founders of new firms are likely to be drawn), regions with low economic performance are likely to be dominated by less efficient incumbents, employing less qualified human capital. Firms founded by less qualified human capital are likely to have a lower impact on the business dynamics of a region and, therefore, a lower impact on subsequent employment growth, whether through enhanced efficiency or through amplified innovation.

3.3 Econometric methodology

The basic relationship to be modeled is adapted from Baptista et al. (2008), where the change in regional employment between period $t-2$ and period t is explained by the firm birth rates in periods t, $t-1$, $t-2\ldots n$, and has the following form:

$$\begin{aligned}\Delta\mathrm{EMP}_{t,r} = & \left[\alpha_0^I.\mathrm{BIR}_{t,r}^I + \alpha_1^I.\mathrm{BIR}_{t-1,r}^I + \cdots \right.\\ & \left. + \alpha_n^I.\mathrm{BIR}_{t-n,r}^I\right] + \left[\alpha_0^{II}\mathrm{BIR}_{t,r}^{II} + \alpha_1^{II}\mathrm{BIR}_{t-1,r}^{II}\right.\\ & \left. + \cdots + \alpha_n^{II}\mathrm{BIR}_{t-n,r}^{II}\right] + X_{t,r}.\beta + \varepsilon_t \qquad (1)\end{aligned}$$

where $\Delta\mathrm{EMP}_{t,r}$ is the change in regional employment between period $t-2$ and period t for region r; $\mathrm{BIR}_{t-i,r}^I$, $\mathrm{BIR}_{t-i,r}^{II}$ are the firm birth rates in period $t-i$ for type I and type II start-ups (e.g.: type I—knowledge-based firms; type II—other firms), with $i = 0,\ldots,n$ being the lag periods considered for region r; and $X_{t,r}$ are the control variables. For the present study, yearly start-up rates at the beginning of the current employment change period and for the ten preceding years are included.

However, an additional problem arises due to the significance of path dependency of regional new firm formation over time. We find that there is persistency of new firm formation over time at the regional level. The start-up rate in period t is significantly correlated with the start-up rate in the previous year and is also significantly determined by new firm formation activity 5, 10 and 15 years previously. The initial strong pattern of path dependency weakens over time. Almost 50% of the variation of the start-up rate in t can be explained by new firm formation activity 1, 5, 10 and 15 years previously.[9] This means that correlations between start-up rates over time are mostly significant, leading to multicollinearity that makes interpretation of coefficients in the models difficult. In order to deal with this problem, the lag structures for the effect of regional start-up rates on regional employment growth are estimated using Almon polynomials (see Trivedi 1978 and van Stel and Storey 2004, for details). The Almon lag procedure reduces the effects of multicollinearity in distributed lag settings by imposing a particular structure on the lag coefficients. In the Almon method, parameter restrictions are imposed in such way that the coefficients of the lagged variables are a polynomial function of the lag, producing a more compact model that overcomes the problems of multicollinearity.

[9] Tables containing the correlations of new firm entry over time are omitted due to space limitations, but are available from the authors upon request.

When estimating the effects of start-up rates in different types of sectors (knowledge-based and others), we are introducing additional sources of bias, as residuals become correlated over time and heteroskedasticity becomes more significant. While studies such as Fritsch and Mueller (2004) and Baptista et al. (2008) used Huber-White robust estimators (i.e. panel corrected standard errors), under the new circumstances, Feasible Generalized Least Squares (FGLS) may be more appropriate as these estimators handle autocorrelation and heteroskedasticity simultaneously (Parks 1967). However, in order to obtain unbiased estimations using FGLS the total number of time observations must be at least as large as the total number of panels (Beck and Katz 1995). In this case we have a panel of 18 years with 30 regions, which may lead to biased estimations. We therefore follow the methodology employed in previous papers, so the results from the Huber-White robust estimators are presented and discussed in Sect. 4. The results from FGLS estimation are quite similar, suggesting that the Huber-White estimations are robust.[10]

A shift-share procedure[11] is used to account for regional differences in industrial structure. Estimation of region-specific fixed effects is expected to capture regional asymmetries including differences in local labor market conditions, house prices and the extent of knowledge/innovation spillovers, as well as different cultural attitudes towards entrepreneurship—regions may differ in how they favor entrepreneurial activity and how they react to business failure. Also, two control variables are included in estimation, namely population density and average size of the firms. The objective of incorporating population density (number of inhabitants per square km) in our models is to control for regional characteristics which might affect the relationships between new firm formation and employment change. Fritsch and Mueller (2008) argue that regional population density is highly correlated with a number of factors such as the wage level, real estate prices, quality of communication infrastructure, qualification of the workforce, and diversity of the labor market. By incorporating the regional average firm size we are controlling for regional market structure, and intensity of regional competition.

Model estimations also correct for spatial autocorrelation. Following Anselin (1988), and Anselin and Florax (1995), the average of the residuals in adjacent regions is included in the estimation. These residuals provide an indication of unobserved influences that affect larger geographical entities than NUTS III and that are not entirely reflected in the explanatory variables.[12]

4 Results

Results are presented in Tables 1, 2, 3, 4, 5, 6 and Figs. 1, 2, 3, 4, 5, 6. We begin by examining differences in the impact of new firm formation on subsequent employment growth between the highly agglomerated regions—Greater Lisbon and Greater Oporto—and other regions, as displayed by Tables 1, 2, 3 and Figs. 1, 2, 3. Table 1 and Fig. 1 present the effects of the total start-up rate on subsequent employment change in highly agglomerated vs. other regions. Table 2 and Fig. 2 display the results for the same two kinds of regions when only knowledge-based firms are considered. Table 3 and Fig. 3 present

[10] The estimation results and corresponding figures for FGLS are omitted due to space constraints but can be made available by the authors upon request.

[11] The relative importance of incumbents and start-ups varies systematically across both regions and industries. For example, start-up rates are systematically higher in services than in manufacturing. Entrepreneurial activity could be systematically overestimated in regions with a high share of industries where start-ups play an important role, while the role of new firm formation in regions with a high share of industries where start-ups are relatively few would be underestimated. Following previous studies—pointed out in Section 1—in order to account for differences in regional industrial structures, and in the relative importance of start-ups and incumbents across industries a shift-share procedure (Ashcroft et al. 1991; Audretsch and Fritsch 2002) is applied in order to derive a measure of sector-adjusted start-up activity. The shift-share measure adjusts the raw data by imposing the same industry composition in each region (See Baptista et al. 2008 for a detailed explanation). Thus, the sector-adjusted number of start-ups is defined as the number of new firms in a region that can be expected to be observed if the composition of industries was identical across all regions.

[12] Estimations showed spatial autocorrelation to be insignificant, therefore not affecting the coefficients for the other variables. To correct for this, following Fritsch and Mueller (2004), we compute for each region the average of the residuals in the neighbouring regions and include this variable as an explanatory variable in the model.

