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R&D Offshoring and the Productivity Growth of European Regions

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Abstract

The recent increase in R&D offshoring have raised fears that knowledge and competitiveness in advanced countries may be at risk of 'hollowing out'. At the same time, economic research has stressed that this process is also likely to allow some reverse technology transfer and foster growth at home. This paper addresses this issue by investigating the extent to which R&D offshoring is associated with productivity dynamics of European (NUTS2) regions. In particular, we explore whether R&D investments abroad have a different impact from those in manufacturing and other business activities. We find that offshoring regions have higher productivity growth, but this positive effect fades down with the number of investment projects carried out abroad. However, a large and positive correlation emerge between the extent of R&D offshoring and the home region productivity growth, supporting the idea that carrying out R&D abroad strengthen European competitiveness.

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

Keywords: Regional Productivity, Foreign Investments, Europe, R&D Offshoring

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1. Introduction

Research and Development (R&D), together with other core business activities, is usually centralized at the firms' headquarters in the home country (Patel and Pavitt, 1991; Narula, 2002; Belderbos, Leten, and Suzuki, 2010), but in the last decades research has documented an increase in the internationaliazion of R&D and inventive activity (Guellec and van Pottelsberghe de la Potterie, 2001; Picci, 2010), which was at first mainly motivated by the need to better exploit existing home-based advantages (i.e. by adapting existing products to foreign markets needs), while more recently the need to source complementary assets, talents and competences abroad also became an important motive (Cantwell, 1995; Kuemmerle, 1999; Patel and Vega, 1999; von Zedtwitz and Gassmann, 2002; Le Bas and Sierra, 2002; Narula and Zanfei, 2005; Manning, Massini, and Lewin, 2008; Dunning and Lundan, 2009; Ambos and Ambos, 2011). This offshoring of R&D activities[1] is part of the broader emerging phenomenon of Global Innovation Networks (GINs), where domestic and foreign R&D labs (as well as production and marketing departments) of multinational and non-multinational firms interact within and across firms boundaries for the global generation and diffusion of innovation (Ernst, 2002, 2011; Barnard and Chaminade, 2011). The trend towards locating R&D activities abroad have raised concerns that the knowledge base of advanced countries may be 'hollowed out', worsening their relative international competitiveness[2]. At the same time, economic research have highlighted the potential benefits of offshoring R&D in terms of reverse technology transfer and increased competitiveness at home. In this work, we address this issue by assessing – for the first time – the extent to which the productivity of European regions is associated with the offshoring of R&D activities by domestic multinational enterprises (MNEs) based in 265 NUTS 2 regions in the EU[3]. The focus on regional productivity allows us to capture not only the direct effect of R&D offshoring on firms' competitiveness, but also the effect through the growth in size of offshoring firms (i.e. through market shares reallocation) and the indirect effect via increase/decrease in local firms' productivity and propensity to enter/exit the market ('spillover' effect)[4]. The effect of R&D offshoring on regional productivity is particularly relevant in the European Union (EU) where outward FDIs account for almost 4% of the EU GDP, but with very differentiated patterns across countries[5] and where regional competitiveness and social and economic cohesion have been crucial concerns for policy makers[6].

[1] [R&D] Offshoring is defined as the location or transfer of [R&D] activities abroad. It can be done internally by moving services from a parent company to its foreign affiliates (sometimes referred to as 'captive' or 'in-house' offshoring), or to third (unrelated) parties (referred to as international or offshore outsourcing) UNCTAD (2006). Due to data limitations, the analysis carried out in this work will refer to 'captive' R&D offshoring only.

[2] See, for example, Lieberman (2004) for the US, and Kirkegaard (2005) or Pro Inno Europe (2007) for Europe

[3] 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.

[4] Unfortunately, due to the lack of disaggregated data we cannot evaluate the relative contribution of these different channels

[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

[6] 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.

In order to investigate whether offshoring of R&D affects regional productivity, we gather data on international investment projects, from which we are able to build unique measures of outward (and inward, which will be used as controls) foreign direct investment (FDI) in R&D, as well as in manufacturing and other business activities, at the regional level (NUTS 2), for the countries of the European Union (EU-27). We then estimate regressions of productivity growth as a function of the lagged number of international R&D projects, controlling for a measure of inward FDIs, as well as other regional characteristics and country fixed effects. We find that offshoring regions have higher productivity growth and a positive correlation emerges between the number of R&D projects abroad and the home region productivity. Inward investments are also positively associated with regional productivity growth, but only above a certain threshold.

The rest of the paper is organized as follows: Section 2 presents the related literature; Section 3 provides details on the characteristics of the data and focuses on how the main variables of interest have been measured and constructed, while Section 4 illustrates the econometric specification and results. Section 5 concludes the paper.

