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Foreign Investments and Productivity Evidence from European Regions☆

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Abstract

Differences in productivity across regions have been mainly attributed to agglomeration economies, technology and human capital, while almost no evidence has been provided on the role of internationalization. In this paper we build unique measures of outward and inward foreign direct investment (FDI) counts at the NUTS 2 level and we assess the relationship between regional productivity and foreign investments in Europe. Regions with larger outflows of foreign investments show higher productivity growth, but this correlation fades down with the number of investments and eventually becomes negative in regions with very high outward orientation. Inward investments are also positively associated with regional productivity growth, but only above a certain threshold. Results are robust to the introduction of a number of regional characteristics, to the control for endogeneity of foreign investments, and for spatial dependence.

JEL classification: C23, C26, F23, O47, O52, R11

Keywords: Regional productivity, foreign investments, Europe, spatial econometric models, instrumental variables,

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1. Introduction

Regional competitiveness and social and economic cohesion have been crucial concerns for policy makers —especially in the European Union (EU)[1]— and have attracted a considerable amount of economic research. In particular, empirical works have focused on explaining differences in productivity among EU regions. Agglomeration economies, technology and human capital have been most often considered as the key dimensions to explain such differences[2]. With the notable exeception of Gambardella, Mariani, and Torrisi (2008), internationalization is rarely considered as a factor affecting regional productivity. This is probably due to the lack of accurate measures of a region's openness[3]. This lack of evidence is at odds with the increasing relevance of regions in the global economy, and in Europe in particular. With the free movement of goods, capital and labour, it makes less and less sense to think about economic relations within Europe in terms of the standard paradigm of international trade. One should rather take a regional perspective and emphasize relations of sub-national units within the EU and with the rest of the world (Krugman, 1993). In this work, using a novel dataset on international investment projects, we are able to build unique measures of outward and inward foreign direct investment (FDI) at the regional level (NUTS 2)[4] for the countries of the European Union (EU-27). This allows us to assess – for the first time – the extent to which regional productivity is associated with internationalization, and in particular with foreign investments by multinational enterprises (MNEs). This issue is particularly relevant in the European Union (EU), which is a major home and host area for FDIs: both inward and outward FDIs account for almost 4% of the EU GDP, but with very differentiated patterns across countries[5]. Empirical works have also documented that inward FDIs are not uniformly distributed across regions within individual countries (Head and Mayer, 2004; Basile, Castellani, and Zanfei, 2008). Instead, evidence is lacking on the different propensity of European regions to engage in outward FDIs.

In order to investigate whether foreign investments actually affect regional productivity, we estimate regressions of (one-year) productivity growth as a function of one-year-lagged foreign investments. We find that inward FDIs have a positive and significant effect on regional productivity growth, but this effect is sizable only for a relatively large number of investment projects. Conversely, regions with at least one outward FDI project have higher productivity growth, but the effect of FDIs fades down with the number of projects, and may eventually become negative in regions with very large outward flows. These results are robust to a number of controls. In particular, we have added several regional characteristics (both in level and in first-differences), accounted for spatial dependence and controlled for the possible endogeneity of FDIs.

This piece of evidence bears implications for policy. In particular, it suggests, on the one hand, that fears of hollowing-out as a consequence of outward investments are not entirely founded, and local economies may in fact benefit from the fact that incumbent firms move some production abroad, and, on the other hand, that substantial investments may be needed to generate sizable effects on host country regional productivity growth.

The rest of the paper is organized as follows: Section 2 presents the related literature on the links between foreign direct investments and productivity; Section 3 describes our empirical strategy; Section 4 provides details on the characteristics of the data and focuses on how the main variables of interest have been measured and constructed; Section 5 provides some descriptive evidence, while Section 6 illustrates the econometric results and the robustness checks. Section 7 concludes the paper.

[1]As a matter of fact, 35% of the EU budget for the period 2007-2013 has been allocated to promote social and economic cohesion among the regions of its member states.

[2]See, for example, the empirical evidence on EU regions in Ciccone (2002), Paci and Usai (2000).

[3]In fact, Gambardella, Mariani, and Torrisi (2008) introduce a generic measure of openness using the share of hotels in the population and the share of the population which speaks a second language.

[4]NUTS is an acronym for Nomenclature of Units for Territorial Statistics which indicates a hierarchical classification of administrative areas used by the European statistical office (Eurostat). NUTS levels (1-3) indicate different degrees of aggregation.

[5]For example outward FDIs, as a share of GDP, go from values close to zero in most New Member States, to around 1% in countries such as Italy and Greece and more than 5% in the UK, France and Spain; on the other hand, inward FDIs range from around 1% of GDP in Greece, Italy and Germany, to more than 10% of GDP in Bulgaria, Belgium and Estonia.

2. Foreign investments and productivity: theory and evidence

2.1. Theory

From a theoretical point of view, the links between foreign investments and productivity of home and host countries have been investigated extensively, but with inconclusive results. Substantial work have been done regarding the direct and indirect effects of inward FDIs on host economies. Direct effects refer to the fact that incoming multinationals tend be relatively more productive than domestic firms and to concentrate in higher productivity sectors (Barba Navaretti and Venables, 2006). Thus, entry of foreign multinationals changes the composition of the host economy –both within and between sectors– contributing to increase the aggregate productivity. Foreign multinationals may also have indirect effects, inducing pecuniary and technological externalities but also determining a business stealing effect (Görg and Strobl, 2005; Castellani and Zanfei, 2006). While the former usually provide a positive contribution to aggregate productivity, the latter may have opposite effects. To the extent that local firms are less productive than the foreign ones, the business stealing effect, forcing local firms to shrink or exit, may be beneficial for the aggregate productivity. However, if foreign multinationals transfer only the relatively lower value added activities in the host region (such as in the case of offshoring of distribution activities), while domestic firms carried out most of the production process in the region, the crowding-out effect may be detrimental for aggregate productivity dynamics, since exiting firms would account for a larger share of regional value added.

Outward investments have direct and indirect effects on the productivity of the home economy too. As for the direct effects, firms engaging in foreign activities (either through export or foreign investments) are more productive than purely domestic ones, since they need to overcome the cost of doing business abroad. By going abroad, firms can reach larger markets, thus they grow larger and this contributes to increasing aggregate productivity (Helpman, Melitz, and Yeaple, 2004). At the same time, this allows firms to reap the benefit of higher economies of scale and provides further incentives to invest in R&D (Petit and Sanna-Randaccio, 2000). Furthermore, foreign investors may be able to source foreign knowledge (Cantwell, 1995; Fosfuri and Motta, 1999), which will increase their productivity, boost their growth, and contribute to raising aggregate productivity. Admittedly, outward investments may also be associated with a decrease in the size and productivity of home activities. This would occur when domestic firms relocate a substantial share of their activities abroad. In this case, the competitiveness boost may not be able to compensate the loss in terms of value-added resulting from offshoring.

Outward investments may also contribute to increase the aggregate productivity through indirect effects on the performance of local firms. On the one hand, an increase in size, productivity and/or knowledge of home multinationals may spill-over on other domestic firms through input-output relations and imitation. On the other hand, to the extent that investing firms move value-added creating activities, domestic suppliers along the value chain may be forced to shrink or to exit. At the same time, opportunities may arise in upstream or downstream sectors, for example in activities like logistics, R&D, design, and other business services. The overall effect of this process on aggregate productivity may be positive or negative, according to the balance between the productivity of firm entering (or increasing the market share) and exiting the market (or shrinking).

Various theoretical arguments can be used to support that the effects of (inward and outward) FDIs are relatively confined in space and, thus, the regional level would more appropriate than the contry level to capture them. First, the smaller the units of observation, the easier would be to appreciate the direct effects of inward and outward FDI, which may be more diluted in more aggregate data. Second, indirect effects may be enhanced by the geographic proximity, which can be important for transmitting knowledge as face-to-face communication (Audretsch and Feldman, 2004). Third, in the presence of transport costs, vertical linkages (which foster pecuniary and knowledge externalities) occur between closely-located suppliers and customers (Venables, 1996). Finally, to the extent that multinationals serve the local markets, crowding out and business stealing effects are spatially confined. Admittedly, since firms competing with multinationals may not be local companies, these effects are likely to span across regional borders.

2.2. Evidence

Since theoretical results do not predict clearcut effects, the issue of whether foreign direct investments have positive or negative effects on aggregate productivity becomes mainly an empirical question. Applied works on inward FDIs and productivity have provided sound evidence that the entry of MNEs is associated with a positive direct contribution to the productivity of host economies; moreover, multinational firms contribute to changes in the industrial mix towards relatively more knowledge and technology intensive sectors. Evidence on indirect effects is more mixed, and it seems to depend both on the characteristics of the multinational investments and those of firms in the host economy. Econometric evidence on inward FDIs and productivity have been provided mainly with firm-level studies on one (or more) countries and with more aggregate cross-country studies (Barba Navaretti and Venables, 2006). A few empirical works have also taken a regional perspective within individual countries. For example Mullen and Williams (2007) analyze the regional spillovers of FDI in US states, while in Europe, among others, Driffield (2004) and Girma and Wakelin (2007) focus on UK regions, Crespo, Fontoura, and Proença (2009) on Portugal, Altomonte and Colantone (2009) on Romania, Halpern and Murakozy (2007) on Hungary. Most of these studies specifically address the spatial aspects of spillover and find that, indeed, the activity of foreign multinationals affects relatively more the productivity of domestic firms located nearby. Rather surprinsingly, despite the increasing competition among local territories both within and across national boundaries to attract foreign investors (Basile, Castellani, and Zanfei, 2008; Blonigen and Kolpin, 2007; Davies, 2005), cross-country evidence of the effects of inward FDIs at a sub-national level is still lacking.

The literature on outward investments and productivity is more scattered, but has gained momentum in the last decade. Many studies in this field have provided evidence that firms investing abroad tend to be more productive than their home country counterparts (Greenaway and Kneller, 2007): these results would predict that in regions with a larger share of highly productive firms (thus a higher average productivity) one would observe a higher number of firms investing abroad. Other studies have found that investing abroad may further reinforce productivity of investing firms (Barba Navaretti, Castellani, and Disdier, 2010; Branstetter, 2006; Debaere, Lee, and Lee, 2010; Griffith, Harrison, and Reenen, 2006), while only a few works in this literature have addressed the indirect effects from firms investing abroad (Castellani and Zanfei, 2006; Vahter and Masso, 2007), finding that the growth of domestic multinationals in the home country can be a source of spillovers for the local firms.

At the aggregate level, few studies have been conducted on the relation between outward FDIs and productivity, and they also show mixed results. For example, van Pottelsberghe de la Potterie and Lichtenberg (2001), in a panel of 13 developed countries, find that outward investments are a more effective channels for international technology transfer among countries with respect to inward FDIs, Driffield, Love, and Taylor (2009) find that outward FDIs are positively related to productivity growth in UK, while Bitzer and Görg (2009), who examine the effect of outward and inward FDIs on domestic total factor productivity for 17 OECD countries, report that only the latter are positively related to a country productivity. To the best of our knowledge there are no studies at the sub-national level regarding the effects of outward FDIs on the productivity of local economies.

3. The empirical model

In order to assess the effect of inward and outward foreign direct investments on regional productivity we specifiy the following econometric model:

$$y_{ij,t} = \gamma_{OUT} OFDI^{stock}_{ij,t-1} + \gamma_{INW} IFDI^{stock}_{ij,t-1} + \beta kl_{ij,t} + \mathbf{x_{ij,t}}\delta + \mu_i + t \cdot \eta_j + \tau_t + \epsilon_{ij,t}, \qquad (1)$$

where $y_{ij,t}$ is the (log of the) labour productivity of the ith region in the jth country at time t, and $OFDI^{stock}_{ij,t-1}$ and $IFDI^{stock}_{ij,t-1}$ are, respectively, (log of) the stocks of outward and inward foreign direct investments in the ith region at the $t-1$ time period. We make the hypothesis that foreign direct investments affect productivity with one-year lag[6]. We include a set of regional characteristics that economic theory has

[6]This is explicitly tested against the hypothesis that FDI have a contemporaneous effect on productivity in Section 6.

indicated as determinants of productivity and which are likely to be correlated with inflows and outflows FDI in European regions. Thus, the model is augmented with $kl_{ij,t}$, which indicates the (log of the) capital-labour ratio and $\mathbf{x_{ij,t}}$, which is a vector of (the log of) other regional characteristics, such as the level of human capital, the stock of technological capital, the regional industrial composition and the degree of concentration/diversification of the regional industry [7]. We include a vector of regional effects, μ_i, to control for unobserved (and time invariant) regional characteristics which could be correlated both with the stocks of foreign direct investments (incoming or outgoing from the region) and with the regional productivity; a vector of time effects, τ_t, to control for factors affecting all regions in the same way in a given year; while the interaction $t \cdot \eta_j$ is introduced in order to capture the country-specific trends in labour productivity, which could be due, for example, to institutional characteristics affecting not only the level of productivity, but also the growth rate (Nicoletti and Scarpetta, 2003). First-differencing equation 1 wipes out the regional fixed effect and leaves us with differences in FDI stocks on the right hand side. This is a handy solution in our case since, as we will discuss in the next section, we do not have information on FDI stocks, because of a constraint on the available data.

The first differenced equation can be written as

$$\Delta y_{ij,t} = \gamma_{OUT}\Delta OFDI^{stock}_{ij,t-1} + \gamma_{INW}\Delta IFDI^{stock}_{ij,t-1} + \beta\Delta kl_{ij,t} + \Delta\mathbf{x_{ij,t}}\delta + \eta_j + \tau_t + \Delta\epsilon_{ij,t}, \quad (2)$$

where Δ indicates the difference between the variable at time t and the variable at time $t-1$. With respects to the variables measuring foreign direct investments, differences are computed between the variable at time $t-1$ and the variable at time $t-2$.