Table 1 Impact of lagged start-up rates on regional employment growth by agglomeration/business dynamics levels—robust fixed effects

	Unrestricted	Almon method (4th order polynomial)				Unrestricted	Almon method (4th order polynomial)		
Highly agglomerated regions					*Modestly agglomerated regions*				
Start-up rate t	−0.535	α_0	0.298	0.298	Start-up rate t	1.356***	α_0	1.443***	1.443
	[−1.55]		[0.73]			[4.51]		[4.66]	
Start-up rate $t-1$	1.342*	α_1	−0.683***	0.040	Start-up rate $t-1$	0.947***	α_1	−1.229***	0.589
	[1.82]		[−3.48]			[3.09]		[−5.39]	
Start-up rate $t-2$	0.442	α_2	0.515***	0.314	Start-up rate $t-2$	−0.022	α_2	0.433***	0.272
	[1.26]		[3.36]			[−0.14]		[3.17]	
Start-up rate $t-3$	0.821***	α_3	−0.095***	0.729	Start-up rate $t-3$	0.156	α_3	−0.062**	0.225
	[4.38]		[−4.05]			[0.99]		[−2.57]	
Start-up rate $t-4$	1.027***	α_4	0.005***	1.013	Start-up rate $t-4$	0.432*	α_4	0.003**	0.253
	[10.62]		[4.69]			[1.88]		[2.38]	
Start-up rate $t-5$	1.184***			1.015	Start-up rate $t-5$	0.522**			0.226
	[14.08]					[2.54]			
Start-up rate $t-6$	1.041***			0.698	Start-up rate $t-6$	−0.108			0.088
	[2.82]					[−0.47]			
Start-up rate $t-7$	−0.299			0.147	Start-up rate $t-7$	−0.549***			−0.151
	[−1.02]					[−3.29]			
Start-up rate $t-8$	−0.796***			−0.435	Start-up rate $t-8$	−0.305*			−0.411
	[−6.20]					[−1.99]			
Start-up rate $t-9$	−0.503			−0.728	Start-up rate $t-9$	−0.055			−0.542
	[−1.47]					[−0.24]			
Start-up rate $t-10$	−0.408*			−0.293	Start-up rate $t-10$	−0.676***			−0.325
	[−1.99]					[−4.98]			
$\sum$ coefficients start-up rate t to $t-10$	3.316			2.797/4.254[a]	$\sum$ coefficients start-up rate t to $t-10$	1.698			1.667/2.945[a]
					Firm size	0.932***			0.936***
						[5.69]			[5.70]
					Population density	−0.023			−0.022
						[−0.57]			[−0.56]
					Constant	−9.760			−9.545
						[−1.07]			[−1.11]
					Log-likelihood	−1562.85			−1572.51
					Adjusted R^2	0.2370			0.2266
					No. of observations	510			510

Notes: Robust t statistics in brackets. Significant at: 1%-level ***; 5%-level **; 10%-level *

[a] Sum of coefficients excluding negative coefficients after third phase

the results when the effects of the start-up rates for knowledge-based firms and other firms are estimated simultaneously for each type of region.

Results are presented for the unrestricted and restricted (Almon polynomial lag) models. Estimation of the Almon polynomial lag model assumes that the effect of changes in yearly start-up rates is distributed over eleven periods (t to $t-10$). Almon lag models were estimated for the second through to the fifth order of the polynomial. A critical issue in applying the

Table 2 Impact of lagged knowledge-based start-up rates on regional employment growth by agglomeration/business dynamics levels—robust fixed effects

	Unrestricted	Almon method (4th order polynomial)				Unrestricted	Almon method (4th order polynomial)		
Knowledge-based firms									
Highly agglomerated regions					*Modestly agglomerated regions*				
Start-up rate *t*	−10.529***	α_0	−7.046***	−7.046	Start-up rate *t*	13.659***	α_0	12.528***	12.528
	[−3.18]		[−4.06]			[3.34]		[3.25]	
Start-up rate $t-1$	−13.657***	α_1	−18.797***	−15.982	Start-up rate $t-1$	−0.248	α_1	−19.925***	0.060
	[−7.15]		[−10.24]			[−0.07]		[−6.20]	
Start-up rate $t-2$	−11.520***	α_2	11.546***	−11.299	Start-up rate $t-2$	−4.343	α_2	8.693***	−1.953
	[−12.27]		[6.48]			[−1.68]		[5.35]	
Start-up rate $t-3$	−0.578	α_3	−1.764***	−0.728	Start-up rate $t-3$	1.67	α_3	−1.297***	0.889
	[−0.24]		[−5.09]			[0.49]		[−4.55]	
Start-up rate $t-4$	9.870***	α_4	0.079***	9.904	Start-up rate $t-4$	6.990*	α_4	0.061***	4.442
	[5.95]		[4.26]			[2.02]		[4.09]	
Start-up rate $t-5$	15.926***			16.670	Start-up rate $t-5$	7.631**			6.016
	[4.00]					[2.34]			
Start-up rate $t-6$	22.781***			17.542	Start-up rate $t-6$	1.621			4.375
	[6.89]					[0.43]			
Start-up rate $t-7$	11.182***			12.397	Start-up rate $t-7$	−4.91			−0.262
	[4.38]					[−1.18]			
Start-up rate $t-8$	−2.721			3.010	Start-up rate $t-8$	−3.91			−6.222
	[−1.22]					[−1.23]			
Start-up rate $t-9$	−1.668			−6.942	Start-up rate $t-9$	−2.966			−10.379
	[−0.26]					[−0.77]			
Start-up rate $t-10$	−13.500***			−11.879	Start-up rate $t-10$	−14.633**			−8.151
	[−5.34]					[−4.98]			
$\sum$ coefficients start-up rate *t* to $t-10$	5.586			5.647/24.468[a]	$\sum$ coefficients start-up rate *t* to $t-10$	0.561			1.341/26.355[a]
					Firm size	0.628***			0.633***
						[4.03]			[4.10]
					Population density	−0.060			−0.056
						[−1.55]			[−1.54]
					Constant	9.633			8.835
						[1.02]			[1.00]

Table 2 continued

	Unrestricted	Almon method (4th order polynomial)	Unrestricted	Almon method (4th order polynomial)
Log-likelihood			−1609.50	−1612.65
Adjusted R^2			0.0838	0.0948
No. of observations			510	510

Notes: Robust *t* statistics in brackets. Significant at: 1%-level ***; 5%-level **; 10%-level *

[a] Sum of coefficients excluding negative coefficients after third phase

Almon lag procedure is determining which order of polynomial to chose.[13]

As can be seen in Figs. 1, 2, 3, the patterns of effects of new business formation on employment change are different for highly agglomerated and modestly agglomerated regions. New firm formation in highly agglomerated regions initially has a negative effect, suggesting that displacement effects occur rapidly upon entry of new firms. The direct effect of new business formation in other regions is generally positive. In highly agglomerated regions, however, positive effects of new firm creation on employment change become dominant after the second year, and their magnitude is higher than that of positive indirect effects in other regions. In both cases, the effect tails off from the sixth year onwards. This means that Hypothesis 1 of our study is confirmed.

The pattern of effects when only knowledge-based firms are considered is somewhat different. Knowledge-based firms seem to play a more significant role in business dynamics and displacement effect than other firms, since negative selection effects occur both in highly and modestly agglomerated regions, and the decline in total employment goes on until the third period. Only after that do positive spillovers become dominant. These effects are much stronger for highly agglomerated regions, leading to a clearly positive overall effect on total employment. Hence, Hypothesis 2 of our study is confirmed in particular for highly agglomerated regions.