2. Related literature

2.1. Theory

Aggregate productivity dynamics can be explained by changes in productivity at the level of the firm (the within-component of productivity growth) and by reallocation of resources across incumbents and through entry and exit (the between-component) (Bartelsman and Doms, 2000). The literature on the effects of R&D offshoring has focussed on the within-component, and has provided already a certain amount of empirical evidence at the firm-level (see section 2.2). R&D offshoring increases firms' productivity by augmenting their stock of knowledge. The growing need for enhanced innovation capability is leading firms to expand technology sourcing and interaction with different and geographically dispersed actors (Narula and Zanfei, 2005). On the one hand, R&D labs abroad are needed to be able to quickly and effectively adapt products to the need and specificities of local markets. Eventually, innovation developed for the local markets can be decontextualized and become part of the knowledge base of the multinational firms and exploited elsewhere Zanfei (2000). On the other hand, R&D offshoring is needed to gain access to crucial inputs such as knowledge and technology complementary to those developed at home, as well as and highly qualified and/or lower cost R&D personnel (Manning, Massini, and Lewin, 2008; Cantwell, 1995; Chung and Yeaple, 2008; Puga and Trefler, 2010). However, R&D offshoring does not necessarily imply that knowledge and productivity at home increase. First, offshored labs need to be able to actually extract knowledge from foreign locations, and this may need time and investments in order to establish relations with actors in the host innovation system (Narula and Michel, 2009). Second, the firm must be able to manage reverse knowledge transfers (from the offshored labs back to the headquarters and the rest of the company), which may require the adoption of sophisticated mechanisms for the dissemination and integration of both explicit and tacit knowledge (Gupta and Govindarajan, 2000).

One less explored channel through which R&D offshoring can affect aggregate productivity in the home region is through the reallocation of market shares. As a matter of fact, theoretical and empirical work tend to agree that offshoring allows to sell more, thanks to the fact that offshoring firms can charge lower prices or adapt products to local needs (Grossman and Rossi-Hansberg, 2008; Barba Navaretti, Castellani, and Disdier, 2010). Provided that offshoring firms are the relatively more productive ones (Helpman, Melitz, and Yeaple, 2004), regional productivity would increase even in the extreme case where no firm increases its own productivity, simply because offshoring firms increase their market share.

R&D offshoring may also have indirect effects on the productivity, size and entry/exit of other firms in the home region. This mechanism is similar to the spillover effects which has been analysed at length with reference to inward FDI and foreign-owned firms (Castellani and Zanfei, 2006). By opening R&D labs abroad, multinational firms may close down activities in the home country, thus disrupting linkages with local firms and institutions. This shrinks the activities of local firms, which may ultimately be forced to exit. Alternatively, if R&D offshoring enables some reverse knowledge transfer, domestic counterparts may also benefit of some positive externalities, via labour mobility, imitation or inter-firm linkages.

In sum, R&D offshoring affects home productivity through a variety of channels, and only some of them are observable at the level of individual firms. An aggregate perspective allows to evaluate the net effects of such different transmission channels. Furthermore, the effects of offshoring are most likely relatively confined in space and, thus, the regional level would more appropriate than the country level to capture them[7]. Admittedly, the drawback of this type of analysis is that we cannot pin it down to the various channels[8].

2.2. Empirics

This paper relates to a number of other empirical studies available in the literature. As in Gambardella, Mariani, and Torrisi (2008) – and unlike the bulk of the works on the determinants of productivity differences among EU regions, which focus on the role of agglomeration economies, technology and human capital (e.g. Ciccone, 2002; Paci and Usai, 2000) — the productivity of European regions is explained by some measure of openness[9].

Our work is also linked with studies investigating the effect of R&D offshoring on knowledge production at home. In this line of research, Criscuolo, Narula, and Verspagen (2005) and Criscuolo (2009) find evidence of reverse technology transfer for European firms using patent citation data, while Piscitello and Santangelo (2010) and D'Agostino,

[7]First, the smaller the units of observation, the easier it would be to appreciate the direct effects of 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)

[8]Aggregating micro-level information would help us obtaining sharper answer (see Altomonte and Colantone, 2009). Unfortunately, this does not appear as a viable alternative at the moment since the available firm-level data comparable across countries (e.g. from Amadeus) provide a rather poor match with aggregate data (and for a few countries), but it is on the agenda for future research

[9]Gambardella, Mariani, and Torrisi (2008) measure regional openness as the share of hotels in total population and the share of the population which speaks a second language

Laursen, and Santangelo (2010) support the hypothesis that patenting activity in OECD countries and regions benefit from offshored R&D activities in Emerging economies (BRICKST). Using firm-level data, from the Spanish Technological Innovation Panel (Nieto and Rodriguez, 2011) find a positive relation between offshoring and innovation performance, with a greater effect on product than on process innovations and through captive offshoring than offshore outsourcing. Similar results have been reported from a survey on 158 EU companies. According to R&D managers of the interviewed firms companies have benefitted from R&D offshoring as far as i) the ability to choose successful R&D projects, ii) length of time it takes to commercialise an innovative idea, iii) the cost efficiency of product innovation processes or iv) the ability to learn about R&D conducted by other firms are considered (Pro Inno Europe, 2007).