The relationship between investments stocks and flows can be formalized, with some approximation[8] as

$$\Delta_{(t-1,t-2)}OFDI^{stock}_{ij} \cong OFDI^{flows}_{t-1}, \quad (3)$$

and

$$\Delta_{(t-1,t-2)}IFDI^{stock}_{ij} \cong IFDI^{flows}_{t-1}. \quad (4)$$

Plugging 3 and 4 into 2 yields

$$\Delta y_{ij,t} = \gamma_{OUT}OFDI^{flows}_{ij,t-1} + \gamma_{INW}IFDI^{flows}_{ij,t-1} + \beta\Delta kl_{ij,t} + \Delta\mathbf{x_{ij,t}}\delta + \eta_j + \tau_t + \Delta\epsilon_{ij,t}. \quad (5)$$

Equation 5 has an appealing interpretation in our case: the parameters γ_{OUT} and γ_{INW} explicitly consider the relationship between outward and inward flows of investments and the growth rate of the labour productivity.

4. Data and variables

4.1. Data sources

We exploit an original database, which has been compiled recovering data from different sources. Data refer to European regions, at the NUTS 2 level: this level of analysis has been chosen for three main reasons. First of all, it is suitable for taking into account the within-country heterogeneity (in terms of labour productivity, foreign direct investments and the other observed and unobserved characteristics); second, it allows for comparable units across different countries; finally, more information is available on other regional characteristics at this level of disaggregation.

Information on regional gross value added come from the *EU Regional Database* developed and maintained by Eurostat[9], while data on employment and capital investments at the regional level come from

[7] The choice of the control variables is based on previous theoretical and empirical works. We cross-refer the reader to the Appendix A for a detailed discussion on the control variables and their measurement.

[8] The approximation is due to the fact that change in the stock is given by the flow of investments plus the depreciation of the existing capital stock. Unfortunately the lack of the stock of investments forces us to rely on the approximation illustrated in the text.

[9] See the Eurostat web page
`http://epp.eurostat.ec.europa.eu/portal/page/portal/region_cities/`.

the *European Regional Database*, developed by Cambridge Econometrics (release 2006). We have used these information in order to build a measure of labour productivity and a measure of the capital-labour ratio at the regional level. Data on outward and inward FDIs, come from *fDi Markets* an online database maintained by fDi Intelligence —a specialist division of the Financial Times Ltd—, which monitors crossborder investments covering all sectors and countries worldwide. Relying on media sources and company data, fDi Markets collects detailed information on cross-border greenfield investments (available since 2003). fDi Markets data are based on the announcement of the investment and provides daily updated data. For each FDI project, fDi Markets reports information on the investment (e.g., the leading industry sector of the investment), the home and host countries, and regions and cities involved, and the investing company (e.g., location, parent company). The database is used as the data source for FDI project information in UNCTAD's World Investment Report and in publications by the Economist Intelligence Unit.

4.2. Labour Productivity

The dependent variable is the labour productivity, which has been computed as the ratio of the regional gross valued added (at basic prices in millions of euro) obtained from the Regio database, to employment (thousands) in in each region, which has been recovered from the European Regional Database. Given that the price indexes for the gross value added are not available at the regional level, the nationwide indexes, which are available in the *Growth and Productivity Accounts* database developed by EU KLEMS[10] (releases 2008 and 2009), were used to deflate the value added. The last year for which information on value added are available in the Regio database is 2006. The variable has been included in logs in the performed econometric analysis, y_{ijt}.

4.3. Foreign investments

Data on inward and outward foreign direct investments flows ($IFDI_{ijt}^{flows}$, $OFDI_{ijt}^{flows}$) have been recovered from the fDi Markets database. This source tracked 60,301 worldwide investments projects appeared on publicly available information sources in the period 2003-2008[11]. One of the limitations of the fDi Market database is that it collects planned future investments. Some of these projects may not actually be realized or may be realized in a different form from the one originally announced. However, the database is regularly updated and projects which have not been completed are deleted from the database. In this regards, data on the projects related to the early years of the series should be more reliable than data regarding the last years of the series. We tackle this issue by dropping the last two years of data, so we use information on FDI from 2003 to 2006. Our measures of FDI flows is then built as the number of inward/outward investment projects in/from each region in each year of the period 2003-2006:

$$wFDI_{ijt}^{flows} = \#\text{of projects in region } i \text{ belonging to country } j\text{, in year } t,$$

where $w = \{I, O\}$, are respectively inward and outward investments.

Admittedly, the count of FDI projects may not be an accurate proxy of FDI flows, since it does not weights investments for the value of the capital involved. However, the correlation coefficients (0.82 and 0.83), reported in Table 1, between the distribution of FDI projects by EU countries and the actual distribution of FDI flows, as reported by UNCTAD, reassures us that data on investment projects are actually a good proxy for FDI flows. As expected, almost 90% of EU outward investments are made from EU-15 countries, while inward investments are split more evenly among EU-15 and EU-12 countries: United Kingdom, Germany and France result to be the leading countries both in terms of inward and outward FDIs in the period which goes from 2003 to 2006. As for the inward investments, Poland, Romania, Hungary, Czech Republic and Bulgaria show a good performance.[12].

[10] See the web page of the EU KLEMS project at `http://www.euklems.net/`

[11] A team of in-house analysts search daily for investment projects from various publicly available information sources, including, Financial Times newswires, nearly 9,000 media, over 1,000 industry organisations and investment agencies, data purchased from market research and publication companies. Each project identified is cross-referenced against multiple sources,

Table 1: fDi Markets projects vs. UNCTAD Flows, 2003-2006

	Outward			Inward	
Country	# proj.	flows	Country	# proj.	flows
Germany	22.2	11.7	United Kingdom	16.0	25.8
United Kingdom	20.3	16.3	France	9.2	15.2
France	13.8	17.6	Germany	8.3	8.1
Italy	6.3	5.7	Poland	6.5	3.0
Netherlands	5.9	13.7	Spain	6.2	7.2
Sweden	5.9	4.7	Romania	5.9	1.7
Austria	5.1	2.0	Hungary	5.4	1.4
Spain	4.6	11.7	Czech Republic	4.1	1.5
Finland	3.1	0.3	Bulgaria	4.1	1.1
Belgium	2.5	7.9	Ireland	4.1	-1.6
Denmark	1.9	1.4	Italy	3.9	5.9
Ireland	1.4	2.7	Sweden	3.2	3.4
Slovenia	1.1	0.1	Netherlands	3.1	5.1
Greece	0.9	0.4	Belgium	2.9	10.8
Latvia	0.9	0.0	Slovakia	2.6	0.8
Estonia	0.6	0.1	Lithuania	2.4	0.2
Portugal	0.5	1.2	Austria	2.2	1.9
Luxembourg	0.5	1.0	Denmark	1.9	1.2
Poland	0.5	0.7	Latvia	1.7	0.2
Czech Republic	0.5	0.1	Estonia	1.5	0.4
Hungary	0.4	0.4	Portugal	1.3	1.5
Lithuania	0.4	0.0	Greece	1.1	0.6
Cyprus	0.2	0.1	Finland	0.9	1.2
Romania	0.2	0.0	Slovenia	0.8	0.2
Slovakia	0.1	0.0	Luxembourg	0.4	2.7
Bulgaria	0.1	0.0	Cyprus	0.3	0.3
Malta	0	0.0	Malta	0.2	0.2
Total	100	100		100	100
Pearson corr. coefficient	0.82			0.83	

Unfortunately, official statistics on inward and outward investments at the regional level are not available, so we cannot benchmark fDi Markets data as this finer geographical level. However, we can check the data against previous results and some theoretical expectations. To this end, we will exploit the visual representation of the geographical distribution of the number of investment projects at the NUTS 2 level, provided in Figure 1. In line with previous evidence on the role of agglomeration economies for the location of multinational firms (e.g. Crozet, Mayer, and Mucchielli (2004); Bobonis and Shatz (2007)), inward and outward investments appear highly concentrated in a limited number of clustered regions within each country, including the regions around the major cities. In the subsequent econometric analysis, we will assess to what extent this within-country heterogeneity in inward and outward investments maps into different productivity dynamics. A closer inspection of the maps in Figure 1 reveals that outward investments are concentrated in some of the core regions of Continental Europe and the UK, while inward investments are also frequent in a number of peripheral areas, such as the Eastern European countries, Ireland, Scotland and Andalusia in Spain. The latter result is consistent with previous evidence on the positive role of EU Structural and Cohesion Policies in attracting FDI in peripheral regions (Basile, Castellani, and Zanfei, 2008).

5. Descriptive analysis

The time structure of our data imposes some constraints on the empirical analysis. In particular, regional productivity is observed only up to 2006, while information on foreign investments are available for the period 2003-2008. Thus, if we want to assess the econometric relationship between the latter and the former, we are left with four years of data: 2003, 2004, 2005 and 2006. Due to the lack of the information regarding some regional characteristics, regions belonging to Norway, Switzerland and Denmark cannot be considered[13].

Table 2 provides some basic statistics for the variables used in the econometric analysis. As concerns foreign investments, Table 2 shows that, on average, from each region about 14 outgoing investments and 10 incoming investments per year have been recorded. However, the distribution of the number of investments is highly skewed: from more than 25% of regions no outward investment in one year would originate and more than 10% would not attract any inward investment.

The skewness of the foreign investments variables induces us to model their effect as a combination of a dummy taking value equal to '0' for those observations (region/year) where no investments have taken place and a continuous variables taking the value equal to the log of the number of investments in the case of non-zero investments, and '0' otherwise[14]. In other words, investments variables enter the regressions as follow:

$$\mathrm{w}FDI(d)_{i,t} = \begin{cases} = 1 & \text{if \# of investments } {}^{w}_{i,t} > 0 \\ = 0 & \text{if \# of investments } {}^{w}_{i,t} = 0 \end{cases}$$

$$\mathrm{w}FDI(log)_{i,t} = \begin{cases} = log(\text{\# of investments } {}^{w}_{i,t}) & \text{if \# of investments } {}^{w}_{i,t} > 0 \\ = 0 & \text{if \# of investments } {}^{w}_{i,t} = 0 \end{cases}$$

where $w = \{I, O\}$ are respectively inward and outward investments. This specification allows to distinguish the effect of a region being generally involved in the internationalization process, which is captured by the dummy variable, from the effect of the degree of internationalization, which is captured by the continuous variable in logs.

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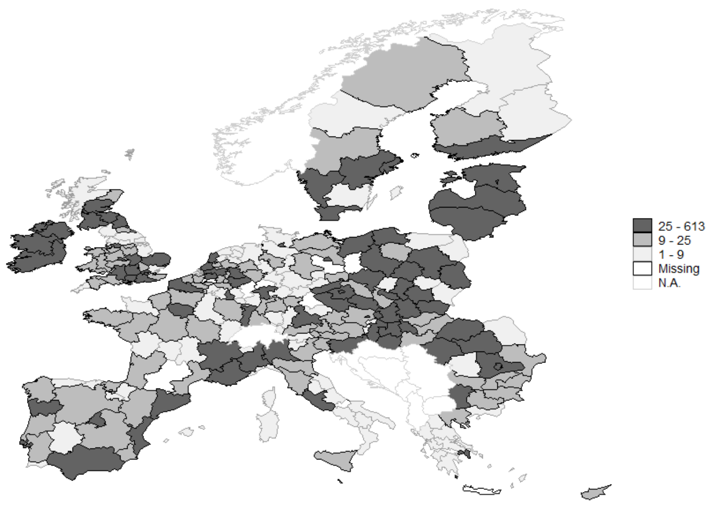
and over 90% of projects are validated with company sources. More information at `http://fdimarkets.com/`

[12] A careful inspection reveals that the number of projects overestimates inward FDIs to some New Member States, such as Poland, Romania, Bulgaria, Hungary and Czech Republic, probably due to the fact that these countries received a large number of project of relatively small-scale investments project

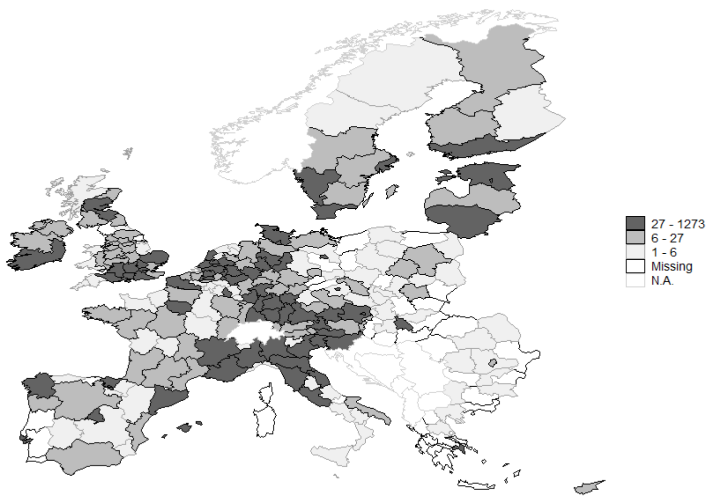
[13] See Table 13 in the Appendix for the detailed list of regions, that have been considered in the econometric analysis.

[14] We take the log of the number of investments so that we can interpret the coefficient of the continuous variable as an elasticity.