When the effects of the start-up rates for knowledge-based firms and other firms are estimated simultaneously for highly agglomerated and modestly agglomerated regions (Table 3 and Fig. 3) the pattern of results suggests that the type of start-up (knowledge-based versus other firms) plays a more important role in stimulating displacement and indirect positive spillovers than the type of region. Knowledge based start-ups have an initial negative effect on employment

[13] An appropriate way to do this is to use Likelihood Ratio tests. Comparing the Nth order Almon polynomial model with the $(N + 1)$th order Almon polynomial model comes down to a Likelihood Ratio test with one restriction, since each additional order of the polynomial adds one restriction to the model. In the present case, we find that the 4th order polynomial provides the best fit for the lag structure of the effects of new firm formation on regional employment change in each of the cases under analysis, so we present the estimation results for that model.

Table 3 Impact of lagged knowledge-based and other firms' start-up rates on regional employment growth by agglomeration/business dynamics levels—robust fixed effects

	Unrestricted	Almon method (4th order polynomial)				Unrestricted	Almon method (4th order polynomial)		
Highly agglomerated regions									
Knowledge-based firms					*Other firms*				
Start-up rate *t*	25.272***	α_0	3.852	3.852	Start-up rate *t*	−3.883***	α_0	−1.212	−1.212
	[3.36]		[0.90]			[−3.51]		[−1.41]	
Start-up rate *t* − 1	−13.384***	α_1	−1.109	2.152	Start-up rate *t* − 1	2.834***	α_1	−1.341	−1.625
	[−3.03]		[−0.14]			[3.10]		[−1.51]	
Start-up rate *t* − 2	5.8	α_2	−1.027	0.698	Start-up rate *t* − 2	−0.139	α_2	1.134**	−0.906
	[1.40]		[−0.25]			[−0.20]		[2.09]	
Start-up rate *t* − 3	−8.394**	α_3	0.475	0.929	Start-up rate *t* − 3	1.307***	α_3	−0.217**	0.070
	[−2.74]		[0.77]			[3.50]		[−2.49]	
Start-up rate *t* − 4	14.788***	α_4	−0.039	3.343	Start-up rate *t* − 4	−0.225	α_4	0.012***	0.716
	[3.75]		[−1.38]			[−0.86]		[2.83]	
Start-up rate *t* − 5	−2.175			7.499	Start-up rate *t* − 5	1.245***			0.731
	[−0.41]					[2.76]			
Start-up rate *t* − 6	−20.887***			12.017	Start-up rate *t* − 6	2.601***			0.101
	[−6.97]					[5.56]			
Start-up rate *t* − 7	46.017***			14.575	Start-up rate *t* − 7	−4.261***			−0.905
	[4.08]					[−5.40]			
Start-up rate *t* − 8	4.191			11.914	Start-up rate *t* − 8	−1.501*			−1.728
	[0.42]					[−2.00]			
Start-up rate *t* − 9	6.295			−0.168	Start-up rate *t* − 9	−1.668**			−1.526
	[0.84]					[-2.32]			
Start-up rate *t* − 10	−24.508***			−26.808	Start-up rate *t* − 10	0.546			0.832
	[−3.51]					[−4.98]			
∑ coefficients start-up rate *t* to *t* − 10	33.015			30.002/56.978[a]	∑ coefficients start-up rate *t* to *t* − 10	−3.144			−2.125
Modestly agglomerated regions									
Knowledge-based firms					*Other firms*				
Start-up rate *t*	5.452**	α_0	2.459	2.459	Start-up rate *t*	0.966**	α_0	1.230***	1.230
	[2.20]		[0.95]			[2.51]		[3.07]	
Start-up rate *t* − 1	−5.602	α_1	−3.412	−1.328	Start-up rate *t* − 1	1.551***	α_1	−1.081	0.634
	[−1.30]		[−0.54]			[2.85]		[−1.69]	

Table 3 continued

	Unrestricted	Almon method (4th order polynomial)				Unrestricted	Almon method (4th order polynomial)		
Start-up rate $t-2$	−4.988	α_2	−0.686	−4.794	Start-up rate $t-2$	0.308	α_2	0.582*	0.658
	[−1.28]		[−0.18]			[0.74]		[1.86]	
Start-up rate $t-3$	−5.35	α_3	0.333	−6.731	Start-up rate $t-3$	0.691**	α_3	−0.103**	0.875
	[−1.20]		[0.46]			[2.72]		[−2.08]	
Start-up rate $t-4$	−3.107	α_4	−0.022	−6.458	Start-up rate $t-4$	1.020***	α_4	0.005**	0.985
	[−0.59]		[−0.55]			[4.15]		[2.12]	
Start-up rate $t-5$	−7.079			−3.821	Start-up rate $t-5$	1.392***			0.811
	[−1.63]					[5.83]			
Start-up rate $t-6$	−5.928			0.806	Start-up rate $t-6$	0.264			0.305
	[−1.37]					[0.77]			
Start-up rate $t-7$	12.510**			6.521	Start-up rate $t-7$	−1.160***			−0.457
	[2.29]					[−3.75]			
Start-up rate $t-8$	15.975**			11.895	Start-up rate $t-8$	−1.360***			−1.272
	[2.10]					[−3.26]			
Start-up rate $t-9$	14.045***			14.972	Start-up rate $t-9$	−1.123***			−1.813
	[2.87]					[−3.87]			
Start-up rate $t-10$	12.137*			13.266	Start-up rate $t-10$	−2.118***			−1.624
	[2.00]					[−4.71]			
$\sum$ coefficients start-up rate t to $t-10$	28.065			26.781	$\sum$ coefficients start-up rate t to $t-10$	0.431			0.331
					Firm size	0.782***			0.751***
						[5.16]			[5.06]
					Population density	0.038			0.032
						[0.90]			[0.80]
					Constant	−20.974**			−17.552*
						[−2.14]			[−1.84]
					Log-likelihood	−1528.78			−1545.71
					Adjusted R^2	0.3007			0.2895
					No. of observations	510			510

Notes: Robust t statistics in brackets. Significant at: 1%-level ***; 5%-level **; 10%-level *

[a] Sum of coefficients excluding negative coefficients after third phase

Table 4 Impact of lagged start-up rates on regional employment growth by labor productivity—robust fixed effects