Our study follows a also fruitful line of research on outward investments and productivity, which has taken mainly a firm-level perspective. Many studies in this field have provided evidence that investing abroad may foster output growth and further reinforce productivity of investing firms (Barba Navaretti, Castellani, and Disdier, 2010; Debaere, Lee, and Lee, 2010; Griffith, Harrison, and Reenen, 2006)

3. Data and variables

3.1. 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 [10].

3.2. 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 from the *EU Regional Database* developed and maintained by Eurostat[11], while data on employment at the regional level come from the *European Regional Database*, developed by Cambridge Econometrics (release 2006). Value added has been deflated using nationwide indexes, available in the *Growth and Productivity Accounts* database developed by EU KLEMS[12] (releases 2008 and 2009). The last year for which information on value added are available in the Regio database is 2006. 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.

[10] See Table A.3 in the Appendix for the detailed list of regions, that have been considered in the econometric analysis.

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

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

Figure 1 provides a graphical representations of the variables measuring the labour productivity in levels and growth at the NUTS 2 level. Labour productivity levels 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. In order to account for possible biases stemming from these country patterns in productivity growth, country dummies will introduced in our estimated equation.

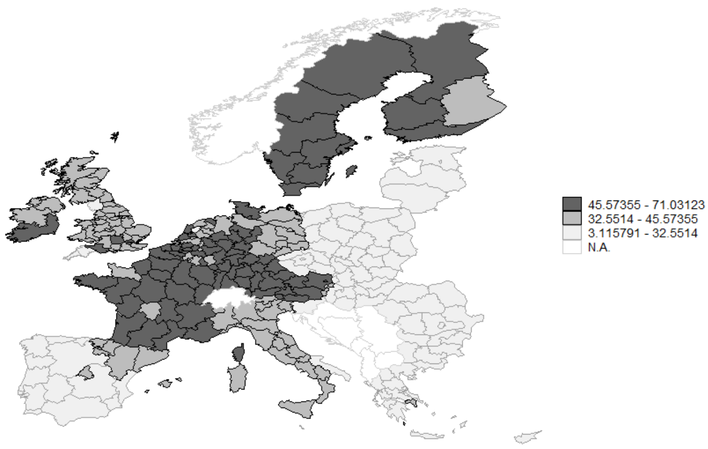
3.3. Measures of offshoring

Data on offshoring have been recovered 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)[13]. *fDi Markets* data are based on the announcement of the investment and provides daily updated data. For each investment 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. This source tracked 60,301 worldwide investments projects appeared on publicily available information sources in the period 2003-2008.

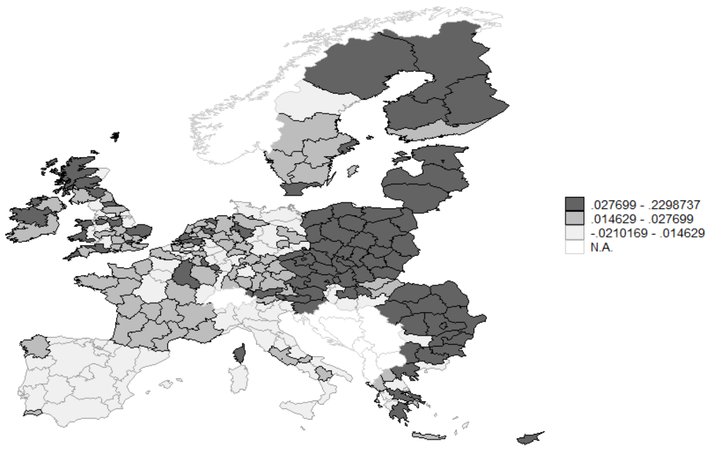
One of the limitations of the *fDi Markets* database is that it collects planned future investments. Some of these projects may not actually be realized or may be realized in a different form from the one originally announced. However, the database is regularly updated and projects which have not been 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 foreign investments from 2003 to 2006. Our measures of offshoring is then built as the number of outward investment projects from each region in each year of the period 2003-2006. We have also built measures of inward investments at the regional level, to control for possible confounding effects due to the fact that regions engaged in outward internationalization may also be those attracting more foreign multinationals. Admittedly, the count of investments projects may not be an accurate proxy of offshoring activity, 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 investments 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%

[13]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 organizations and investment agencies, data purchased from market research and publication companies. Each project identified is cross-referenced against multiple sources, and over 90% of projects are validated with company sources. More information at `http://fdimarkets.com/`

Figure 1: Regional patterns of labour-productivity level and growth, 2003-2006 (average)



(a) Labour productivity (level)



(b) Labour productivity (growth)

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.[14].