Figure 1: Regional distribution of international investment projects, 2003-2006



(a) Inward investments



(b) Outward investments

Table 2: Descriptive statistics, 2003-2006

Variable	**Notation**	**Unit**	**Count**	**Obs.**	**Mean**	**Std. Dev**	**p10**	**p25**	**p50**	**p75**	**p90**
Outward FDI	OFDI	count	14135	1032	13.697	39.710	0	0	3	11	30
Inward FDI	IFDI	count	10802	1032	10.467	19.825	0	1	4	12	24
Labour productivity	y	ratio (log)		1017	3.360	0.751	1.956	3.202	3.651	3.856	3.948
Capital-labour ratio	kl	ratio (log)		1036	4.148	0.863	2.714	3.949	4.387	4.753	4.923
Human capital	$hcap$	ratio (log)		1010	-1.468	0.378	-2.040	-1.728	-1.403	-1.189	-1.035
Herfindahl index	hhi	formula (log)		922	-1.377	0.177	-1.602	-1.514	-1.391	-1.246	-1.144
Innovation stock	$tech$	formula (log)		1036	-0.992	1.859	-3.721	-2.360	-0.416	0.397	0.982
Share of other industies	SH_EF	share		922	0.089	0.023	0.062	0.072	0.084	0.101	0.119
Share of High-tech man.	SH_HT	share		922	0.066	0.035	0.028	0.043	0.060	0.084	0.112
Share of Low-tech man.	SH_LT	share		922	0.125	0.046	0.068	0.088	0.122	0.153	0.191
Share of KI svcs	SH_KIS	share		922	0.316	0.088	0.212	0.254	0.309	0.379	0.431
Share of LKI svcs	SH_LKIS	share		922	0.336	0.047	0.280	0.312	0.338	0.364	0.392
Labour productivity-growth rate	$\Delta_{(t,t-1)}y$	ratio (log, differences)		1017	0.020	0.044	-0.017	0.003	0.017	0.034	0.059
Capital-labour ratio-growth rate	$\Delta_{(t,t-1)}k$	ratio (log, differences)		1036	0.022	0.026	-0.003	0.007	0.018	0.032	0.053
Human capital-growth rate	$\Delta_{(t,t-1)}hcap$	ratio (log, differences)		1002	0.039	0.072	-0.037	-0.002	0.036	0.074	0.119
Herfindahl index-growth rate	$\Delta_{(t,t-1)}hhi$	formula (log, differences)		891	0.009	0.035	-0.033	-0.009	0.008	0.028	0.048
Innovation stock-growth rate	$\Delta_{(t,t-1)}tech$	formula (log, differences)		1036	0.047	0.156	-0.079	-0.018	0.033	0.081	0.174
Share of other industries-growth rate	$\Delta_{(t,t-1)}$ SH_EF	share (differences)		891	0	0.009	-0.010	-0.004	0.001	0.006	0.012
Share of High-tech man.-growth rate	$\Delta_{(t,t-1)}$ SH_HT	share (differences)		891	0	0.009	-0.011	-0.006	-0.001	0.004	0.009
Share of Low-tech man.-growth rate	$\Delta_{(t,t-1)}$ SH_LT	share (differences)		891	0	0.011	-0.016	-0.009	-0.002	0.003	0.009
Share of KI svcs.-growth rate	$\Delta_{(t,t-1)}$ SH_KI	share (differences)		891	0	0.015	-0.012	-0.003	0.004	0.013	0.022
Share of LKI svcs.-growth rate	$\Delta_{(t,t-1)}$ SH_LKIS	share (differences)		891	0	0.016	-0.017	-0.009	0.002	0.010	0.020

Figure 2 provides a graphical representations of the variables measuring the labour productivity in levels and growth at the NUTS 2 level. Labour productivity, are clearly higher in the core regions of the EU-15, while decline in Southern European regions and reach minimum values in the regions of EU-12 countries. As for the growth rates, rather similar patterns are observed in regions belonging to the same country mainly in EU-12 countries, but also in Italy, France and Spain; while in Germany and UK productivity growth displays a remarkable within-country variability. These insights are confirmed in Tables 10 and 11 reported in the Appendix, which present descriptive statistics by country. In order to account for possible biases stemming from these country patterns in productivity growth, country dummies will introduced in our estimated equation, as illustrated in Equation 5.

6. Econometric analysis

6.1. Baseline results

Following the specification of FDI variables in Section 5, the estimated model becomes:

$$\begin{aligned}\Delta y_{ij,t} = \alpha + \beta \Delta kl_{ij,t} + \Delta \mathbf{x_{ij,t}}\delta + \\ + \gamma_O^d OFDI(d)_{ij,t-1} + \gamma_O^{log} OFDI(d)_{ij,t-1} \cdot OFDI(log)_{ij,t-1} + \\ + \gamma_I^d IFDI(d)_{ij,t-1} + \gamma_I^{log} IFDI(d)_{ij,t-1} \cdot IFDI(log)_{ij,t-1} + \\ + \eta_j + \tau_t + \Delta\epsilon_{ij,t}. \quad (6)\end{aligned}$$

We estimate Equation 6 by OLS, and the results are reported in Table 3. In this case we are left with three pooled cross-sections of first-differenced equations: 2004-2003, 2005-2004 and 2006-2005[15]. In this and the following regressions we report robust standard errors clustered by regions to control for the lack of independence of observations referring to the same region over time[16].

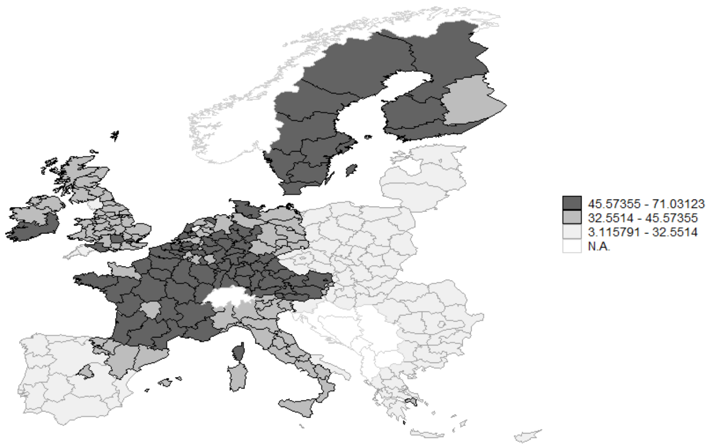
In Specification (1), we look at the effects of inward and outward foreign direct investments (made in year $t-1$) on productivity growth rates, taking into account the change in the capital-labour ratio but without controlling for the other regional characteristics (i.e. human capital, technological capital, the industrial mix and its degree of concentration/diversification). Coefficient of the variables related to inward FDIs, $\widehat{\gamma_I^d}$ and $\widehat{\gamma_I^{log}}$, suggest that for low levels of incoming investments the effect on regional productivity is negative, because the value of the coefficient of the dummy variable dominates the coefficient of the continuous variable. However, the effect of outward FDIs increases as the number of incoming projects becomes larger: in other words, inward FDIs have a positive effect on regional productivity, above a threshold number of investments. On the other hand, outward FDIs have a positive effect on regional productivity, $\widehat{\gamma_O^d}$, but the effect decreases as the number of outward investments increases, as captured by $\widehat{\gamma_O^{log}}$. In Specification (2) the change in the quality of the industrial mix is taken into account, together with changes in the level of human capital, in the technological capital stock and in the degree of concentration/diversification of the industrial mix. A non-negligible loss in the sample size occurs from Specification (1) to (2), and this is mainly due to the lack of data for sectoral employment shares in several regions: these missing values bring to corresponding loss of usable observations in the industrial mix variables (SH_{s*ijt}) and in the Herfindahl-Hirschman index (HHI_{ijt})[17]. To a lesser extent, few missing values are in the variables measuring the level of human capital and the technological capital. Despite the sizable reduction in sample size, results

[15]It is worth mentioning that it would be highly desirable to specify differences longer than one-year for productivity growth but, given the short time span available in our data, this would reduce the number of observations, thus increasing measurement errors and reducing the precision of our estimates.

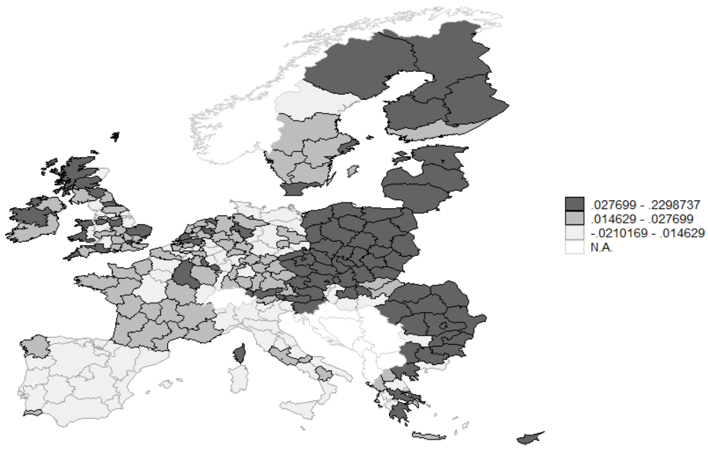
[16]All the regressions have been estimated using Stata 10.1, except for those in Section 6.2.2, which have been run using the environment `R`.

[17]Data for employment shares are not available for the following regions in some (or all) of the three waves of growth rates: Belgium (BE34), Germany (DE30, DE41, DE42, DE50, DE60, DEB2, DED3, DEE0) Denmark (all regions; DK01, DK02,

Figure 2: Regional patterns of labour-productivity level and growth, 2003-2006 (average)



(a) Labour productivity (level)



(b) Labour productivity (growth)

Table 3: Econometric results - Baseline (OLS)

		Specification		
		1	2	3
Variable	Coefficient			
OFDI$_{t-1}$ (dummy)	γ_O^d	0.0088***	0.0076***	0.0075**
		(0.0029)	(0.0029)	(0.0029)
OFDI$_{t-1}$(log. of n.inv)	γ_O^{log}	-0.0030***	-0.0027***	-0.0029***
		(0.0009)	(0.0009)	(0.0010)
IFDI$_{t-1}$(dummy)	γ_I^d	-0.0074***	-0.0024	-0.0072***
		(0.0026)	(0.0025)	(0.0027)
IFDI$_{t-1}$(log. of n.inv)	γ_I^{log}	0.0031***	0.0020*	0.0031***
		(0.0011)	(0.0011)	(0.0012)
$\Delta_{t,t-1}kl$	β	0.2401***	0.3592***	0.2392***
		(0.0839)	(0.1088)	(0.0842)
$\Delta_{t,t-1}$hcap	δ_{hcap}		-0.0120	0.0003
			(0.0164)	(0.0137)
$\Delta_{t,t-1}$hhi	δ_{hhi}		0.1975***	0.1577**
			(0.0616)	(0.0740)
$\Delta_{t,t-1}$tech	δ_{tech}		-0.0001	0.0008
			(0.0083)	(0.0100)
$\Delta_{t,t-1}$SH_EF	δ_{EF}		0.0420	0.1434
			(0.1434)	(0.1509)
$\Delta_{t,t-1}$SH_HD	δ_{HD}		0.0910	0.1638
			(0.1381)	(0.1416)
$\Delta_{t,t-1}$SH_LD	δ_{LD}		-0.1648	-0.1430
			(0.1438)	(0.1557)
$\Delta_{t,t-1}$SH_KIS	δ_{KIS}		-0.3420**	-0.1876
			(0.1325)	(0.1690)
$\Delta_{t,t-1}$SH_LKIS	δ_{LKIS}		-0.4560***	-0.3052*
			(0.1417)	(0.1751)
Constant	α	0.0272***	0.0212***	0.0270***
		(0.0039)	(0.0039)	(0.0039)
Country dummies	η_j	Yes	Yes	Yes
Year dummies	τ_t	Yes	Yes	Yes
Observations		755	659	746
Regions		258	237	255
Significance levels: * 10%, ** 5%,*** 1%				
Cluster-robust standard errors in brackets				

on coefficients of outward foreign investments do not change much, while in the case of incoming projects, the coefficient on dummy variable, $\widehat{\gamma_I^d}$, slightly drops becoming non significantly different from zero and the coefficient of the number of projects, $\widehat{\gamma_I^{log}}$, becomes poorly significant, even if the coefficient is rather stable in magnitude. The observed changes in the coefficients are the result of the sample-selection due to missing values in sectoral employment shares. This fact is confirmed by Specification (3), in which we have filled in most of the missing values in the vector $\mathbf{x_{ij,t}}$[18].

Results from Specification (3) are in line with those of Specification (1). The result on inward investments is a slightly sensitive to choice of the sample under analysis rather than to the introduction of further controls. Overall, Specification (3) is our favorite one, because it allows to control for an important set of regional characteristics without reducing the sample size. The cost for this choice is the use of variables with some imputed values for a limited number of observations: that is, the effect of the regional characteristics which we use as controls could not be always consistent. However, there is no reason to think that this should affect the sign and the magnitude of the coefficients related to inward and outward FDIs variables. By the way, most of the coefficients of the controls result to be not significant for explaining the regional productivity growth. In particular, neither the contemporaneous change in the human capital, nor the change in the technology capital –even if they show the expected signs– seem to significantly explain the regional differences in productivity growth. However, the vector of controls is jointly significant, as reported in the first row of Table 4. In Table 4 (second row) we report a test for the joint significance of foreign direct investments variables: the null hypothesis of no effect by inward and outward foreign direct investments flows is tested and rejected. This confirms the significant role played by foreign direct investments in explaining differences in regional growth rates, once a large set of regional characteristics together with unobserved country-specific trends in productivity have been taken into account. In the third row of Table 4, an F-test on the joint significance of country effects is carried out. The evidence of national trends in labour productivity captured by the national effects is clear: the country dummies result to be jointly significant and failing to account for them would bring us to neglect the significant national patterns of growth, also emerging from Figure 2. It is worth mentioning that after controlling for such country effects, regional differences in the growth in patents and in human capital do not appear to be correlated to the regional productivity growth, while the correlation with international orientation is still significant, although rather small in magnitude[19].