	Unrestricted	Almon method (4th order polynomial)				Unrestricted	Almon method (4th order polynomial)		
High labor productivity regions					*Low labor productivity regions*				
Start-up rate t	0.540	α_0	0.549	0.549	Start-up rate t	0.644**	α_0	0.797***	0.797
	[1.26]		[1.38]			[2.39]		[2.88]	
Start-up rate $t-1$	0.198	α_1	−1.038	−0.041	Start-up rate $t-1$	−0.291	α_1	−2.564***	−0.730
	[0.81]		[−1.54]			[−0.47]		[−3.46]	
Start-up rate $t-2$	−0.330	α_2	0.527*	−0.017	Start-up rate $t-2$	−1.140**	α_2	1.209***	−0.805
	[−1.11]		[1.72]			[−2.55]		[3.65]	
Start-up rate $t-3$	0.131	α_3	−0.083*	0.264	Start-up rate $t-3$	−0.289	α_3	−0.180***	−0.209
	[0.37]		[−1.82]			[−0.63]		[−3.89]	
Start-up rate $t-4$	0.916***	α_4	0.004*	0.541	Start-up rate $t-4$	0.767**	α_4	0.008***	0.474
	[3.33]		[1.87]			[2.19]		[4.05]	
Start-up rate $t-5$	1.041***			0.645	Start-up rate $t-5$	0.891*			0.864
	[3.03]					[2.03]			
Start-up rate $t-6$	0.240			0.499	Start-up rate $t-6$	0.835*			0.779
	[0.47]					[1.72]			
Start-up rate $t-7$	−0.755*			0.121	Start-up rate $t-7$	−0.102			0.239
	[−1.86]					[−0.21]			
Start-up rate $t-8$	0.037			−0.378	Start-up rate $t-8$	−0.537			−0.537
	[0.14]					[−1.63]			
Start-up rate $t-9$	−0.018			−0.794	Start-up rate $t-9$	−0.896*			−1.130
	[−0.04]					[−1.93]			
Start-up rate $t-10$	−1.469***			−0.831	Start-up rate $t-10$	−1.021**			−0.918
	[−4.01]					[−4.98]			
$\sum$ coefficients start-up rate t to $t-10$	0.531			0.557/2.560[a]	$\sum$ coefficients start-up rate t to $t-10$	−1.139			−1.177/1.408[a]
					Firm size	−0.057			−0.055
						[−0.30]			[−0.30]
					Population density	−0.050			−0.049
						[−1.61]			[−1.65]
					Constant	16.965*			17.027**
						[2.02]			[2.08]
					Log-likelihood	−1612.59			−1617.48
					Adjusted R^2	0.0726			0.0775
					No. of observations	510			510

Notes: Robust t statistics in brackets. Significant at: 1%-level ***; 5%-level **; 10%-level *

[a] Sum of coefficients excluding negative coefficients after third phase

change, followed by significant, positive indirect effects occurring from the fourth (highly agglomerated regions) and fifth (modestly agglomerated regions) periods onwards. The overall effect of knowledge-based start-ups seems to be clearly positive regardless of the regional degree of agglomeration while the overall effects of other types of start-ups appear not to be significant. The patterns of the effects of knowledge based start-ups on employment growth estimated simultaneously with the effects of other types of startups (depicted in Fig. 3) appear to have a fairly similar shape to those obtained from estimation

Table 5 Impact of lagged knowledge-based start-up rates on regional employment growth by labor productivity—robust fixed effects

	Unrestricted	Almon method (4th order polynomial)				Unrestricted	Almon method (4th order polynomial)		
High labor productivity regions					*Low labor productivity regions*				
Start-up rate t	6.058	α_0	1.958	1.958	Start-up rate t	3.385	α_0	4.618	4.618
	[1.33]		[0.52]			[0.84]		[1.37]	
Start-up rate $t-1$	−15.212***	α_1	−22.773***	−9.820	Start-up rate $t-1$	−3.113	α_1	−17.429***	−6.683
	[−3.40]		[−4.43]			[−0.90]		[−3.07]	
Start-up rate $t-2$	−9.472***	α_2	12.933***	−6.602	Start-up rate $t-2$	−9.328**	α_2	6.927***	−8.690
	[−4.42]		[6.77]			[−2.07]		[3.18]	
Start-up rate $t-3$	6.741	α_3	−2.031***	2.815	Start-up rate $t-3$	−9.542	α_3	−0.827**	−5.329
	[0.98]		[−5.99]			[−1.44]		[−2.65]	
Start-up rate $t-4$	16.278***	α_4	0.094***	11.892	Start-up rate $t-4$	2.038	α_4	0.029*	0.164
	[4.38]		[4.47]			[0.29]		[1.84]	
Start-up rate $t-5$	15.005***			16.353	Start-up rate $t-5$	4.602			5.248
	[2.84]					[0.66]			
Start-up rate $t-6$	12.872***			14.181	Start-up rate $t-6$	11.541*			8.071
	[3.24]					[1.85]			
Start-up rate $t-7$	−4.120			5.621	Start-up rate $t-7$	7.413			7.472
	[−0.59]					[0.71]			
Start-up rate $t-8$	0.583			−6.825	Start-up rate $t-8$	1.799			2.985
	[0.13]					[0.34]			
Start-up rate $t-9$	−3.032			−18.392	Start-up rate $t-9$	−7.883			−5.168
	[−0.34]					[−0.82]			
Start-up rate $t-10$	−39.686***			−22.054	Start-up rate $t-10$	−14.130			−16.072
	[−3.62]					[−4.98]			
$\sum$ coefficients start-up rate t to $t-10$	−13.985			−10.874/36.397[a]	$\sum$ coefficients start-up rate t to $t-10$	−13.218			−13.384/7.857[a]
					Firm size	−0.051			−0.051
						[−0.25]			[−0.25]
					Population density	−0.052			−0.052
						[−1.66]			[−1.67]
					Constant	18.611**			18.611**
						[2.25]			[2.27]
					Log-likelihood	−1623.77			−1626.92
					Adjusted R^2-squared	0.0311			0.0427
					No. of observations	510			510

Notes: Robust t statistics in brackets. Significant at: 1%-level ***; 5%-level **; 10%-level *

[a] Sum of coefficients excluding negative coefficients after third phase

of their single effect across regions (depicted in Fig. 2). The main difference seems to be the downward tail of the effect of knowledge-based start-ups on employment change in agglomerated regions occurring from about year nine, suggesting that the more intense business dynamics observed in these regions may lead to shorter-lived effects of these start-ups.

Table 6 Impact of lagged knowledge-based and other firms' start-up rates on regional employment growth by labor productivity—robust fixed effects

	Unrestricted	Almon method (4th order polynomial)				Unrestricted	Almon method (4th order polynomial)		
High labor productivity regions									
Knowledge-based firms					*Other firms*				
Start-up rate *t*	0.751	α_0	−6.583	−6.583	Start-up rate *t*	−0.264	α_0	0.522	0.522
	[0.13]		[−1.14]			[−0.40]		[0.67]	
Start-up rate *t* − 1	−20.340***	α_1	−8.711	−8.980	Start-up rate *t* − 1	1.344**	α_1	−1.176	−0.169
	[−4.70]		[−0.58]			[2.48]		[−0.66]	
Start-up rate *t* − 2	−4.901	α_2	7.773	−3.870	Start-up rate *t* − 2	−0.143	α_2	0.553	−0.143
	[−0.64]		[1.01]			[−0.17]		[0.69]	
Start-up rate *t* − 3	10.440***	α_3	−1.547	2.660	Start-up rate *t* − 3	−0.566	α_3	−0.07	0.262
	[2.89]		[−1.16]			[−1.29]		[−0.58]	
Start-up rate *t* − 4	13.030**	α_4	0.089	6.658	Start-up rate *t* − 4	0.648	α_4	0.002	0.764
	[2.53]		[1.23]			[1.15]		[0.40]	
Start-up rate *t* − 5	−3.883			6.302	Start-up rate *t* − 5	2.208***			1.135
	[−0.74]					[3.48]			
Start-up rate *t* − 6	−1.705			1.903	Start-up rate *t* − 6	1.527*			1.201
	[−0.51]					[1.85]			
Start-up rate *t* − 7	−2.204			−4.094	Start-up rate *t* − 7	−0.380			0.845
	[−0.46]					[−0.66]			
Start-up rate *t* − 8	5.713			−7.114	Start-up rate *t* − 8	−0.382			0.004
	[0.44]					[−0.63]			
Start-up rate *t* − 9	5.107			−0.449	Start-up rate *t* − 9	−0.761*			−1.330
	[0.34]					[−1.93]			
Start-up rate *t* − 10	5.974			24.741	Start-up rate *t* − 10	−3.091**			−3.110
	[0.29]					[−4.98]			
$\sum$ coefficients start-up rate *t* to *t* − 10	7.982			11.173	$\sum$ coefficients start-up rate *t* to *t* − 10	0.140			−0.017
Low labor productivity regions									
Knowledge-based firms					*Other firms*				
Start-up rate *t*	6.141	α_0	4.458	4.458	Start-up rate *t*	0.252	α_0	0.625	0.625
	[1.53]		[0.89]			[0.47]		[1.41]	
Start-up rate *t* − 1	1.859	α_1	1.437	3.170	Start-up rate *t* − 1	0.052	α_1	−2.391***	−0.693
	[0.27]		[0.13]			[0.07]		[−3.66]	