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

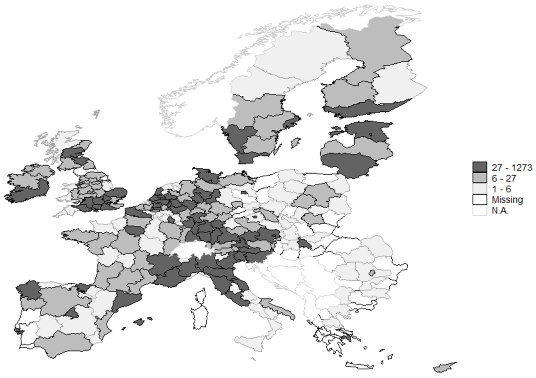
	Outward			Inward	
Country	# proj.	flows	Country	# proj.	flows
Germany	22.2	11.7	United Kingdom	16.0	25.8
United Kingdom	20.3	16.3	France	9.2	15.2
France	13.8	17.6	Germany	8.3	8.1
Italy	6.3	5.7	Poland	6.5	3.0
Netherlands	5.9	13.7	Spain	6.2	7.2
Sweden	5.9	4.7	Romania	5.9	1.7
Austria	5.1	2.0	Hungary	5.4	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, a casual inspection based on Figure 3(a) highlight some expected patterns. In particular, they appear highly concentrated in a limited number of clustered regions within each country, including the regions around the major cities.

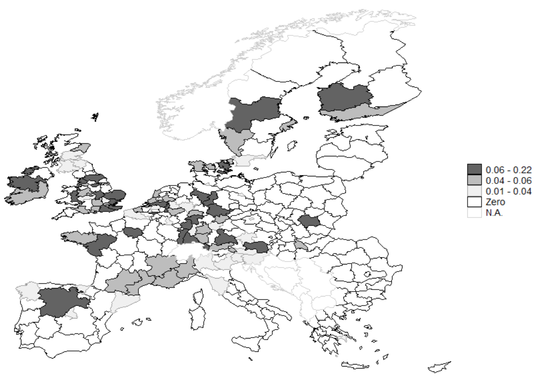
Exploiting the information on the main business activity involved in each of the international projects in the *fDi Markets* database, Figure 3(b) reports the share of R&D

[14]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 relatively small-scale investments projects

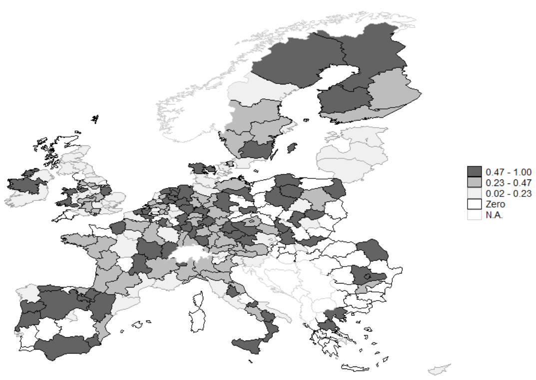
Figure 2: Regional distribution of offshoring projects, 2003-2006



(a) Total number of offshoring projects



(b) Share of R&D projects



(c) Share of manufacturing projects

offshoring projects over the 2003-2008 period, while Figure 3(c) shows, for comparison, the share of outward investments in manufacturing activities. In line with the idea that R&D offshoring is still a limited, although increasing phenomenon, only a relatively small number of regions have some R&D offshoring activity, while manufacturing offshoring is much more pervasive and accounts for a larger share of total outward investments in each region, while R&D are usually a small portion.

Table 2 and A.1 provide some basic statistics for the variables later used in the econometric analysis. As concerns offshoring, Table 2 shows that, on average, from each region about 12.75 offshoring and 9.28 incoming projects per year have been recorded. However, the distribution of the number of projects is highly skewed: more than 25% of regions have no offshoring and more than 10% would not attract any inward investment. This skewness is even more evidence in the case of R&D offshoring, who is carried out by slightly more than 10% of the regions (the 90^{th} percentile is equal to 1).

Table 2: Descriptive statistics, 2003-2005

variable	**mean**	**p10**	**p25**	**p50**	**p90**	**p95**	**p99**	**max**
OFF	12.75	0	0	2	30	55	129	404
OFF^{rd}	.54	0	0	0	1	2	12	29
OFF^{manuf}	3.14	0	0	1	8	13	33	90
INW	9.28	0	1	4	23	35	75	209

4. Econometric analysis

We estimate the effect of offshoring on the home region productivity growth, controlling for inward FDIs, the growth of capital-labour ratio, country-fixed effects and other regional characteristics. However, the skewness of the foreign investments variables induces us to model their effect as a combination of two dummy taking value equal to '0' for those observations (region/year) where no investments have taken place ($OFF(d)$ and $INW(d)$) and two continuous variable ($OFF(n)$ and $INW(n)$) taking the value equal to the number of investments in the case of non-zero investments, and '0' otherwise. This specification allows to distinguish the effect of a region being generally involved in offshoring, which is captured by the dummy variable, from the effect of the extent of offshoring, which is captured by the continuous variable.