Table 4: Tests on parameters of the baseline Specification (3)

Null Hypothesis (H0)	Conditions	F-Statistics	Critical value (5%)
No regional characteristics effects	$\beta = \delta' = 0$	2.92	1.92
No FDIs effects	$\gamma_w^{log} = \gamma_w^d = 0$	3.52	2.41
No country dummies effects	$\eta' = 0$	119.65	1.56

Finally, let us comment on the threshold effects of inward and outward investments. From Equation 6, the marginal effect of an inward or outward investment on regional productivity growth can be computed

DK03), Spain (ES43), Finland (FI20), France (FR83), Greece (GR11, GR13, GR21, GR22, GR23, G25, GR42, GR43), Italy (ITC2), Netherlands (NL23), Poland (—just for the growth rate 2004-2003— all regions; PL11, PL12, PL21, PL22, PL31, PL32, PL33, PL34, PL41, PL42, PL43, PL51, PL52, PL61, PL62, PL63), Portugal (PT15), United Kingdom (UKE2, UKF3, UKK3, UKK4, UKM5, UKM6).

[18] We have imputed the missing values in two steps. First, for the period 2002-2006, we assumed that missing values were equal to 'the last or the first available data' in the series. In other words, if an observation was missing in a given region in 2004 but it was observable in 2003, the value in 2004 was set equal to that of 2003. On the other hand, if the observation was missing in a given region in 2002 but it was observable in 2003, the value in 2002 was set equal to that of 2003. Thus, we assumed 'zero-changes' were information was not available. Second, in the cases where no data was available or a given region throughout the 2003-2006 period, we imputed using national averages.

[19] The derivative of regional productivity with respect to outward investment, evaluated at the median number of projects, is 0.43%, which amounts to one-forth of the median productivity growth (1.7%), when the 75^th percentile is 3.4%. Instead, the effect of inward investments at the median is -0.29%.

as:

$$\frac{\partial \Delta y}{\partial wFDI} = \gamma_w^d + \gamma_w^{log} \cdot log(wFDI). \tag{7}$$

The marginal effect of one more investment will be positive as long as

$$log(wFDI) > \frac{-\gamma_w^d}{\gamma_w^{log}}. \tag{8}$$

In particular, taking Specification (3) as a reference, with $\widehat{\gamma_I^d}$ = -0.0072 and $\widehat{\gamma_I^{log}}$ = 0.0031, the marginal effect of receiving one more inward investment would be positive for a number of investments greater or equal than $\exp^{\frac{0.0072}{0.0031}}$=10.2. For outward investments, with $\widehat{\gamma_O^d}$ = 0.0075 and $\widehat{\gamma_O^{log}}$ = -0.0029, the marginal effect will be positive up to $\exp^{\frac{-0.0075}{-0.0029}}$=13.3 investments.

Figure 3: Cumulative frequency of region/year observation by number of inward and outward FDIs, 2003-2006

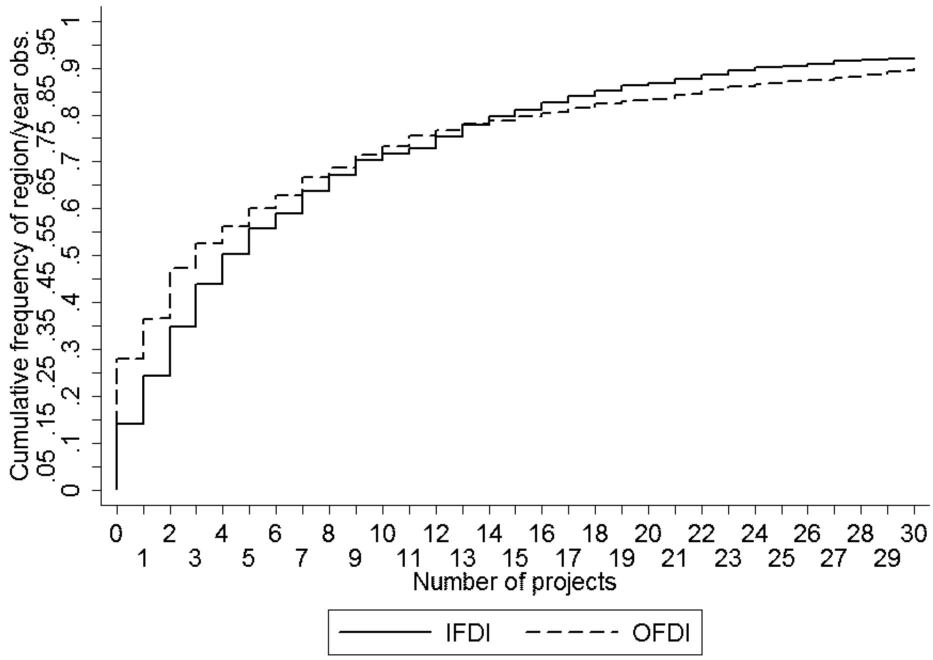


Figure 3 allows to appreciate the extent to which inward and outward investments contribute to productivity growth of EU regions. The Figure plots the cumulative distribution of region/year observations by the number of inward and outward FDIs. The first thing to notice is that outward FDIs are 'twice more rare' than inward FDIs: 28% of region/year obervations have zero outgoing projects, as opposed to only 14% in the case of incoming investments. However, there is a sizable number of cases with a rather large number of outward investments, so that the cumulative distributions for OFDI and IFDI cross at 13 investments. Recalling that the threshold level of investments above which the effect is positive is 10.2, from Figure 3 we gather that approximately 30% of region/year observations are above this threshold, and benefit from inward investments. In the case of outward investments, 28% of regions would increase their productivity growth by 0.75% making one project abroad, while about 22% are above the 13.3 threshold, and have thus lower productivity growth then non-internationalized. The remaining 50% are actually experiencing higher productivity growth, thanks to their international orientation.

6.2. *Robustness checks*

In the previous section we have argued that both inward and outward foreign investments can be a key determinant of differences in productivity growth among the European regions. In the present section we will show that these results are robust to various specifications, and that are not significantly affected by spatial dependence, endogeneity and omitted variables.

6.2.1. *Different specifications of the production function and of the effect of contemporaneous investments*

Our model is based on a specification of labour productivity regressed on the capital-labour ratio. This is a relatively common specification for empirical analyses on regional data, and is basically equivalent to assuming a Cobb-Douglas production function with constant returns to scale. In this section, we relax the assumption of CRS and estimate the following regression:

$$\begin{aligned}\Delta va_{ij,t} = \alpha + \beta_k \Delta k_{ij,t} + \beta_l \Delta l_{ij,t} + \Delta \mathbf{x_{ij,t}} \delta + \\ + \gamma_O^d OFDI(d)_{ij,t-1} + \gamma_O^{log} OFDI(d)_{ij,t-1} \cdot OFDI(log)_{ij,t-1} + \\ + \gamma_I^d IFDI(d)_{ij,t-1} + \gamma_I^{log} IFDI(d)_{ij,t-1} \cdot IFDI(log)_{ij,t-1} + \\ + \eta_j + \tau_t + \Delta\epsilon_{ij,t}. \quad (9)\end{aligned}$$

where $va_{ij,t}$ is (the log of) gross regional value added, while $k_{ij,t}$ and $l_{ij,t}$ denote (the log of) the stock of capital and the total employment in the region. Results, reported in the third column of Table 5, confirm the baseline estimates of Column (3) in Table 3: $\hat{\gamma_O^d}$ and $\hat{\gamma_I^d}$ are slightly larger in absolute value, while $\hat{\gamma_O^{log}}$ and $\hat{\gamma_I^{log}}$ are smaller. This changes the thresholds: with those estimates the effect of OFDI would be negative only for regions with more than 35.63 outgoing projects (i.e. less than 10% of the sample), while the effect of IFDI would be positive for regions with more than 15.76 incoming projects (i.e. slightly less than 25% of regions). One should notice that the unconstrained specification of the production function yields unplausibly low returns on capital and labour and significantly decreasing returns to scale. This is probably due to the well known downward bias when estimating production functions in first-differences (Griliches and Mairesse, 1995). This leads us to prefer our baseline estimates.

A further control on the specification concerns our hypothesis that foreign direct investments (both inward and outward) would affect productivity growth with a one-year lag. In order to support this hypothesis, we estimate two additional specifications: the first one with the variables regarding contemporaneous investments only, and the second one with both lagged and contemporaneous investments.

Results, which are reported in Table 5, definitely support our *a priori*: as highlighted in specification (3_lag1), contemporaneous investments do not have significant correlation with regional productivity growth, except for a small effect of inward investments. Moreover, in the third Column of Table 5, once we introduce both contemporaneous and lagged investments, only the the latter have a significant effect on productivity growth, and the magnitude of the coefficients does not change significantly. It is worth noting that the specification with lagged investments is also more robust to endogeneity problems: if shocks to current productivity growth would also determine a larger flows of inward and outward investment projects, Specification (3_lag1) may be more sensitive to the simultaneity issue and the use of lagged investments should lessen this problem. We will get back to the issue of endogeneity later in this section.

6.2.2. *Accounting for spatial dependence*

In our baseline estimation we implicitly assumed that spatial interactions among regions are fully captured by the inclusion of country fixed effects. However, this assumption would hold only if the spatial regional effects were time invariant and specific to each country, i.e. limited to regions belonging to the same country and affecting all the regions belonging to the same country with the same intensity. This is partially confirmed by the maps in Figure 2 and by the high significance of the country dummies in Table 4, but it could be a too restrictive assumption. First, spatial interactions could occur also among regions which belong to different countries; second, they can be time-variant; third, benefits from being localized nearer to

Table 5: Robustness check: specification of the production function and the effect of foreign investments (OLS)

		Specification			
		3	3_pf	3_lag1	3_lag2
Variable	Coefficient				
OUT(dummy)$_{t-1}$	γ_O^d	0.0075**	0.0085***		0.0097***
		(0.0029)	(0.0029)		(0.0037)
OUT(log. of n.inv)$_{t-1}$	γ_O^{log}	-0.0029***	-0.0024**		-0.0036*
		(0.0009)	(0.0010)		(0.0018)
INW(dummy)$_{t-1}$	γ_I^d	-0.0072***	-0.0081***		-0.0067**
		(0.0027)	(0.0026)		(0.0029)
INW(log. of n.inv)$_{t-1}$	γ_I^{log}	0.0031***	0.0029**		0.0027
		(0.0012)	(0.0012)		(0.0017)
OUT(dummy)$_t$	λ_O^d			-0.0032	-0.0067
				(0.0035)	(0.0042)
OUT(log. of n.inv)$_t$	λ_O^{log}			-0.0009	0.0010
				(0.0008)	(0.0018)
INW(dummy)$_t$	λ_I^d			-0.0009	0.0002
				(0.0030)	(0.0032)
INW(log. of n.inv)$_t$	λ_I^{log}			0.0019*	0.0008
				(0.0011)	(0.0015)
$\Delta_{t,t-1}kl$	β	0.2392***		0.2491***	0.2444***
		(0.0842)		(0.0825)	(0.0850)
$\Delta_{t,t-1}k$	β_k		0.1191**		
			(0.0521)		
$\Delta_{t,t-1}l$	β_l		0.3348*		
			(0.1754)		
$\Delta_{t,t-1}$HCAP	δ_{HCAP}	0.0003	-0.0013	0.0004	-0.0005
		(0.0137)	(0.0138)	(0.0138)	(0.0137)
$\Delta_{t,t-1}$HHI	δ_{HHI}	0.1577***	0.1776***	0.1666**	0.1519**
		(0.0740)	(0.0675)	(0.0737)	(0.0730)
$\Delta_{t,t-1}$INNOV	δ_{INNOV}	0.0008	-0.0010	-0.0002	0.0001
		(0.0100)	(0.0098)	(0.0104)	(0.0098)
Constant	α	0.0270***	0.0308***	0.0288***	0.0293***
		(0.0039)	(0.0038)	(0.0039)	(0.0039)
Country dummies	η_j	Yes	Yes	Yes	Yes
Year dummies	τ_t	Yes	Yes	Yes	Yes
Industrial mix	$\delta_{SH_{s*}}$	Yes	Yes	Yes	Yes
Observations		746	746	746	746
Regions		255	255	255	255

Significance levels: * 10%, ** 5%,*** 1%
Cluster-robust standard errors in brackets

more productive regions can be differentiated even within a country (different intensities of spatial interactions). In the presence of spatial dependence the inference based on OLS estimates of the Specification (3) may not be reliable. This can be further complicated by the fact that FDI also display a tendency to cluster (as shown in 1) which ends up creating spatial dependence(Blonigen, Davies, Waddell, and Naughton, 2007). In other words, since both productivity and FDI tend to be correlated in space, not accounting for spatial dependence may induces us to wrongly infer a causal relation between FDI and productivity.

Following Elhorst (2010), regional interactions can be modeled using both a spatial autoregressive (or spatial lag) model and a spatial error model. The former assumes that the productivity growth of each region is influenced by that of the neighboring regions. The differenced Equation 5 can be rewritten in the following way, in order to account for spatial interactions in the dependent variable:

$$\begin{aligned}\Delta y_{ij,t} = \alpha + \lambda W \Delta y_{ij,t} + \beta \Delta kl_{ij,t} + \Delta \mathbf{x_{ij,t}} \delta + \\ + \gamma_O^d OFDI(d)_{ij,t-1} + \gamma_O^{log} OFDI(d)_{ij,t-1} \cdot OFDI(log)_{ij,t-1} + \\ + \gamma_I^d IFDI(d)_{ij,t-1} + \gamma_I^{log} IFDI(d)_{ij,t-1} \cdot IFDI(log)_{ij,t-1} + \\ + \eta_j + \tau_t + \Delta \epsilon_{ij,t} \quad (10)\end{aligned}$$

where W represents the spatial weight matrix, $W\Delta y_{ij,t}$ is the spatially lagged dependent variable, λ is the spatial autoregressive coefficient. In this work we adopt a binary contiguity matrix, in which each w_{ij} take value '1' or '0', if regions i and j are, respectively, neighbors or not: we define as neighbors all the regions within a 392 km radius of the region centroid[20].