Table 6 continued

	Unrestricted	Almon method (4th order polynomial)				Unrestricted	Almon method (4th order polynomial)		
Start-up rate $t-2$	1.757	α_2	−3.515	−0.806	Start-up rate $t-2$	−1.090*	α_2	1.268***	−0.567
	[0.29]		[−0.60]			[−1.84]		[4.56]	
Start-up rate $t-3$	−7.801	α_3	0.841	−4.238	Start-up rate $t-3$	0.288	α_3	−0.205***	0.133
	[−1.00]		[0.82]			[0.50]		[−5.02]	
Start-up rate $t-4$	−4.919	α_4	−0.05	−5.099	Start-up rate $t-4$	1.084*	α_4	0.010***	0.777
	[−0.65]		[−0.89]			[1.94]		[4.71]	
Start-up rate $t-5$	−9.174			−2.568	Start-up rate $t-5$	1.419***			0.977
	[−1.44]					[3.17]			
Start-up rate $t-6$	2.457			2.965	Start-up rate $t-6$	0.500			0.586
	[0.35]					[0.75]			
Start-up rate $t-7$	20.745*			9.906	Start-up rate $t-7$	−1.216**			−0.305
	[1.92]					[−2.13]			
Start-up rate $t-8$	13.158			15.449	Start-up rate $t-8$	−1.205			−1.361
	[1.03]					[−1.49]			
Start-up rate $t-9$	9.248			15.586	Start-up rate $t-9$	−1.335**			−2.008
	[1.19]					[−2.55]			
Start-up rate $t-10$	12.231			5.096	Start-up rate $t-10$	−1.921***			−1.429
	[0.84]					[−3.88]			
$\sum$ coefficients start-up rate t to $t-10$	45.702			43.919	$\sum$ coefficients start-up rate t to $t-10$	−3.172			−3.266
					Firm size	−0.025			−0.034
						[−0.12]			[−0.17]
					Population density	−0.038			−0.039
						[−1.22]			[−1.30]
					Constant	14.092			14.836*
						[1.59]			[1.75]
					Log-likelihood	−1593.55			−1601.55
					Adjusted R^2	0.0984			0.1156
					No. of observations	510			510

Notes: Robust t statistics in brackets. Significant at: 1%-level ***; 5%-level **; 10%-level *

[a] Sum of coefficients excluding negative coefficients after third phase

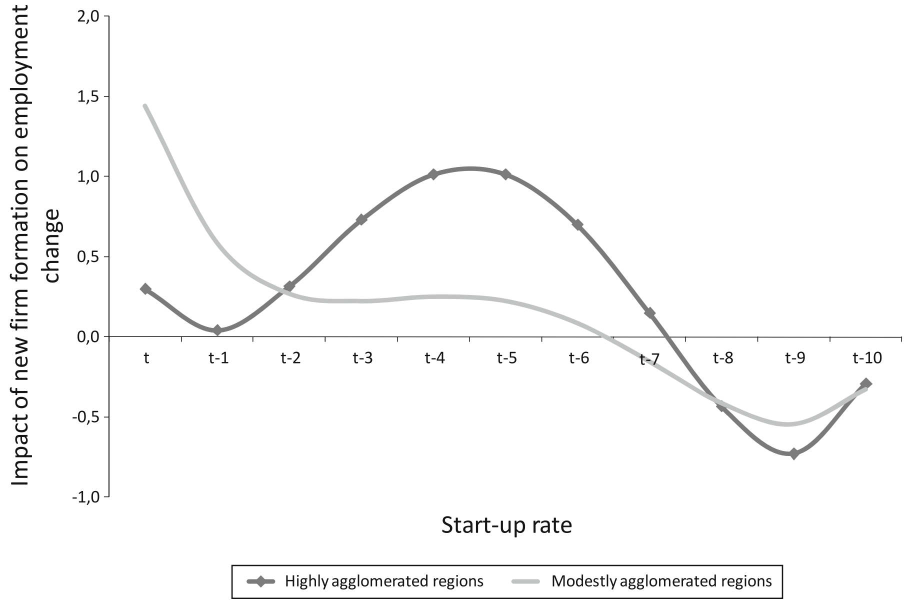


Fig. 1 Estimated lag structure (4th order Almon polynomial) of the impact of start-ups (all industries) on regional employment change in highly agglomerated regions and modestly agglomerated regions—robust fixed effects

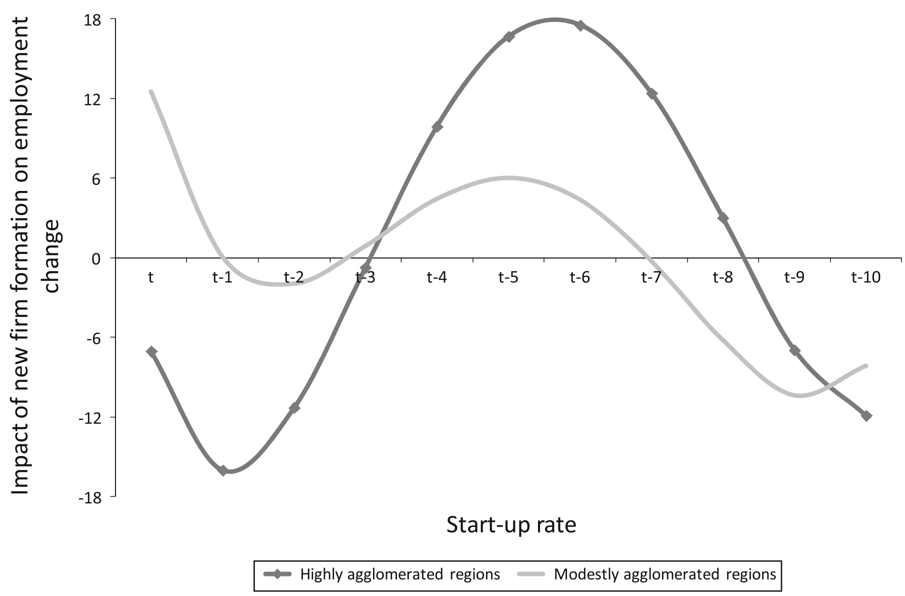


Fig. 2 Estimated lag structure (4th order Almon polynomial) of the impact of the formation of knowledge-based firms on regional employment change in highly agglomerated and modestly agglomerated regions—robust fixed effects

Despite this irregularity, which occurs only some 9 years after start-up, it seems clear that Hypothesis 2 (differences in type of start-up) plays a more important role in explaining variations on the impact of new business formation on subsequent employment growth than Hypothesis 1 (differences in the type of region). In fact, while the overall effect of start-up rates on employment growth appears to be clearly greater in highly agglomerated regions than in other regions when knowledge-based start-ups are concerned, the same conclusion cannot be clearly drawn for other types of start-ups. This suggests that the creation of knowledge-based firms imparts greater positive indirect effects on employment change in regions with high levels of agglomeration and business dynamics. The same is not clearly true for start-ups that are not knowledge-based. This is possibly due to the fact that start-ups in these sectors are likely to be less innovative, so other firms have less to gain from spillovers.