The estimated equation then becomes:

$$\begin{aligned}\Delta y_{ij,t} = \alpha + \beta \Delta kl_{ij,t} + \Delta \mathbf{x_{ij,t}} \delta + \\ + \gamma^d OFF(d)_{ij,t-1} + \gamma^n OFF(d)_{ij,t-1} \cdot OFF(n)_{ij,t-1} + \\ + \lambda^d INW(d)_{ij,t-1} + \lambda^n INW(d)_{ij,t-1} \cdot INW(n)_{ij,t-1} + \\ + \eta_j + \tau_t + \Delta \epsilon_{ij,t}. \quad (1)\end{aligned}$$

where $kl_{ij,t}$ indicates the (log of the) capital-labour ratio, $\mathbf{x_{ij,t}}$ is a vector 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. We also include a vector of time effects, τ_t, to control for factors affecting all regions in the same way in a given year; while η_j is introduced in order to capture the country-specific trends in labour productivity. We make the hypothesis that foreign investments affect productivity with one-year lag[15].

Table 3: The effect of offshoring on EU regional productivity growth (OLS regressions)

	(1)	(2)	(3)	(4)
$OFF(d)_{t-1}$	0.0065***	0.0059**	0.0062***	0.0056**
	(0.0025)	(0.0024)	(0.0024)	(0.0024)
$OFF(n)_{t-1}$		-0.0001***	-0.0002***	-0.0002***
		(0.0000)	(0.0001)	(0.0001)
$OFF(n)^{rd}_{t-1}$			0.0014**	
			(0.0006)	
$OFF(n)^{man}_{t-1}$				0.0002
				(0.0002)
$INW(d)_{t-1}$	-0.0052**	-0.0055**	-0.0055**	-0.0057**
	(0.0023)	(0.0023)	(0.0023)	(0.0023)
$INW(n)_{t-1}$		0.0003***	0.0003***	0.0003***
		(0.0001)	(0.0001)	(0.0001)
$\Delta_{t,t-1}kl$	0.2234***	0.2416***	0.2429***	0.2412***
	(0.0809)	(0.0803)	(0.0803)	(0.0802)
Constant	0.0206***	0.0214***	0.0222***	0.0215***
	(0.0038)	(0.0036)	(0.0036)	(0.0036)
Country dummies	Yes	Yes	Yes	Yes
N. observations	769	769	769	769
N. regions	265	265	265	265

We estimate Equation 1 by OLS, and the results are reported in the columns (1) and (2) of Table 3. In this case we are left with three pooled cross-sections of first-differenced equations: 2004-2003, 2005-2004 and 2006-2005 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

OLS estimates of equation 1 are reported in column (1) and (2) of Table 3. To be precise, in column (1) we estimate only the effect of the two dummies taking value 1 if a region has at least one outgoing or incoming investment project (respectively), while in column (2) we also estimate the effect of the number of investments. Results support that offshoring regions have a 0.6 percentage points higher productivity growth, while regions receiving inward investments appear to have lower productivity growth. Column (2) helps qualify this result: while the positive effect of offshoring is slightly decreasing in the number of investments, a higher number of incoming multinationals is associated with higher productivity growth. We performed a number of robustness checks, which we do not report here to save space[16]. In particular, *(i)* we tested (and

[15]This specification can be though as deriving from one in levels, once accounted for regional fixed effects by first-differencing. See (Castellani and Pieri, 2011) for more details.

[16]The reader can refer to (Castellani and Pieri, 2011) for details

rejected) that offshoring may have contemporaneous effects on productivity growth, and that past offshoring may be endogenous with respect to current productivity growth ; *(ii)* we included controls for spatial dependence, as well as regional characteristics (in levels) –including population, a dummy for regions hosting the country capitals, the level of education, employment density, patenting activity, sectoral specialization– none of which change the results significantly.