A different specification of the spatial dependence is the spatial error model, which posits that, conditional on regressors, the error terms are correlated in space. In our case, the spatial error model can be written as

$$\begin{aligned}\Delta y_{ij,t} = \alpha + + \beta \Delta kl_{ij,t} + \Delta \mathbf{x_{ij,t}} \delta + \\ + \gamma_O^d OFDI(d)_{ij,t-1} + \gamma_O^{log} OFDI(d)_{ij,t-1} \cdot OFDI(log)_{ij,t-1} + \\ + \gamma_I^d IFDI(d)_{ij,t-1} + \gamma_I^{log} IFDI(d)_{ij,t-1} \cdot IFDI(log)_{ij,t-1} + \\ + \eta_j + \tau_t + \rho W \Delta u_{ij,t} + \Delta \epsilon_{ij,t} \quad (11)\end{aligned}$$

where W represents the spatial weight matrix, $\Delta u_{ij,t}$ reflects the spatially autocorrelated error term, and ρ is the spatial autocorrelation coefficient.

Both the spatial lag and spatial error model can be estimated by Maximum Likelihood (ML).

The main difference between the two models is that, in the spatial-lag case, productivity growth of neighboring regions is the channel trough which externalities are transmitted in space, while in the spatial-error model one assumes that the regional dependence arises from the spatial propagation of idiosyncratic shocks. Since we do not have an *a priori* on the shape of regional interactions, we estimate both Equation 10 and 11 by ML, using the the routine developed by Millo and Piras (2009) for the environment `R` and applying the spatial contiguity matrix previously defined. Results of the estimation are reported in Table 6. Since both the theory and the routine have been defined for balanced panel data, we have to drop some observations in order to balance our panel dataset: the final sample consists of 702 observations and 234 regions. In the first column of Table 6, we report the baseline model –which does not account for spatial interactions– estimated by OLS on the balanced panel (Specification 3_bal). It is possible to compare it with Specification (3) in Table 3, noting that all the coefficients of the FDI variables slightly drop, both in absolute values and in their statistical significance, due to the sample selection. However, the positive effects of inward and outward FDIs (as well as the threshold effects) are basically unchanged. Estimating the spatial lag model (Specification (3_splag)) we obtain a spatial autoregressive coefficient ($\widehat{\lambda}$) equal to 0.68, supporting the existence of significant spatial dependence. Nonetheless, all the FDI variables remain significant, and the magnitude of the coefficients does not change much.

[20]This threshold have been computed as the minimum distance that allow each region to have at least one neighbor, i.e. at least one out-of-diagonal element is equal to one. However, taking a larger radius does not affect the results.

Table 6: Spatial lag and spatial error models (ML)

Variable	Coefficient	Specification: 3_bal	3_splag1	3_splag2	3_sperr1	3_sperr2
OUT_{t-1}(dummy)	γ_O^d	0.0058**	0.0043*	0.0066**	0.0045*	0.0051*
		(0.0027)	(0.0024)	(0.0026)	(0.0023)	(0.0026)
OUT_{t-1}(log. of n.inv)	γ_O^{log}	-0.0021*	-0.0018*	-0.0043***	-0.0020**	-0.0040***
		(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)
$IFDI_{t-1}$(dummy)	γ_I^d	-0.0057*	-0.0053**	-0.0045	-0.0049*	-0.0041
		(0.0026)	(0.0026)	(0.0029)	(0.0026)	(0.0029)
$IFDI_{t-1}$(log. of n.inv)	γ_I^{log}	0.0021*	0.0020*	0.0047***	0.0023**	0.0046***
		(0.0011)	(0.0011)	(0.0011)	(0.0011)	(0.0011)
$\Delta_{t,t-1}kl$	β	0.2070***	0.2372***	0.0839**	0.2208***	0.1624***
		(0.0782)	(0.0477)	(0.0389)	(0.0460)	(0.0444)
$\Delta_{t,t-1}$hcap	δ_{hcap}	0.0056	0.0039	0.0182	-0.0010	0.0163
		(0.0135)	(0.0129)	(0.0142)	(0.0124)	(0.0141)
$\Delta_{t,t-1}$hhi	δ_{hhi}	-0.0178	0.0750	0.0592	0.0814	0.0701
		(0.1105)	(0.0640)	(0.0706)	(0.0630)	(0.0725)
$\Delta_{t,t-1}$tech	δ_{tech}	0.0057	0.0115	0.0191**	0.0106	0.0224***
		(0.0150)	0.0077)	(0.0081)	(0.0073)	(0.0083)
Constant	α	0.0231***	-0.0031	-0.0005	0.0219***	0.0175*
		(0.0060)	(0.0055)	(0.0032)	(0.0082)	(0.0091)
(Spatial autoregressive coefficient)	λ		0.6786***	0.7807***		
			(0.0467)	(0.0357)		
(Spatial autocorrelation coefficient)	ρ				0.7556***	0.8137***
					(0.0406)	(0.0332)
Country dummies		Yes	Yes	No	Yes	No
Year dummies		Yes	Yes	Yes	Yes	Yes
Industrial mix		Yes	Yes	Yes	Yes	Yes
Observations		702	702	702	702	702
Regions		234	234	234	234	234
Significance levels: * 10%, ** 5%,*** 1%						

Specification (3_splag2) reports the estimation of the spatial lag model without the inclusion of the country dummies: interestingly enough, the specification with the country dummies should be preferred: first, a non-negligible number of country dummies (5 over 19) are significant in Specification (3_splag) and the null hypothesis that they are jointly significant cannot be rejected; second, the model without country dummies (Specification 3_splag2) shows an unplausible coefficient of the capital-labour ratio (0.08); third the spatial autoregressive coefficient is larger in the model without the country dummies (0.78), thus indicating their ability in capturing state-specific spatial dependence. This suggests that country dummies may be capturing time-invariant and country-specific spatial specificities, such as institutional characteristics, which cannot entirely be captured by the spatial autoregressive term.

The results of the spatial error model, confirm the presence of spatial dependence, which is indicated by the high and significant spatial autocorrelation coefficient, $\widehat{\rho}$=(0.75). In line with the spatial lag model, the coefficient of the dummy variable related to outward investments shrinks with respect to Specification (3_bal)— from (0.0058) to (0.0045)— and the same is true for the coefficient of the dummy variable of the inward investments —from (0.0057) to (0.0049). This result can be explained by the fact that in the spatial error model, the spatial parameter could pick up the well-known geographical agglomeration phenomenon of the inward foreign investments. The spatial error model has also been estimated without the country dummies, and the results are reported in the last column of the Table. As for the spatial lag model, results support the use of a richer model, including country dummies. In sum, we have showed that even if country dummies capture substantial spatial dependence, some still remains in the residual. However, controlling for such spatial effects does not affect our results, neither in terms of magnitude, nor in terms of statistical significance.

6.2.3. Testing for endogeneity

This paper is ultimately interested in estimating the effect of foreign investments flows on productivity growth. However, the relation may also go the other way around: regions with higher productivity growth rates may attract a larger number of foreign investments or may be home to a larger number of investments. In order to test for this possible reverse causality, we use an instrumental variable approach. In particular, we can exploit the fact that foreign investments variables are correlated with past productivity levels and with other regional characteristics at $t-1$, such as the human capital ($hcap_{t-1}$), technology capital ($tech_{t-1}$) and the degree of sectoral concentration/diversification (hhi_{t-1}). These variables are good candidates as instruments since they are most likely exogenous to current shocks to productivity growth. GMM estimates are reported in the second column of Table 7 and support our choice of instruments. The Kleibergen-Paap LM underidentification statistics rejects the null hypothesis, supporting our prior that the instruments are in fact correlated with foreign investments. The Hansen-Sargan test does allow to reject the null hypothesis of no overidentification, comforting about the exogeneity of the instruments. Coefficients of inward investments are in line with Specification (3), but with higher standard errors, due to the lower precision of the IV estimates with respect to OLS; coefficients of outward investments are even larger (in magnitude) than those in Specification (3), yielding an higher threshold number of outward investments up to which the effect is positive. However, the endogeneity C test (last row of the Table) does not reject the null hypothesis that FDIs are exogenous, thus OLS should be preferred to the GMM approach in this case.

In the third and fourth column of the Table, we specify a dynamic model: indeed, if higher past productivity growth rates were the cause for an higher number of inward and outward investments, and there was a persistence in regional growth rates we may have captured a spurious correlation between investment flows and current productivity growth, instead of a true 'effect' from FDIs to productivity growth. In the third column (3_gmm2), we test for the endogeneity of the lagged growth rate. Both the under- and over-identification tests confirm the validity of the instruments. Coefficient of both inward and outward investments are stable and significant, and the lagged growth rate is not significant: moreover, the endogeneity test does not reject his null hypothesis. Finally, in the fourth column (3_gmm3) we treat both the lagged growth rate and foreign investments variables as endogenous variables: the tests still suggest that OLS is to be preferred[21].

[21]Interestingly enough, excluding the country dummies endogeneity tests would change dramatically. This suggests that

Overall, our tests suggest that, once controlled for country-specific effects, foreign investments are not endogenous to regional productivity growth; thus OLS estimates should be preferred to GMM.

Table 7: Testing for endogeneity (GMM)

		Specification			
		3	3_gmm1	3_gmm2	3_gmm3
Variable	Coefficient				
OUT_{t-1}(dummy)	γ_O^d	0.0075**	0.0160	0.0074**	0.0351
		(0.0029)	(0.0144)	(0.0030)	(0.0269)
OUT_{t-1}(log. of n.inv)	γ_O^{log}	-0.0029***	-0.0051	-0.0023**	-0.0111
		(0.0010)	(0.0041)	(0.0011)	(0.0077)
IFDI_{t-1}(dummy)	γ_I^d	-0.0072***	-0.0074	-0.0060**	-0.0176
		(0.0027)	(0.0155)	(0.0029)	(0.0351)
IFDI_{t-1}(log. of n.inv)	γ_I^{log}	0.0031***	0.0027	0.0019	0.0089
		(0.0012)	(0.0044)	(0.0017)	(0.0066)
$\Delta_{t,t-1}kl$	β	0.2392***	0.2534***	0.2114**	0.2736**
		(0.0842)	(0.0953)	(0.0924)	(0.1374)
$\Delta_{t,t-1}$hcap	δ_{hcap}	0.0003	-0.0003	-0.0026	0.0050
		(0.0137)	(0.0135)	(0.0138)	(0.0184)
$\Delta_{t,t-1}$hhi	δ_{hhi}	0.1577**	0.1092	0.1201	0.1410
		(0.0740)	(0.0729)	(0.0755)	(0.0862)
$\Delta_{t,t-1}$tech	δ_{tech}	0.0008	0.0037	0.0047	-0.0030
		(0.0100)	(0.0100)	(0.0131)	(0.0166)
$\Delta y_{ij,t}$				0.1082	-0.2314
				(0.2578)	(0.4622)
Constant	α	0.0270***	0.0244***	0.0235**	0.0263
		(0.0039)	(0.0082)	(0.0092)	(0.0230)
Country dummies	η_j	Yes	Yes	Yes	Yes
Year dummies	τ_t	Yes	Yes	Yes	Yes
Industrial mix	$\delta_{SH_{s*}}$	Yes	Yes	Yes	Yes
Observations		746	746	746	Yes
Regions		255	255	255	255
Underidentification test(Kleibergen-Paap LM statistic)			20.309	9.838	5.329
Underidentification test(p-value)			0.0265	0.0432	0.0696
Overidentification test (Hansen J statistic)			4.867	1.181	0.036
Overidentification test (p-value)			0.8457	0.7576	0.8501
Endogeneity C test			2.473	0.074	1.869
Endogeneity C test (p-value)			0.6495	0.7853	0.8670
Significance levels: * 10%, ** 5%,*** 1%					
Cluster-robust standard errors in brackets					

6.2.4. Regional controls in levels

Given the relevance of the country effects in Specification (3), we would like to exclude that our results are biased due to further unobserved regional effects correlated to productivity trends at the regional level. In order to cope with this problem, we can augment Specification (3) by including the set of regional controls in levels at the beginning of the period for each cross-section[22] Moreover, we include the level of labour productivity at the beginning of the period, given that it could explain a significant part of the productivity growth rate (catching-up).

country effects capture unobserved characteristics common to all regions in a country, which are correlated both with FDIs and productivity growth and which, if not taken into account, would bring to a correlation between regressors and the error term due to omitted variables. Results obtained excluding country dummies from the regressors are available from the authors upon requests.

[22] In principle, one could add regional fixed effects to the equation in first-differences but, one the one hand there is not clear theoretical motive to assume region-specific trends in productivity and, on the other hand, given the short time series, that would leave very little variation to identify our coefficients.

Thus, the vector $\mathbf{x_{ij,t-1}}$ of regional controls at the beginning of the period can be written as

$$\mathbf{x_{ij,t-1}} = (y_{ij,t-1}, kl_{ij,t-1}, hcap_{ij,t-1}, hhi_{ij,t-1}, tech_{ij,t-1})\,. \quad (12)$$

We further include in Equation 6 a vector of time invariant characteristics, $\mathbf{z_{ij}}\varphi$, which contains the following information:

- Two dummy variables for coastal ($COAST$) and capital ($CAPT$) regions, which take value '1', respectively, in the case in which the region lies on the coast or if it is the capital region of the country. The coastal dummy (information come from Salz, Buisman, Smit, and de Vos, 2006) should account for the general accessibility of a region, which should correlated with its productivity and the degree of internationalization, while the capital dummy is intended to capture agglomeration economies, which could certainly be a driver of productivity growth and which are generally associated with the economic activity and related services taking place in a country's capital.