In order to shed further light on the nature of regional dynamics, we look more closely at the economic performance of modestly agglomerated

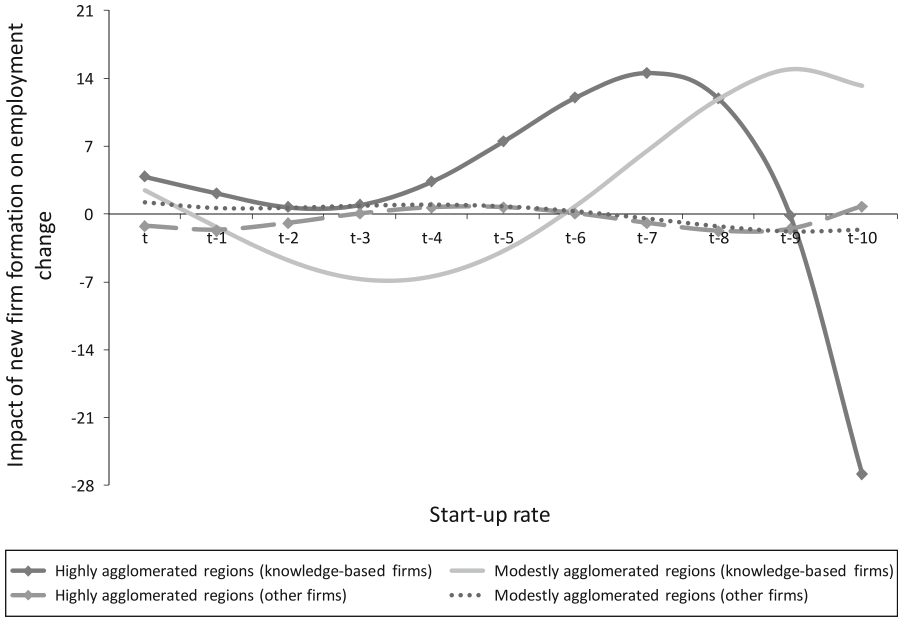
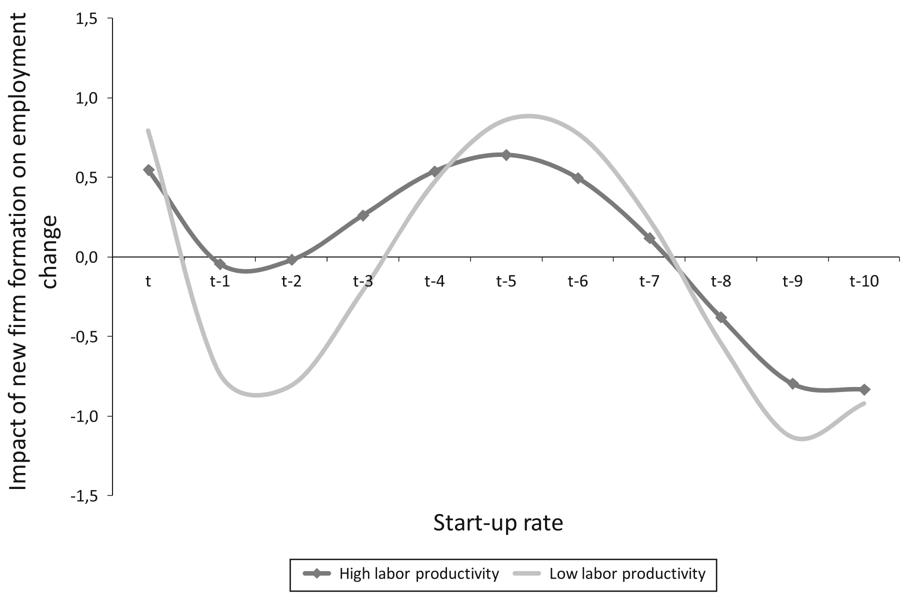


Fig. 3 Estimated lag structure (4th order Almon polynomial) of the impact of the formation of knowledge-based firms and other firms on regional employment change in highly agglomerated and modestly agglomerated regions—robust fixed effects

Fig. 4 Estimated lag structure (4th order Almon polynomial) of the impact of the formation of start-ups (all industries) on regional employment change in high- and low labor productivity regions—robust fixed effects



regions, differentiating between those with relatively high labor productivity (upper quartile) and those with relatively low labor productivity (lower quartile), as can be seen in Fig. 7 in Appendix. Table 4 and Fig. 4 present the effect of the total start-up rate on subsequent employment growth in high labor productivity and low labor productivity regions. Table 5 and Fig. 5 display the results for the same two kinds of regions when only knowledge-based firms are considered. Table 6 and Fig. 6 present the results when the effects of the start-up rates for knowledge-based firms and other firms are estimated simultaneously for high labor productivity and low labor productivity regions.

While differences in the effect of total start-ups on subsequent employment change between higher and

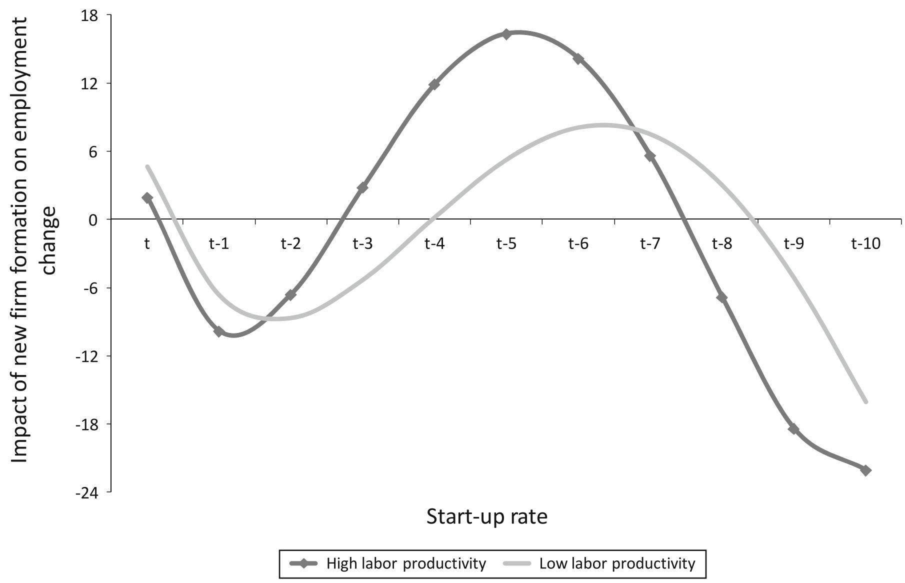


Fig. 5 Estimated lag structure (4th order Almon polynomial) of the impact of the formation of knowledge-based firms on regional employment change in high- and low labor productivity regions—robust fixed effects