From Equation 1, it is possible to compute the threshold number of offshoring investments above which the overall effect is negative, and the number of inward investments above which the overall effect is positive. In particular, taking the partial derivative of labour productivity growth with respect $OFF(d)$

$$\frac{\partial \Delta y}{\partial OFF(d)} = \gamma^d + \gamma^n \cdot OFF(n). \tag{2}$$

The effect of offshoring will be positive as long as

$$OFF(n) > \frac{-\gamma^d}{\gamma^n}. \tag{3}$$

As for the effect of inward investments, the same calculation would yield that the effect is positive for

$$INW(n) > \frac{-\lambda^d}{\lambda^n}. \tag{4}$$

In particular, taking Specification (2) as a reference, with $\widehat{\gamma^d}$ = -0.0059 and $\widehat{\gamma^n}$ = 0.00013, the marginal effect of offhoring would be positive for a number of outgoing project smaller or equal to $\frac{0.0059}{0.00013}$=44.6. From Table 2 we gather that this is between the 90^{th} and 95^{th} percentile, meaning that less than 10% of the regions actually experience a negative effect of offshoring on productivity growth. Conversely, the threshold for inward investments is $\frac{0.0055}{0.0003}$=18.2, which is between the 75^{th} and 90^{th} percentile, suggesting that about one-quarter of regions benefit from incoming multinationals.

The effect of R&D offshoring (as opposed to offshoring of manufacturing or other activites) on regional productivity is investigated augmenting the specification (1) with the number of outward investment in R&D and in manufacturing. In formal terms, our estimated equation takes the following form:

$$\begin{aligned} \Delta y_{ij,t} = \alpha + \beta \Delta kl_{ij,t} + \Delta \mathbf{x_{ij,t}} \delta + \\ + \gamma^d OFF(d)_{ij,t-1} + \gamma^n OFF(n)_{ij,t-1} + \gamma^{ba} OFF(n)^{ba}_{ij,t-1} \\ + \lambda^d INW(d)_{ij,t-1} + \lambda^n INW(n)_{ij,t-1} + \eta_j + \tau_t + \Delta\epsilon_{ij,t}. \end{aligned} \tag{5}$$

where *ba* denotes the business activity (i.e. R&D or manufacturing).

Results reported in column (3)-(6) Table 3, show that R&D offshoring is associated with significantly higher productivity growth, while the effect of offshoring production is not different from the overall effect. It is worth mentioning that the magnitude of the effect of R&D offshoring is remarkable: our estimates suggest that comparing two regions that have the same degree of offshoring (and everything else constant), if we let one have an additional R&D project abroad in one year, this region would experience a rise in productivity growth by 0.14 percentage points the next year.

So far we have considered as offshoring also investments between regions of different countries but within Europe. Let us now overcome this assumption and focus on the effects of R&D offshoring towards countries outside Europe, as opposed to offshoring within the area. Table 4 presents some descriptive statistics of R&D offshoring both intra and extra Europe. Rather interestingly, less than one-third of R&D offshoring projects are directed towards other European countries (both within and outside the EU), so the bulk of investments is actually directed to non-European countries. As already stressed in a report for the EU (Pro Inno Europe, 2007) the main non-European recipients of R&D offshoring are China and India, then are developed countries and other South-East-Asian countries. Other developing countries, which include important destinations such as Brazil and Russia, attract also a considerable number of projects. In Table 5 we assess the effect of offshoring R&D within Europe versus non-European countries. Results suggest that offshoring R&D within Europe does not bring significantly different productivity gains than offshoring R&D outside Europe: both the coefficients are is similar in magnitude, but they are rather imprecisely estimated. When we consider R&D offshoring towards specific areas, we find that the effect on productivity growth is always positive, including the case of China, but in most cases it is imprecisely estimated. The effect is larger and significant in the case of R&D offshoring toward South-East-Asian countries. Conversely, regions offshoring R&D more intensively towards India experience a significantly lower productivity growth. This be explained by a number of concurrent factors. For example, it could signal that offshoring towards India substitute for R&D activities in the home regions, thus decreasing productivity, that reverse technology is less effective from Indian affiliates or that investing in India is not associated with firm growth at home (and thus reallocation of market share to offshoring firms). At any rate, a closer inspection of the patterns of R&D offshoring in India is necessary, in order to better grasp the reasons for the peculiar effect that these investments have on European regions' productivity growth.

Table 4: Descriptive statistics on R&D offshoring, 2003-2006

variable	**mean**	**p50**	**p90**	**p95**	**p99**	**max**
OFF^{rd}	.549	0	1	2	12	29
$OFF^{rd\text{ - }intra\ europe}$	.171	0	0	1	4	9
$OFF^{rd\text{ - }extra\ europe}$	.377	0	1	2	10	20
$OFF^{rd\text{ - }developed}$	.071	0	0	0	2	5
$OFF^{rd\text{ - }china}$	.104	0	0	1	3	6
$OFF^{rd\text{ - }india}$	.074	0	0	0	2	6
$OFF^{rd\text{ - }south\ east\ asia}$	.047	0	0	0	2	5
$OFF^{rd\text{ - }others}$	.079	0	0	0	2	7

Table 5: The effect of offshoring on EU regional productivity growth (OLS regressions)