- We also control for regions which are eligible for European structural funds. A dummy which takes value '1' has been included, when the region is indicated by the European Commission as eligible for 'Objective 1' funds[23].

Results are reported in Table 8.

Overall, the effects of inward and outward foreign direct investments on regional productivity are robust both after taking into account the set of regional characteristics at the beginning of the period and the set of time-invariant regional characteristics. Specification (3_reg3) which is the more demanding, given the high number of covariates and their correlation, shows that the coefficient of the variables related to outward FDIs are still significant even if they slightly decrease in magnitude. Results on the inward FDIs variables are also robust: both the dummy and the continuous variable are significant and they do not change much in terms of magnitude with respect to Specification (3). The capital-labour ratio is stable across all different specifications, while the productivity level at the beginning of the period is never significant, even when it is included without regional controls, as in Specification (3_reg4).

6.2.5. Accounting for the size of regions

To avoid that variables measuring foreign investments capture a generic effect of the 'size' of the region, given that these are the only non-normalized variable on the right-hand side of Equation 6, we included two proxies for the size of regions. In the second column of Table 9 we included a measure of the total population in the vector of regional controls, while in the third column we included the gross value added. Finally, in the fourth column we have normalized the number of investments by the gross value added. Overall, results are not sensitive to the inclusion of a measure of regional size: total population and the gross value added of the region are not significant in Specification (3_size1) nor in (3_size2), while the results from Specification (3_size3), where the number of FDI projects is normalized by the regional value added are in line with Specification (3).

7. Concluding remarks

Despite the increasing evidence of integration of sub-national economies in the global arena, and the positive role of multinational firms for economic prosperity in local economies documented in a number of recent studies, evidence on the relationship between foreign investments and regional performance is lacking. Exploiting an original and extensive dataset on FDIs, we investigate the relationship between FDIs and productivity growth in a sample of European regions. The results of the econometric analysis support that both inward and outward foreign direct investments have positive effects on productivity growth at the

[23] The list of the eligible regions can be found at
`http://ec.europa.eu/regional_policy/objective1/index_en.htm`.

Table 8: Robustness check: regional characteristics (OLS)

Variable	Coefficient	Specification 3	3_reg1	3_reg2	3_reg3	3_reg4
OUT(dummy)_{t-1}	γ_O^d	0.0075**	0.0066**	0.0064**	0.0065**	0.0075**
		(0.0029)	(0.0030)	(0.0031)	(0.0031)	(0.0029)
$\text{OUT(log. of n.inv)}_{t-1}$	γ_O^{log}	-0.0029***	-0.0021*	-0.0022*	-0.0023*	-0.0032***
		(0.0010)	(0.0011)	(0.0011)	(0.0012)	(0.0010)
INW(dummy)_{t-1}	γ_I^d	-0.0072***	-0.0067**	-0.0068**	-0.0068**	-0.0067**
		(0.0027)	(0.0028)	(0.0028)	(0.0028)	(0.0027)
$\text{INW(log. of n.inv)}_{t-1}$	γ_I^{log}	0.0031***	0.0023*	0.0022*	0.0022*	0.0027**
		(0.0012)	(0.0012)	(0.0012)	(0.0012)	(0.0012)
$\Delta_{t,t-1}kl$	β	0.2392***	0.2620***	0.2647***	0.2601***	0.2345***
		(0.0842)	(0.0970)	(0.0986)	(0.0996)	(0.0825)
$\Delta_{t,t-1}\text{hcap}$	δ_{hcap}	0.0003	0.0020	0.0016	0.0019	-0.0002
		(0.0137)	(0.0140)	(0.0140)	(0.0141)	(0.0138)
$\Delta_{t,t-1}\text{hhi}$	δ_{hhi}	0.1577**	0.1181	0.1195	0.1181	0.1464*
		(0.0740)	(0.0775)	(0.0775)	(0.0778)	(0.0758)
$\Delta_{t,t-1}\text{tech}$	δ_{tech}	0.0008	0.0003	0.0014	0.0013	0.0005
		(0.0100)	(0.0107)	(0.0108)	(0.0108)	(0.0100)
y_{t-1}	ϕ_y				0.0062	0.0093
					(0.0131)	(0.0077)
kl_{t-1}	$\phi_{kl,t-1}$		0.0069	0.0070	0.0054	
			(0.0062)	(0.0062)	(0.0072)	
hcap_{t-1}	ϕ_{hcap}		0.0033	0.0031	0.0038	
			(0.0056)	(0.0058)	(0.0060)	
hhi_{t-1}	ϕ_{hhi}		-0.0379**	-0.0377**	-0.0372**	
			(0.0184)	(0.0182)	(0.0183)	
tech_{t-1}	ϕ_{tech}		0.0017	0.0023	0.0021	
			(0.0016)	(0.0016)	(0.0017)	
COAST	φ_{COAST}			0.0024	0.0023	
				(0.0017)	(0.0017)	
CAPT	φ_{CAPT}			0.0038	0.0035	
				(0.0033)	(0.0034)	
OBJ1	φ_{OBJ1}			0.0031	0.0035	
				(0.0026)	(0.0026)	
Constant	α	0.0270***	-0.0597	-0.0536	-0.0599	-0.0084
		(0.0039)	(0.0376)	(0.0378)	(0.0387)	(0.0296)
Country dummies	η_j	Yes	Yes	Yes	Yes	Yes
Year dummies	τ_t	Yes	Yes	Yes	Yes	Yes
Industrial mix*		Yes	Yes	Yes	Yes	Yes
Observations		746	746	746	746	746
Regions		255	255	255	255	255

* The industrial mix include both $\Delta_{t,t-1}SH_{s*}$ (differences) and $SH_{s*ji,t-1}$ (lagged)
Significance levels: * 10%, ** 5%,*** 1%
Cluster-robust standard errors in brackets

Table 9: Robustness check: regional size (OLS)

Variable	Coefficient	Specification			
		3	3_size1	3_size2	3_size3
OUT(dummy)_{t-1}	γ_O^d	0.0075**	0.0079***	0.0079***	0.0074***
		(0.0029)	(0.0030)	(0.0030)	(0.0026)
$\text{OUT(log. of n.inv)}_{t-1}$	γ_O^{log}	-0.0029***	-0.0025***	-0.0024**	
		(0.0010)	(0.0009)	(0.0010)	
INW(dummy)_{t-1}	γ_I^d	-0.0072***	-0.0067**	-0.0069***	-0.0073***
		(0.0027)	(0.0026)	(0.0026)	(0.0025)
$\text{INW(log. of n.inv)}_{t-1}$	γ_I^{log}	0.0031***	0.0034***	0.0035***	
		(0.0012)	(0.0012)	(0.0012)	
$\text{OUT(log. of n.inv/gva)}_{t-1}$	γ_O^{log}				-0.0025**
					(0.0010)
$\text{INW(log. of n.inv/gva)}_{t-1}$	γ_I^{log}				0.0036***
					(0.0012)
$\Delta_{t,t-1}kl$	β	0.2392***	0.2351***	0.2376***	0.2372***
		(0.0842)	(0.0848)	(0.0849)	(0.0844)
$\Delta_{t,t-1}$HCAP	δ_{HCAP}	0.0003	-0.0002	-0.0001	0.0001
		(0.0137)	(0.0137)	(0.0138)	(0.0137)
$\Delta_{t,t-1}$HHI	δ_{HHI}	0.1577**	0.1555**	0.1575**	0.1577**
		(0.0740)	(0.0737)	(0.0739)	(0.0740)
$\Delta_{t,t-1}$INNOV	δ_{INNOV}	0.0008	0.0008	0.0007	0.0007
		(0.0100)	(0.0099)	(0.0099)	(0.0099)
Constant	α	0.0270***	0.0491***	0.0146	0.0363***
		(0.0039)	(0.0155)	(0.0130)	(0.0103)
pop_{t-1}	ϕ_{pop}		-0.0018		
			(0.0012)		
value added_{t-1}	ϕ_{gva}			-0.0017	
				(0.0015)	
Country dummies	η_j	Yes	Yes	Yes	Yes
Year dummies	τ_t	Yes	Yes	Yes	Yes
Industrial mix*		Yes	Yes	Yes	Yes
Observations		746	746	746	746
Regions		255	255	255	255

* The industrial mix include both $\Delta_{t,t-1}SH_{s*}$ (differences) and $SH_{s*ji,t-1}$ (lagged)
Significance levels: * 10%, ** 5%,*** 1%
Cluster-robust standard errors in brackets

regional level, after controlling for a relevant set of regional characteristics, such as human and technological capital, industry mix, and productivity trends at the country level. The econometric analysis has provided –to our knowledge for the first time– a robust evidence of positive effects in a large set of NUTS2 regions in almost all countries of the European Union (EU-27). Previous studies with a regional perspective have focused on comparisons within single countries and have addressed only the role of 'inward' investments as a driver of increasing local performance. Moreover, those few studies which have attempted to assess the specific role of outward investments on productivity have taken a country perspective, almost neglecting the sub-national level of analysis. This is most unfortunate, given that the regional level of analysis is particularly appropriate to capture indirect and compositional effects of FDIs. Our results are consistent with the idea that direct effects of MNEs on productivity and positive indirect effects (i.e. pecuniary and technology externalities) prevail over negative indirect effects (crowding-out and business stealing effects), thus resulting in a positive effect on aggregate productivity. This is in line with previous empirical literature on the entry of MNEs, finding a positive direct contribution to the productivity of the host economy; moreover, it reinforces the (scatter) previous evidence on the positive effects of having a larger number of outward investing firms in a territory.

Our specification allows to add an important qualification to previous results. In particular, inward foreign investments have a positive effect on regional productivity only above a certain threshold level. This result can be explained by the fact that, even large firms, such as multinationals, produce a relatively small value added in the host country with respect to the economy of a NUTS2 region. Therefore, entry of one or few multinationals make a relatively small contribution to the aggregate productivity, and it requires several foreign entries, to make a appreciable direct effect. On the other hand outward investments seem to have a positive effects up to a certain threshold, which is however very high in our sample. Results from our preferred specification suggest that about 30% of regions have higher productivity growth, thanks to the relatively large flows of inward investments, while in 50% of the cases productivity growth is higher due to outward investments.

These results are robust to different specifications of the econometric model, like the inclusion of a number of regional characteristics, controls for spatial dependence in productivity growth across European regions, and for the endogeneity of FDIs. The positive effects of inward and outward FDIs are robust and quite stable also in terms of magnitude of the coefficients. Admittedly, the effect is rather small in magnitude, but it should be noted that the effect of other important regional characteristics such as human and technological capital, regional size, being a coastal region, hosting the country's capital and being eligible for Objective 1 Structural Funds is not significantly different from zero.

In conclusion, our results support that both inward and outward FDIs can bring significant benefits to regional economies by increasing productivity growth. This has important implications for local and national policy. One the one hand, governments should implement policies to attract inward FDIs conducive to higher productivity growth, but the effort must be substantial, so that foreign entries reach the threshold level required to determine positive effects. On the other hand, the fear of hollowing-out European knowledge which has accompanied measures aimed at reducing outward investments is not completely founded. Our results suggest that up to a certain point it is good for a region that local firms invest abroad. Thus, this calls for policies aimed at removing the obstacles to foreign investments.[24]

[24]Admittedly, many policies limiting outward investments were also motivated by the fear of job losses. While we cannot say anything on the effect on regional employment here, we argue that higher productivity growth is likely to increase jobs in the medium-run, whatever the displacement effect in the short run.

A. Appendix

A.1. Labour productivity

Some remarks on the labour-productivity measure should be made. First, data on the regional employment are drawn from the European Regional Database. We chose to use this source, since the employment series of the Regio database has a higher number of missing values which would have decreased the set of regions under analysis. The downside of this choice is that in the version of the European Regional Database available to us, values for 2005 and 2006 were forecast. However, we checked that correlation with the actual (non missing) values, reported by the more updated Regio dataset is very high (0.95). Second, in order to build deflators for regions belonging to Cyprus, Estonia, Latvia, Lithuania and Malta (which are actually all single-region country) we have used the series of price index in the previous release of the EU KLEMS database (2008) given that they were not available in the last release yet. Third, for Bulgarian and Romanian regions we have used the 'Eurozone' series of price index, given that the national series were not available in the database.

In Tables 10 and 11 we show that regions belonging to EU-12 New Member States show (on average) an higher labour productivity growth rate (5%) with respect to regions belonging to 'Old' EU-15 countries (1.2%). This is in line with the literature that claims for the role of the economy restructuring and catching-up to the technological frontier as the main explanations for this phenomenon. Among the countries in the EU-15, it is possible to appreciate a certain amount of heterogeneity in growth rates. United Kingdom, Italy, Spain and Portugal show low performance in terms of labour productivity growth during the period 2003-2006. France and Germany show modest growth trends. Ireland shows the best performance on average, even showing a large standard error, which is likely due to the big difference between the region of Dublin (IE02) which saw a strong economic performance over the past number of years, and the other region (Border, Midland and Western, IE01); some North-European countries show fast growth rates, as the Netherlands (2.7%), Sweden (2.6%), and Finland (2.5%), which is in line with previous analysis at the country level (see O'Mahony, Rincon-Aznar, and Robinson, 2010, among others). Among the New Member States, Romania, Slovakia, Lithuania and Czech Republic show the best performance in terms of labour productivity growth. It is interesting to note the relative higher standard deviations in the growth rates of regions belonging to EU-12 with respect to regions belonging to the 'Old' member states. This is probably due to the fact that there is a considerable amount diversity in growth experience: for example in Romania, the capital region (RO32) shows the highest growth rate (0.169), while other regions perform differently (RO12, RO21, RO22); in the Czech Republic, Moravskoslezsko (CZ08) — which benefits from its location on the borders of Poland and Slovakia —, the Central Bohemian Region (CZ02) and the region of Prague (CZ01) show the best performance in terms of labour productivity growth, while the North East (CZ05) performs rather poorly.