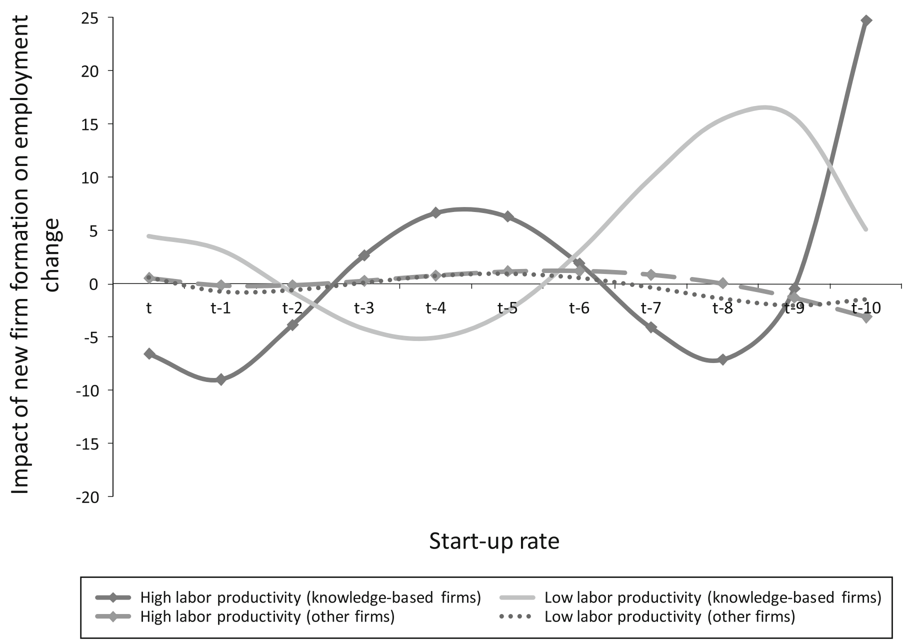


Fig. 6 Estimated lag structure (4th order Almon polynomial) of the impact of the formation of knowledge-based firms and other firms on regional employment change in high- and low labor productivity regions—robust fixed effects

lower labor productivity regions are not large, the pattern of effects again appears to suggest that more dynamic (i.e. productive) regions experience stronger displacement effects and stronger subsequent positive supply-side effects (thus confirming Hypothesis 1). The difference becomes clearer when we focus our analysis exclusively on knowledge-based start-ups. Comparing Fig. 5 with Fig. 4 we see that when only knowledge-based start-ups are considered, displacement effects dominate overall employment change immediately after entry in higher productivity regions, while positive indirect effects become dominant after only 2 years. When all start-ups are considered, positive indirect effects occur after 3 years for higher productivity regions. In any case, the overall effect of knowledge-based start-ups on subsequent employment growth is clearly greater than that of other types of start-ups for both kinds of regions (thus confirming Hypotheses 2).

Table 6 and Fig. 6 present the effects of the start-up rates for knowledge-based start-ups and other firms for high labor productivity and low labor productivity regions. These results confirm our previous observation that the type of start-up plays a more important role than the type of region when determining the effects of new business formation on subsequent employment growth. In both higher and lower labor productivity regions the negative displacement effects and positive indirect spillover effects are of greater magnitude for knowledge-based start-ups than for other types of start-ups. The pattern of the effects requires some interpretation, however. In lower productivity regions, the negative selection effect that originates from the entry of knowledge-based start-ups is very strong indeed, and goes on until after the fifth year after entry. This is possibly due to the fact that new firms represent a significant efficiency improvement over existing firms in low economic performance regions, and their entry brings about the displacement of incumbents and the concomitant increase in unemployment. Selection effects brought about by knowledge-based entrants in higher labor productivity regions are of lower magnitude, and occur earlier, after the third year.

The simultaneous estimation of the impact of the formation of knowledge-based firms and other firms on regional employment change in both highly agglomerated and modestly agglomerated regions reveals a pattern of dynamics (depicted in Fig. 6) which is to some extent different from what is obtained from the estimations for the total start-up rate as well as for the knowledge based firms start-up rate across regions (presented in Figs. 4 and 5). In particular, the curve corresponding to the effect of knowledge based start-ups on highly agglomerated regions shows a somewhat unlikely upper tail from year 9 onwards. This pattern may be caused by the simultaneous estimation of the effects of both entry rates for knowledge-based and other industries (which add up to the total start-up rate), creating some sort of autocorrelation bias. However estimations using FGLS—supposed to correct for AR(1) autocorrelation—show a similar pattern of results, so we keep the robust Huber-White estimators as the reference for our discussion.

Table 7 presents the sum of coefficients of the 11 periods under analysis for all models estimated, taken as an approximation of the overall effect of new firm formation on subsequent employment growth (following the approach taken by Fritsch and Mueller 2008). The sums of the regression coefficients for both the unrestricted models and the fourth order Almon polynomial lag models confirm that the type of start-up plays a more important role in explaining differences in competitive selection and indirect spillover effects across regions than differences in agglomeration and economic performance between regions.

Focusing on the results of the Almon lag estimation, it is possible to observe on Table 7 that knowledge-based start-up rates have an overall positive effect on employment growth in the years after entry in both highly agglomerated and modestly agglomerated regions. When modestly agglomerated regions are divided according to economic performance, the overall positive effect of knowledge-based entry is positive in high economic performance (i.e. high labor productivity) regions, but negative in low labor productivity regions, where a very strong selection/increased competition effect is not completely compensated by the subsequent positive indirect effect.

An important observation that can be made from statistically significant coefficients of Table 7 is that the increases in entry rates for start-ups that are not knowledge-based have very small (or even negative) overall effects on subsequent employment change, and these effects do not change significantly according to the type of region. While it is true that the type of start-up (knowledge-based versus others) matters more than the type of region, it is also true that the levels of agglomeration and labor productivity in regions matter more for the effects of knowledge-based start-ups than for the effects of other start-ups.