	(1)	(2)
$OFF(d)_{t-1}$	0.0062***	0.0058**
	(0.0024)	(0.0024)
$OFF(n)_{t-1}$	-0.0002***	-0.0002***
	(0.0001)	(0.0001)
$OFF(n)_{t-1}^{rd\text{ - }intra\ europe}$	0.0015	0.0022
	(0.0019)	(0.0020)
$OFF(n)_{t-1}^{rd\text{ - }extra\ europe}$	0.0014	
	(0.0010)	
$OFF(n)_{t-1}^{rd\text{ - }developed}$		0.0020
		(0.0025)
$OFF(n)_{t-1}^{rd\text{ - }china}$		0.0029
		(0.0019)
$OFF(n)_{t-1}^{rd\text{ - }india}$		-0.0061***
		(0.0022)
$OFF(n)_{t-1}^{rd\text{ - }south\ east\ asia}$		0.0045***
		(0.0016)
$OFF(n)_{t-1}^{rd\text{ - }others}$		0.0010
		(0.0021)
$INW(d)_{t-1}$	-0.0055**	-0.0059**
	(0.0023)	(0.0023)
$INW(n)_{t-1}$	0.0003***	0.0003***
	(0.0001)	(0.0001)
$\Delta_{t,t-1}kl$	0.2429***	0.2462***
	(0.0804)	(0.0810)
Constant	0.0222***	0.0221***
	(0.0036)	(0.0036)
Country dummies	Yes	Yes
N. observations	769	769
N. regions	265	265

5. Concluding remarks

In recent years, multinational firms have increasingly resorted to offshoring of R&D activities, in order to cope with the need to integrate differentiated sources of knowledge and implement a faster and cheaper innovative process. This is part of the broader phenomenon of Global Innovation Networks (GINs), where domestic and foreign R&D labs (as well as production and marketing departments) of multinational and non-multinational firms interact within and across firms boundaries for the global generation and diffusion of innovation. This process has increasingly involved emerging countries and raised fears that the knowledge base in advanced economies may be 'hollowed out'. At the same time, economic research has emphasized that R&D offshoring may actually strengthen the home economies, by allowing some form of reverse technology transfer, firm growth and spillovers. This paper investigates a part of this story, focussing on 'captive' offshoring of R&D[17] and investigating to what extent productivity growth in 265 EU regions (NUTS 2) is affected by the propensity (and extent) of firms in the regions to set up facilities abroad, with special reference to the creation of R&D labs. Our results suggest that offshoring regions experience a higher productivity growth, but this positive effect fades down with the number of investment projects carried out abroad. However, these 'decreasing returns' to offshoring do not seem to occur in the case of R&D. In fact, our estimates suggest that one additional R&D offshoring project is associated with a significantly higher regional productivity growth the next year. This is effect is positive regardless of whether offshoring occurs within Europe or towards other emerging or advanced countries (with the exception of India).

Although more research is needed in order understand the channels and conditions underlying the positive effect of R&D offshoring on productivity growth at home, our study sends a reassuring message to EU policymakers, since it supports the idea that carrying out R&D abroad (even in China and other emerging economies) strengthens —rather than 'hollows out'— European sources of competitiveness.

[17]Thus we do not address the various aspects of GINs, such as the outsourcing of R&D, or the establishment of collaborative linkages with firms in foreign countries (with or without having a local R&D lab or other firm's facilities)

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.

A.2. Capital-labour ratio

We have included the capital-labour ratio (KL_{ijt}) in our regressions, 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)[18] 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:

$$K_{ij,t=1} = \frac{I_{ij,t=1}}{g_{ij} + \delta}, \tag{6}$$

where $I_{ij,t=1}$ is the amount of capital investments taken by the region i in the first year of the series[19], 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[20]), and δ is depreciation rate which has been set equal to 7.5%[21]. Capital stock from the second year onward has been computed using the following formula:

$$K_{ij,t} = (1 - \delta) \cdot K_{ij,t-1} + I_{ij,t}. \tag{7}$$

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

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

[19] 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 7 for the years under analysis.

[20] 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.

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

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[22]. 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 ($PATAPP_{ijt}$):

$$INNOV_{ij,t} = \sum_{t=t-5}^{t} PATAPP_{ijt}. \tag{8}$$

  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.

  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

[22] 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.

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:

$$HHI_{ijt} = \sum_{s} SH^2_{sijt} = \sum_{s} \left(\frac{L_{sijt}}{L_{ijt}} \right)^2, \tag{9}$$

  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[23]. 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[24].

  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 A.2.

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 A.3. Overall, we can account for 255 regions (and 746 observations) belonging to the EU in our analysis, for the period 2003-2006.