A.2. Capital-labour ratio

We have included the capital-labour ratio (KL_{ijt}) in Equation 1, in order to control for the regional factor share. The variable has been computed as the ratio of the regional capital stock (K_{ijt}) to employment (thousands) in the region (L_{ijt}). The capital stock at the regional level, has been obtained applying the perpetual inventory method (PIM) to the series of capital investments in the region (at 1995 prices in millions of euro)[25] taken from the European Regional Database. As for the employment series, capital investments' information for 2005 and 2006 are forecast.

We followed Hall and Mairesse (1995), and the capital stock at the beginning of the first year has been defined as below:

$$K_{ij,t=1} = \frac{I_{ij,t=1}}{g_{ij} + \delta}, \tag{13}$$

[25]The series comprehend aggregate investments by the following sectors: agriculture, total energy and manufacturing, construction, market and non-market services.

Table 10: Growth rates by country, EU15, 2003-2006

	Δy	Δkl	$\Delta hcap$	Δhhi	$\Delta tech$	ΔSH_EF	ΔSH_HT	ΔSH_LT	ΔSH_KIS	ΔSH_LKIS
Austria	0.022	0.015	0.018	0.001	0.039	0.000	0.001	-0.003	0.001	0.000
	(0.014)	(0.009)	(0.092)	(0.046)	(0.047)	(0.014)	(0.007)	(0.009)	(0.013)	(0.017)
	36	36	36	36	36	36	36	36	36	36
Belgium	0.014	0.014	0.021	0.002	0.009	0.001	-0.001	-0.002	0.002	-0.001
	(0.012)	(0.011)	(0.054)	(0.030)	(0.063)	(0.007)	(0.008)	(0.007)	(0.014)	(0.015)
	44	44	44	40	44	40	40	40	40	40
Germany	0.014	0.003	0.018	0.013	0.022	-0.002	-0.002	-0.002	0.005	0.000
	(0.013)	(0.015)	(0.059)	(0.036)	(0.052)	(0.009)	(0.011)	(0.010)	(0.012)	(0.016)
	156	156	148	140	156	140	140	140	140	140
Denmark	0.018	0.039	.	.	0.044	.	.	.	.	.
	(0.017)	(0.010)	.	.	(0.066)	.	.	.	.	.
	12	12	0	0	12	0	0	0	0	0
Spain	0.008	0.015	0.032	0.012	0.074	0.002	-0.002	-0.004	0.007	0.000
	(0.009)	(0.008)	(0.053)	(0.025)	(0.137)	(0.009)	(0.005)	(0.009)	(0.013)	(0.011)
	68	68	68	66	68	66	66	66	66	66
Finland	0.025	0.032	0.023	0.016	-0.037	0.000	-0.001	-0.003	0.006	0.000
	(0.016)	(0.010)	(0.070)	(0.016)	(0.117)	(0.004)	(0.005)	(0.006)	(0.005)	(0.010)
	20	20	20	16	20	16	16	16	16	16
France	0.017	0.024	0.031	0.016	0.027	0.000	-0.003	-0.004	0.004	0.002
	(0.014)	(0.010)	(0.107)	(0.054)	(0.066)	(0.012)	(0.012)	(0.017)	(0.022)	(0.023)
	88	88	88	84	88	84	84	84	84	84
Greece	0.021	0.066	0.062	0.008	0.092	0.002	0.000	-0.004	0.006	0.005
	(0.034)	(0.036)	(0.086)	(0.032)	(0.242)	(0.008)	(0.007)	(0.010)	(0.014)	(0.011)
	52	52	52	23	52	23	23	23	23	23
Ireland	0.032	0.081	0.047	0.017	0.023	0.007	-0.003	-0.005	0.004	0.002
	(0.023)	(0.013)	(0.037)	(0.015)	(0.075)	(0.005)	(0.004)	(0.006)	(0.006)	(0.009)
	8	8	8	8	8	8	8	8	8	8
Italy	0.005	0.016	0.056	0.008	0.019	0.001	0.000	-0.004	0.008	-0.002
	(0.019)	(0.011)	(0.060)	(0.029)	(0.084)	(0.009)	(0.006)	(0.010)	(0.020)	(0.015)
	84	84	84	80	84	80	80	80	80	80
Luxembourg	0.026	0.022	0.057	0.018	0.051	-0.003	0.001	-0.005	0.013	-0.005
	(0.022)	(0.003)	(0.329)	(0.017)	(0.039)	(0.003)	(0.002)	(0.003)	(0.011)	(0.009)
	4	4	4	4	4	4	4	4	4	4
Netherlands	0.027	0.034	0.049	0.008	0.006	0.000	-0.004	0.002	0.003	0.000
	(0.019)	(0.030)	(0.056)	(0.029)	(0.063)	(0.007)	(0.006)	(0.008)	(0.013)	(0.014)
	48	48	48	44	48	44	44	44	44	44
Portugal	0.010	0.029	0.070	0.007	0.130	-0.004	0.000	-0.004	0.008	0.002
	(0.015)	(0.024)	(0.125)	(0.016)	(0.192)	(0.005)	(0.005)	(0.009)	(0.014)	(0.010)
	20	20	20	15	20	15	15	15	15	15
Sweden	0.026	0.017	0.034	0.006	-0.040	0.002	-0.002	-0.003	0.001	0.002
	(0.024)	(0.023)	(0.020)	(0.024)	(0.076)	(0.004)	(0.004)	(0.007)	(0.011)	(0.009)
	32	32	32	32	32	32	32	32	32	32
United Kingdom	-0.004	0.019	0.032	0.014	-0.003	0.002	-0.003	-0.004	0.006	0.000
	(0.051)	(0.021)	(0.059)	(0.033)	(0.088)	(0.012)	(0.009)	(0.011)	(0.018)	(0.019)
	144	144	136	121	144	121	121	121	121	121
EU_15	**0.012**	**0.021**	**0.034**	**0.011**	**0.025**	**0.000**	**-0.002**	**-0.003**	**0.005**	**0.000**
	(0.028)	(0.024)	(0.074)	(0.035)	(0.107)	(0.010)	(0.009)	(0.011)	(0.016)	(0.016)
	816	816	788	709	816	709	709	709	709	709

Note: the average is reported in the first row; the standard deviation is reported in brackets in the second row and the third row shows the number of observations (region/year)

Table 11: Growth rates by country, EU12, 2003-2006

	Δy	Δkl	$\Delta hcap$	Δhhi	$\Delta tech$	ΔSH_EF	ΔSH_HT	ΔSH_LT	ΔSH_KIS	ΔSH_LKIS
Bulgaria	0.023	-0.006	0.006	-0.001	0.112	0.006	0.001	0.002	-0.001	0.002
	(0.047)	(0.024)	(0.041)	(0.020)	(0.183)	(0.007)	(0.004)	(0.008)	(0.009)	(0.009)
	18	24	18	18	24	18	18	18	18	18
Cyprus	0.030	0.023	0.008	0.005	0.065	0.003	0.000	-0.004	0.005	-0.001
	(0.013)	(0.003)	(0.043)	(0.022)	(0.113)	(0.007)	(0.002)	(0.009)	(0.008)	(0.008)
	3	4	4	4	4	4	4	4	4	4
Czech Republic	0.066	0.003	0.030	0.004	0.088	0.000	0.004	-0.003	0.003	0.000
	(0.054)	(0.018)	(0.050)	(0.029)	(0.116)	(0.009)	(0.007)	(0.009)	(0.008)	(0.012)
	32	32	32	32	32	32	32	32	32	32
Estonia	0.030	0.069	0.029	-0.003	0.061	0.009	-0.001	-0.003	-0.005	0.003
	(0.008)	(0.005)	(0.044)	(0.038)	(0.059)	(0.005)	(0.013)	(0.008)	(0.025)	(0.008)
	3	4	4	4	4	4	4	4	4	4
Hungary	0.012	0.067	0.031	0.012	0.084	0.003	0.000	-0.007	0.003	0.004
	(0.048)	(0.029)	(0.050)	(0.028)	(0.120)	(0.007)	(0.010)	(0.010)	(0.012)	(0.014)
	28	28	28	28	28	28	28	28	28	28
Lithuania	0.073	0.047	0.061	0.009	0.280	0.006	0.000	0.000	0.002	0.008
	(0.004)	(0.013)	(0.018)	(0.007)	(0.262)	(0.008)	(0.003)	(0.003)	(0.006)	(0.002)
	3	4	4	4	4	4	4	4	4	4
Latvia	0.012	0.082	0.030	0.009	0.148	0.008	-0.001	-0.004	0.002	0.005
	(0.051)	(0.008)	(0.073)	(0.020)	(0.168)	(0.005)	(0.003)	(0.007)	(0.008)	(0.005)
	3	4	4	4	4	4	4	4	4	4
Malta	-0.012	0.015	0.060	0.021	0.095	0.002	-0.004	-0.006	0.006	0.004
	(0.042)	(0.010)	(0.072)	(0.027)	(0.110)	(0.009)	(0.015)	(0.008)	(0.005)	(0.014)
	3	4	4	4	4	4	4	4	4	4
Poland	0.034	0.032	0.087	-0.004	0.199	0.004	0.001	-0.002	0.002	0.002
	(0.085)	(0.018)	(0.051)	(0.022)	(0.275)	(0.008)	(0.006)	(0.011)	(0.012)	(0.014)
	64	64	64	32	64	32	32	32	32	32
Romania	0.139	0.016	0.056	-0.016	0.104	0.003	0.000	-0.001	0.003	0.009
	(0.078)	(0.024)	(0.087)	(0.054)	(0.451)	(0.009)	(0.010)	(0.013)	(0.009)	(0.013)
	24	32	32	32	32	32	32	32	32	32
Slovenia	0.026	0.073	0.092	0.011	0.143	0.000	-0.002	-0.007	0.008	0.000
	(0.025)	(0.004)	(0.066)	(0.029)	(0.102)	(0.002)	(0.009)	(0.005)	(0.005)	(0.010)
	4	4	4	4	4	4	4	4	4	4
Slovakia	0.074	0.029	0.067	0.007	0.082	0.003	0.003	-0.004	0.002	0.002
	(0.043)	(0.026)	(0.051)	(0.024)	(0.137)	(0.007)	(0.008)	(0.009)	(0.013)	(0.012)
	16	16	16	16	16	16	16	16	16	16
EU_12	**0.050**	**0.028**	**0.054**	**0.001**	**0.129**	**0.003**	**0.001**	**-0.003**	**0.002**	**0.003**
	(0.075)	(0.032)	(0.063)	(0.033)	(0.252)	(0.008)	(0.008)	(0.010)	(0.010)	(0.012)
	201	220	214	182	220	182	182	182	182	182

Note: the average is reported in the first row; the standard deviation is reported in brackets in the second row and the third row shows the number of observations (region/year) where $I_{ij,t=1}$ is the amount of capital investments taken by the region i in the first year of the series[26], g_{ij} is the rate of growth of capital investments observed in the region in a given span of time (in this case is from 1995-2002[27]), and δ is depreciation rate which has been set equal to 7.5%[28]. Capital stock from the second year onward has been computed using the following formula:

$$K_{ij,t} = (1 - \delta) \cdot K_{ij,t-1} + I_{ij,t}. \tag{14}$$

The variable has been included in logs in the econometric analysis, kl_{ijt}.

A.2.1. Other regional characteristics

In this Section, we detail how regional characteristics — i.e. the level of human capital, the technological capital and the regional industrial mix — have been measured.

- Human capital ($HCAP_{ijt}$) has been proxied by the (log of the) share of population aged 25 or more (thousands) with tertiary-type education degree (ISCED 5-6) in each region. Information come from the EU Regional Database, maintained by Eurostat.
- The regional technological capital ($TECH_{ijt}$) has been proxied by the ratio of the stock of patents applications ($INNOV_{ijt}$) to the total population (thousands) in the region (POP_{ijt}). The stock has been recovered using information on the number of patent applications to the European Patent Office (EPO) coming from each European region, which are available in the database maintained by Eurostat[29]. Data on total population comes from the database developed by Cambridge Econometrics. The stock for the years t = (2003,2004,2005,2006) has been computed as the sum of the patent applications in all sectors in the previous five years ($PATAPP_{ijt}$):

$$INNOV_{ij,t} = \sum_{t=t-5}^{t} PATAPP_{ijt}. \tag{15}$$

  The ratio has been included in logs in the econometric analysis, $tech_{ijt}$.
- We have taken into account the regional industrial mix (SH_{s*ijt}), by introducing the share of employment in six broad sectors s^* of the regional economy: Agriculture, hunting, forestry and fishing (AC), Electricity, gas, water supply and Constructions (EF), High-tech manufacturing & Medium high-tech manufacturing (HD), Medium low-tech manufacturing & Low-tech Manufacturing (LD), Knowledge-intensive services (KI) and Less knowledge-intensive (LKI) services. Each share has been computed in the following way:

$$SH_{s*ijt} = \frac{L_{s*ijt}}{L_{ijt}}$$

  where L_{ijt} and L_{s*ijt} denote, respectively, total employment in the region i which belongs to country j (thousands), and employees belonging to the sector $s*$. To avoid multicollinearity we introduced five coefficients in the regressions. The excluded sectoral share is the AC sector (Agriculture, hunting, forestry, fishing, mining and quarrying). Data regarding employees in each sector come from the database maintaned by Eurostat.

[26] We start computing the capital stock series at 1995 up to 2006, even if in the econometric analysis we use the values from 2002 to 2006. The main motivation relates to the possibility to rest on a more reliable capital stock at the left hand side of Equation 14 for the years under analysis.

[27] For Romanian regions the investments' growth rate has been computed for the period 1998-2002, given the lack of data for the years 1995, 1996 and 1997.