5 Concluding remarks

This study examined differences in the effects of start-up rates on subsequent employment change across regions. In particular, two sources of such differences—types of start-ups and types of regions—were analyzed, leading to two main hypotheses. Firstly, the impact of increases in start-up rates on subsequent employment change will be greater in regions with higher levels of agglomeration and business dynamics; secondly, increases in the start-up rates of knowledge-based firms will have a greater impact on subsequent employment change than increases in the start-up rates

Table 7 Overall effect of new business formation on regional employment change over time

	Sum of coefficients (in parentheses: without negative coefficients after phase III)			
	Feasible generalized least squares		Robust fixed effects	
	Unrestricted	Almon method (4th order polynomial)	Unrestricted	Almon method (4th order polynomial)
Agglomeration/business dynamics levels				
Highly agglomerated regions (all industries)	−0.180	−0.629 (1.442)	3.316	2.797 (4.254)
Modestly agglomerated regions (all industries)	0.435	0.256 (1.840)	1.698	1.667 (2.945)
Highly agglomerated regions (knowledge based industries)	−1.132	−1.799 (14.224)	5.586	5.647 (24.468)
Modestly agglomerated regions (knowledge based industries)	−1.904	−2.402 (17.966)	0.561	1.341 (26.335)
Highly agglomerated regions (knowledge based industries)	18.448	14.838 (31.924)$^{n.s.}$	33.015	30.002 (56.978)$^{n.s.}$
Modestly agglomerated regions (knowledge based industries)	−1.579	−2.364	−3.144	−2.125
Highly agglomerated regions (all industries)	15.948	15.542$^{n.s.}$	28.065	26.781$^{n.s.}$
Modestly agglomerated regions (all industries)	−0.238	−0.520	0.431	0.331
Labor productivity				
High labor productivity (all industries)	0.078	0.085 (1.359)	0.531	0.557 (2.560)$^{n.s.}$
Low labor productivity (all industries)	−0.730	−0.721 (1.527)	−1.139	−1.177 (1.408)
High labor productivity (knowledge based industries)	−2.197	−1.702 (26.632)	−13.985	−10.874 (36.397)
Low labor productivity (knowledge based industries)	−2.829	−1.750 (7.713)$^{n.s.}$	−13.218	−13.384 (7.857)
High labor productivity (knowledge based industries)	0.294	−6.085 (5.026)	7.982	11.173$^{n.s.}$
Low labor productivity (knowledge based industries)	−5.552	−8.711	45.702	43.919$^{n.s.}$
High labor productivity (other industries)	−0.122	0.639$^{n.s.}$	0.140	−0.017$^{n.s.}$
Low labor productivity (other industries)	0.398	0.557	−3.172	−3.266

n.s. coefficients are not statistically significant at the 10% level

of other firms regardless of the type of region where these start-ups occur.

We find that differences between types of start-ups—namely between knowledge based and other firms—dominate differences in regional agglomeration and economic performance (as measured by labor productivity). Knowledge-based start-ups in high business dynamics regions have essentially two effects on subsequent employment change:

i. First, a displacement (selection) effect (which occurs right from entry), likely brought about by increased competition and efficiency gains, leading to the exit of firms and a negative impact on employment;
ii. Second, an indirect, positive spillover effect, likely brought about by amplified innovation, increased efficiency and greater product variety, leading to increases in employment.

Start-ups in knowledge-based sectors have greater effects on subsequent employment growth than other start-ups, regardless of the type of region where these start-ups occur. This result suggests that knowledge-based start-ups have a greater potential to induce change in markets, bringing about both negative selection effects and positive spillover effects on overall employment.

Regional business dynamics, as measured by agglomeration levels and by labor productivity also matter, however. Differences in the effects of new start-ups on subsequent employment growth between more agglomerated, higher firm growth regions and less agglomerated, lower firm growth regions are greater for knowledge-based start-ups than for other types of start-ups. A particularly interesting result is obtained when modestly agglomerated regions are examined according to their levels of economic performance, as measured by labor productivity, the overall positive effect of knowledge-based entry is positive in high labor productivity regions, but negative in low labor productivity regions, where a very strong selection and increased efficiency effect offsets the subsequent positive indirect effect.

The results suggest that, while knowledge-based start-ups (which almost certainly include those more likely to be innovative and have a greater potential for high growth) are likely to impart greater overall benefits on employment than other types of start-ups (likely including the less innovative, low growth ones), these benefits are significantly larger when those start-ups locate in stronger, more dynamic (high agglomeration, high labor productivity) regions. The effects of other types of (non-innovative) start-ups on subsequent employment growth do not change significantly with the type of region where they locate.

Further research should concentrate on other sources of differences between types of start-ups, in order to better ascertain which types of start-ups have a greater impact on subsequent employment growth. For instance, the literature finds that larger, better financed entrants are more likely to survive and grow (Geroski 1995). It is therefore possible that these types of start-ups will have a greater impact on subsequent employment growth than smaller ones. Other sources of differences that may be examined are associated with the innovative potential of start-ups, and include human capital (of both founders and employees) and direct foreign investment (usually associated with technology spillovers.

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Appendix

See Table 8 and Fig. 7.

Table 8 Portuguese NUTS III regions—population density and start-up rates

NUTS III	Region name	Population density (number of residents per square km)	Average share of start-ups 1983–2001 (%)
10101	Minho-Lima	120	2.4
10102	Cávado	304	4.1
10103	Ave	397	5.3
10104	*Greater Oporto*	*1529*	*12.1*
10105	Tâmega	211	5.3
10106	Entre Douro e Vouga	312	3.1
10107	Douro	63	1.5
10108	Alto Trás-os-Montes	32	1.5
10201	Baixo Vouga	208	3.1
10202	Baixo Mondego	170	2.5
10203	Pinhal Litoral	138	3.0
10204	Pinhal Interior Norte	57	1.2
10205	Dão-Lafões	87	2.5
10206	Pinhal Interior Sul	29	0.4
10207	Serra da Estrela	66	0.3
10208	Beira Interior Norte	31	0.9
10209	Beira Interior Sul	23	0.7
10210	Cova da Beira	73	0.8
10301	Oeste	175	4.0
10302	*Greater Lisbon*	*1466*	*19.4*
10303	Península Setúbal	449	6.0
10304	Médio Tejo	105	2.2
10305	Lezíria do Tejo	58	2.3
10401	Alentejo Litoral	20	0.9
10402	Alto Alentejo	22	1.3
10403	Alentejo Central	25	2.0
10404	Baixo Alentejo	18	1.4
10501	Algarve	73	5.5
20101	R. A. Açores	110	2.1
30101	R. A. Madeira	321	2.0

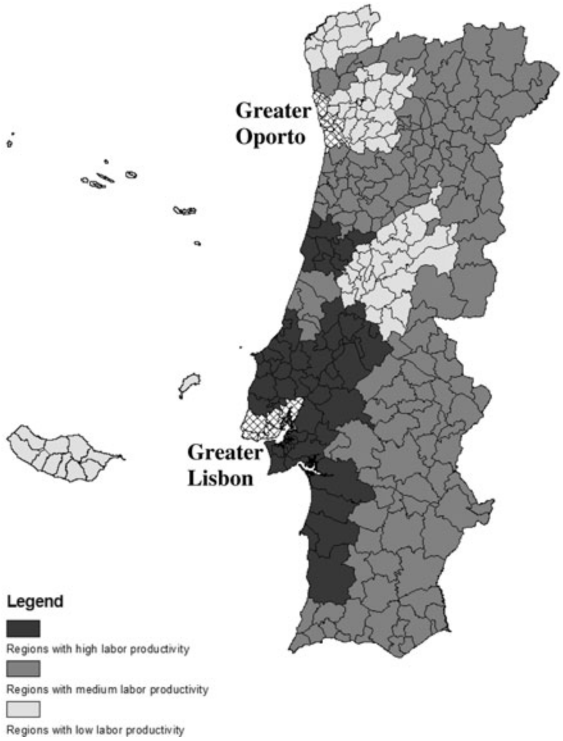

Fig. 7 Map of Portuguese NUTS III regions by labor productivity levels

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