[23]The detailed taxonomy of sectors s is presented in Table A.2 of the Appendix

[24]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 A.1: Descriptive statistics, 2003-2006

Variable	Notation	Unit	Count	Obs.	Mean	Std. Dev	p10	p25	p50	p75	p90
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

Table A.2: 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 A.3: 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 Len	
AT11	Burgenland		DE11	Stuttgart		ITD4	Friuli-Venezia Giulia		ES42	Castilla-la Mancha	
AT12	Niedersterreich		DE12	Karlsruhe		ITD5	Emilia-Romagna		ES43	Extremadura	
AT13	Wien		DE13	Freiburg		ITE1	Toscana		ES51	Catalua	
AT21	Krnten		DE14	Tbingen		ITE2	Umbria		ES52	Comunidad Valenciana	
AT22	Steiermark		DE21	Oberbayern		ITE3	Marche		ES53	Illes Balears	
AT31	Obersterreich		DE22	Niederbayern		ITE4	Lazio		ES61	Andalucia	
AT32	Salzburg		DE23	Oberpfalz		ITF1	Abruzzo		ES62	Regin 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	stra Mellansverige	
BE21	Prov. Antwerpen		DE30	Berlin		ITF6	Calabria		SE21	Smland med arna	
BE22	Prov. Limburg (B)		DE41	Brandenburg-Nordost		ITG1	Sicilia		SE22	Sydsverige	
BE23	Prov. Oost-Vlaanderen		DE42	Brandenburg-Sdwest		ITG2	Sardegna		SE23	Vstsverige	
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	vre Norrland	
BE32	Prov. Hainaut		DE72	Gieen		LT00	Lithuania		**United Kingdom**		36
BE33	Prov. Lige		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	Lneburg		**Poland**		16	UKD3	Greater	
BG32	Severen tsentralen		DE94	Weser-Ems		PL11	Ldzkie		UKD4	Lancashire	
BG33	Severoiztochen		DEA1	Dsseldorf		PL12	Mazowieckie		UKD5	Merseyside	
BG34	Yugoiztochen		DEA2	Kln		PL21	Malopolskie		UKE1	East Riding and North Lincolnshire	
BG41	Yugozapaden		DEA3	Mnster		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	Stredn Cechy		DEC0	Saarland		PL42	Zachodniopomorskie		UKG1	Herefordshire, Worcestershire and Warks	
CZ03	Jihozpad		DED1	Chemnitz		PL43	Lubuskie		UKG2	Shropshire and Staffordshire	
CZ04	Severozpad		DED2	Dresden		PL51	Dolnoslaskie		UKG3	West Midlands	
CZ05	Severovchod		DED3	Leipzig		PL52	Opolskie		UKH1	East Anglia	
CZ06	Jihovchod		DEE0	Sachsen-Anhalt		PL61	Kujawsko-Pomorskie		UKH2	Bedfordshire, Hertfordshire	
CZ07	Stredn Morava		DEF0	Schleswig-Holstein		PL62	Warminsko-Mazurskie		UKH3	Essex	
CZ08	Moravskoslezko		DEG0	Thringen		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	It-Suomi		GR13	Dytiki Makedonia		PT16	Centro (PT)		UKJ4	Kent	
FI18	Etel-Suomi		GR14	Thessalia		PT17	Lisboa		UKK1	Gloucestershire, Wiltshire and North Somerset	
FI19	Lnsi-Suomi		GR21	Ipeiros		PT18	Alentejo		UKK2	Dorset and Somerset	
FI1A	Pohjois-Suomi		GR22	Ionia Nisia		**Romania**		8	UKK3	Cornwall and Isles of Scilly	
FI20	land		GR23	Dytiki Makedonia		RO11	Nord-Vest		UKK4	Devon	
France		22	GR24	Sterea Ellada		RO12	Centru		UKL1	West Wales and The Valleys	
FR10	le 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	Kzp-Magyarorszg		RO42	Vest		UKN0	Northern Ireland	
FR26	Bourgogne		HU21	Kzp-Dunntl		**Slovakia**		4	**Netherlands**		12
FR30	Nord-Pas-de-Calais		HU22	Nyugat-Dunntl		SK01	Bratislavsk		NL11	Groningen	
FR41	Lorraine		HU23	Dl-Dunntl		SK02	Zpadn Slovensko		NL12	Friesland(NL)	
FR42	Alsace		HU31	szak-Magyarorszg		SK03	Stredn Slovensko		NL13	Drenthe	
FR43	Franche-Comt		HU32	szak-Alfld		SK04	Vchodn Slovensko		NL21	Overijssel	
FR51	Pays de la Loire		HU33	Dl-Alfld		**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-Pyrnes		**Italy**		21	ES12	Principado de Asturias		NL33	Zuid-Holland	
FR63	Limousin		ITC1	Piemonte		ES13	Cantabria		NL34	Zeeland	
FR71	Rhne-Alpes		ITC2	Valle d'Aosta/Valle 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-Cte d'Azur		ITD1	Provincia Autonoma Bolzano-Bozen		ES24	Aragn				
FR83	Corse		ITD2	Provincia Autonoma Trento		ES30	Comunidad de Madrid		**Total**		255

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