[28] As robustness checks we also computed the capital stock assuming depreciation rate of 5% and 10%, and we did not register significantly different results.

[29] Data on patent applications are regionalised on the basis of the investors' residence: in the case of multiple investors proportional quotas have been attributed to each region.

Data on employment by sectors are missing for a number of (region/year) observations; in order not to loose those observations, we have used linear interpolation to fill the gaps for all the observations that were 'missing', but which had 'non-missing' observations the year before and the year after the missing ones. We further filled in a small amount of missing observations in the High-tech manufacturing sector (which showed the highest number of missing observations) as the difference between total regional employment and the sum of employees in all the others sectors (AC, EF, Medium-high tech manufacturing, Medium-low tech manufacturing, Low-tech manufacturing, KI, LKI).

- We have controlled for the degree of concentration/diversification of the regional industrial mix. Following the literature (see Cingano and Schivardi, 2004; Bracalente and Perugini, 2008, among others), we have used the Herfindahl-Hirschman index as a proxy for concentration/diversification computed as follows:

$$HHI_{ijt} = \sum_s SH^2_{sijt} = \sum_s \left(\frac{L_{sijt}}{L_{ijt}} \right)^2, \tag{16}$$

where SH_{sijt} are a more detailed disaggregation of the employment shares defined above. In fact, as elements of the HHI we take into account 8 broad sectors, s: Agriculture, hunting, forestry and fishing (AC), Electricity, gas, water supply and Constructions (EF), High-tech manufacturing (HTD), Medium high-tech manufacturing(MHTD), Medium low-tech manufacturing (MLTD), Low-tech Manufacturing (LTD), Knowledge-intensive services (KI) and Less knowledge-intensive (LKI) services. In particular, we consider the HTD and the MHTD as two separate sectors here, and the same holds for the LTD and the MLTD which are considered separate elements of the HHI[30]. The HHI index, which is equal to '1' for regions with all employees in one sector and which goes toward '0' for more diversified regional structures, allows us to control for the sectoral concentration/variety of the region, while by introducing the SH_{s^*it} ratios, we account for the different 'quality' of the industrial mix. For any given level of HHI we expect regional productivity to be higher in regions where the share of high-value added activities (such as High-tech Manufacturing and Knowledge-intensive services) is higher[31].

The HHI enters in logs in the econometric analysis, hhi.

The taxonomy of broad sectors —which have been used in order to build the Herfindahl index of diversification and the shares of employment which proxy the regional industrial mix— has been taken from the list which has been proposed by Eurostat in the EU regional database. We cross-refer the reader to the technical repost by Felix (2006) for further details on the employed taxonomy. Sectors are presented in Table 12.

A.3. List of regions

The list of the NUTS 2 regions which have been considered in the baseline Specification (3) is reported in Table 13. Overall, we can account for 255 regions (and 746 observations) belonging to the EU in our analysis, for the period 2003-2006.

[30] The detailed taxonomy of sectors s is presented in Table 12 of the Appendix

[31] The use of different levels of aggregation in the HHI with respect to these employments shares is motivated both by the achieved greater precision of the Herfindahl-Hirschman index, which aims at capturing the variability in the regional industrial mix, and –on the contrary– by the attempt to minimize over-specification in the estimates of the coefficients of the sectoral employment shares.

Table 12: Breakdown of sectors (Nace Rev. 1.1 codes)

Agriculture, hunting, forestry and fishing	01 to 05 Agriculture, hunting, forestry and fishing
Electricity, gas, water supply and constructions	40 to 41; 45 Electricity, gas, water supply and constructions
High-tech Manufacturing	30 Manufacture of office machinery and computers 32 Manufacture of radio, television and communication equipment and apparatus 33 Manufacture of medical, precision and optical instruments, watches and clocks
Medium High-tech Manufacturing	24 Manufacture of chemicals and chemicals products 29 Manufacture of machinery and equipment n.e.c. 31 Manufacture of electrical machinery and apparatus n.e.c. 34 and 35 Manufacture of transport equipment
Low and medium-low-tech Manufacturing	15 to 22 Manufacture of food products, beverages and tobacco; textiles and textile products; leather and leather products; wood and wood products; pulp, paper and paper products,publishing and printings 23 Manufacture of coke, refined petroleum products and nuclear fuel 25 to 28 Manufacture of rubber and plastic products; basic metals and fabricated metals product; other non-metallic mineral products 36 to 37 Manufacturing n.e.c.
Knowledge-intensive services	61 Water Transport 62 Air Transport 64 Post and telecommunications 65 to 67 Financial intermediation 70 to 74 Real estate, renting and business activities 80 Education 85 Health and social work 92 Recreational, cultural and sporting activities
Less knowledge-intensive services	50 to 52 Motor trade 55 Hotels and restaurants 60 Land transport ; transport via pipelines 63 Supporting and auxiliary transport activities; activities of travel agencies 75 Public administration and defence; compulsory social security 90 Sewage and refuse disposal, sanitation and similar activities 91 Activities of membership organization n.e.c. 93 Other service activities 95 Activities of households as employers of domestic staff 99 Extra-territorial organizations and bodies

Table 13: List of the 255 regions considered in the present study, by country

NUTS	Name	# regions	NUTS	Name	# regions	NUTS	Name	# regions	NUTS	Name	# regions
Austria		9	**Germany**		39	ITD3	Veneto		ES41	Castilla y León	
AT11	Burgenland		DE11	Stuttgart		ITD4	Friuli-Venezia Giulia		ES42	Castilla-la Mancha	
AT12	Niederösterreich		DE12	Karlsruhe		ITD5	Emilia-Romagna		ES43	Extremadura	
AT13	Wien		DE13	Freiburg		ITE1	Toscana		ES51	Cataluña	
AT21	Kärnten		DE14	Tübingen		ITE2	Umbria		ES52	Comunidad Valenciana	
AT22	Steiermark		DE21	Oberbayern		ITE3	Marche		ES53	Illes Balears	
AT31	Oberösterreich		DE22	Niederbayern		ITE4	Lazio		ES61	Andalucia	
AT32	Salzburg		DE23	Oberpfalz		ITF1	Abruzzo		ES62	Región de Murcia	
AT33	Tirol		DE24	Oberfranken		ITF2	Molise		ES70	Canarias (ES)	
AT34	Vorarlberg		DE25	Mittelfranken		ITF3	Campania		**Sweden**		8
Belgium		11	DE26	Unterfranken		ITF4	Puglia		SE11	Stockholm	
BE10	Brussels		DE27	Schwaben		ITF5	Basilicata		SE12	Östra Mellansverige	
BE21	Prov. Antwerpen		DE30	Berlin		ITF6	Calabria		SE21	Småland med öarna	
BE22	Prov. Limburg (B)		DE41	Brandenburg-Nordost		ITG1	Sicilia		SE22	Sydsverige	
BE23	Prov. Oost-Vlaanderen		DE42	Brandenburg-Südwest		ITG2	Sardegna		SE23	Västsverige	
BE24	Prov. Vlaams Brabant		DE50	Bremen		**Latvia**		1	SE31	Norra Mellansverige	
BE25	Prov. West-Vlaanderen		DE60	Hamburg		LV00	Latvia		SE32	Mellersta Norrland	
BE31	Prov. Brabant Wallon		DE71	Darmstadt		**Lithuania**		1	SE33	Övre Norrland	
BE32	Prov. Hainaut		DE72	Gießen		LT00	Lithuania		**United Kingdom**		36
BE33	Prov. Liège		DE73	Kassel		**Luxembourg**		1	UKC1	Tees Valley and Durham	
BE34	Prov. Luxembourg (B)		DE80	Mecklenburg-Vorpommern		LU00	Luxembourg		UKC2	Northumberland, Tyne and Wear	
BE35	Prov. Namur		DE91	Braunschweig		**Malta**		1	UKD1	Cumbria	
Bulgaria		6	DE92	Hannover		MT00	Malta		UKD2	Cheshire	
BG31	Severozapaden		DE93	Lüneburg		**Poland**		16	UKD3	Greater	
BG32	Severen tsentralen		DE94	Weser-Ems		PL11	Lódzkie		UKD4	Lancashire	
BG33	Severoiztochen		DEA1	Düsseldorf		PL12	Mazowieckie		UKD5	Merseyside	
BG34	Yugoiztochen		DEA2	Köln		PL21	Malopolskie		UKE1	East Riding and North Lincolnshire	
BG41	Yugozapaden		DEA3	Münster		PL22	Slaskie		UKE2	North Yorkshire	
BG42	Yuzhen tsentralen		DEA4	Detmold		PL31	Lubelskie		UKE3	South Yorkshire	
Cyprus		1	DEA5	Arnsberg		PL32	Podkarpackie		UKE4	West Yorkshire	
CY00	Cyprus		DEB1	Koblenz		PL33	Swietokrzyskie		UKF1	Derbyshire and Nottinghamshire	
Czech Republic		8	DEB2	Trier		PL34	Podlaskie		UKF2	Leicestershire, Rutland and Northants	
CZ01	Praha		DEB3	Rheinhessen-Pfalz		PL41	Wielkopolskie		UKF3	Lincolnshire	
CZ02	Strední Cechy		DEC0	Saarland		PL42	Zachodniopomorskie		UKG1	Herefordshire, Worcestershire and Warks	
CZ03	Jihozápad		DED1	Chemnitz		PL43	Lubuskie		UKG2	Shropshire and Staffordshire	
CZ04	Severozápad		DED2	Dresden		PL51	Dolnoslaskie		UKG3	West Midlands	
CZ05	Severovýchod		DED3	Leipzig		PL52	Opolskie		UKH1	East Anglia	
CZ06	Jihovýchod		DEE0	Sachsen-Anhalt		PL61	Kujawsko-Pomorskie		UKH2	Bedfordshire, Hertfordshire	
CZ07	Strední Morava		DEF0	Schleswig-Holstein		PL62	Warminsko-Mazurskie		UKH3	Essex	
CZ08	Moravskoslezko		DEG0	Thüringen		PL63	Pomorskie		UKI	London	
Estonia		1	**Greece**		12	**Portugal**		5	UKJ1	Berkshire, Bucks and Oxfordshire	
EE00	Estonia		GR11	Anatoliki Makedonia, Thraki		PT11	Norte		UKJ2	Surrey, East and West Sussex	
Finland		5	GR12	Kentriki Makedonia		PT15	Algarve		UKJ3	Hampshire and Isle of Wight	
FI13	Itä-Suomi		GR13	Dytiki Makedonia		PT16	Centro (PT)		UKJ4	Kent	
FI18	Etelä-Suomi		GR14	Thessalia		PT17	Lisboa		UKK1	Gloucestershire, Wiltshire and North Somerset	
FI19	Länsi-Suomi		GR21	Ipeiros		PT18	Alentejo		UKK2	Dorset and Somerset	
FI1A	Pohjois-Suomi		GR22	Ionia Nisia		**Romania**		8	UKK3	Cornwall and Isles of Scilly	
FI20	Åland		GR23	Dytiki Makedonia		RO11	Nord-Vest		UKK4	Devon	
France		22	GR24	Sterea Ellada		RO12	Centru		UKL1	West Wales and The Valleys	
FR10	Île de France		GR25	Peloponnisos		RO21	Nord-Est		UKL2	East Wales	
FR21	Champagne-Ardenne		GR30	Attiki		RO22	Sud-Est		UKM2	Eastern Scotland	
FR22	Picardie		GR42	Notio Aigaio		RO31	Sud		UKM3	South Western Scotland	
FR23	Haute-Normandie		GR43	Kriti		RO32	Bucuresti		UKM5	North Eastern Scotland	
FR24	Centre		**Hungary**		7	RO41	Sud-Vest		UKM6	Highlands and Islands	
FR25	Basse-Normandie		HU10	Közép-Magyarország		RO42	Vest		UKN0	Northern Ireland	
FR26	Bourgogne		HU21	Közép-Dunántúl		**Slovakia**		4	**Netherlands**		12
FR30	Nord-Pas-de-Calais		HU22	Nyugat-Dunántúl		SK01	Bratislavský		NL11	Groningen	
FR41	Lorraine		HU23	Dél-Dunántúl		SK02	Západné Slovensko		NL12	Friesland(NL)	
FR42	Alsace		HU31	Észak-Magyarország		SK03	Stredné Slovensko		NL13	Drenthe	
FR43	Franche-Comté		HU32	Észak-Alföld		SK04	Východné Slovensko		NL21	Overijssel	
FR51	Pays de la Loire		HU33	Dél-Alföld		**Slovenia**		1	NL22	Gelderland	
FR52	Bretagne		**Ireland**		2	SI0	Slovenia		NL23	Flevoland	
FR53	Poitou-Charentes		IE01	Border, Midlands and Western		**Spain**		17	NL31	Utrecht	
FR61	Aquitaine		IE02	Southern and Eastern		ES11	Galicia		NL32	Noord-Holland	
FR62	Midi-Pyrénées		**Italy**		21	ES12	Principado de Asturias		NL33	Zuid-Holland	
FR63	Limousin		ITC1	Piemonte		ES13	Cantabria		NL34	Zeeland	
FR71	Rhône-Alpes		ITC2	Valle d'Aosta/Vallée d'Aoste		ES21	Pais Vasco		NL41	Noord-Brabant	
FR72	Auvergne		ITC3	Liguria		ES22	Comunidad Foral de Navarra		NL42	Limburg(NL)	
FR81	Languedoc-Roussillon		ITC4	Lombardia		ES23	La Rioja				
FR82	Provence-Alpes-Côte d'Azur		ITD1	Provincia Autonoma Bolzano-Bozen		ES24	Aragón				
FR83	Corse		ITD2	Provincia Autonoma Trento		ES30	Comunidad de Madrid		**Total**		255

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