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# Cohesion Policy Meets Heterogeneous Firms

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# Abstract

In this paper, we empirically test the effects of the EU's 'cohesion policy' on the performance of 273,500 European manufacturing firms after combining regional policy data at NUTS 2 level with firm-level data. In a framework of heterogeneous firms and different absorptive capacity of regions, we show that the financing of 'cohesion policy' by the European Regional Development Fund (ERDF) aimed at direct investments in R&D correlates with an improvement of firms' productivity in a region. Conversely, funding aimed at overall Business Support correlates with negative productivity growth rates. In both cases, we registered an asymmetric impact along the firms' productivity distribution, where a stronger impact can be detected in the first quartile, i.e. less efficient firms in a region. We finally argue that considering the heterogeneity of firms allows a better assessment of the impact of 'cohesion policy' measures.

Keywords: firm performance, total factor productivity, cross-country analysis, convergence, regional policy

JEL classification: D22, D24, E23, F15, L25



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# 1 Introduction

In parallel with the European integration, a ‘cohesion policy’ has been developed to offset the imbalances that could benefit some regions in the core of the continent at the expense of regions at its periphery.<sup>1</sup> In the running financial period 2014-2020, regional policy spending amounts to almost a third of the EU budget (EUR 351.8 billion out of a total EUR 1,082 billion) and is the second largest expenditure item after the Common Agriculture Policy (CAP). Its aim is to reduce regional economic disparities resulting from geographic remoteness, as different levels of prosperity and opportunity may exist both between and within the Member States. In this respect, mutual support through transfers from richer to poorer regions aims to benefit economically and socially deprived regions and close the gap to the EU average. In broader terms, the overall goal is ‘economic, social and territorial cohesion’, which translates into boosting competitiveness and economic growth, providing people with better services, job opportunities and better quality of life, and connecting regions. EU regional policy is implemented through a range of European Structural and Investment Funds (ESI) in a shared management system, carried out by each Member State in partnership with the European Commission. First, the Commission negotiates and approves the National Strategic Reference Framework (NSRF), setting out the main priorities for spending provided by the EU, and the Operational Programme (OP), establishing specific regions’ priorities, objectives, and concrete actions to manage individual projects. Then, managing authorities in each country and/or region select, monitor, and evaluate individual projects submitted by firms, institutions or other entities. The geographical coverage and allocation of transfers are usually based on the level of GDP per capita in PPP compared to the EU average.

In this contribution, we focus on one of the main financial tools of EU regional policy, i.e. the European Regional Development Fund (ERDF). In particular, we restrict our attention to specific sources supporting firms in their innovation strategies and competitiveness.<sup>2</sup> Resources are allocated to regional operational programmes that have specified thematic priorities. For instance, the ERDF for Business Support has been established to help firms or groups of firms, in particular, SMEs, with services and investments in innovation and sustainable production. Complementary to the latter, the ERDF for Research, Technology and Development (RTD) stimulates research and innovation activities through investments in research centres, promoting technology transfers and cooperation between businesses and the scientific environment. Overall, we argue that the ERDF has a dual role: first, it aims at improving the environment of regions, and second, it is a direct financial income for the recipient firms, potentially used as a source for investment.

The impacts of regional policies are usually evaluated at aggregated levels, by country or by region. There is no consensus regarding the outcome of the *Structural Fund Programme*, and research still focuses on aggregate statistics. However, the increasing availability of detailed firm-level data allows a more in-depth investigation of the direct and indirect impact of these policies on their immediate beneficiaries, i.e. the firms, in treated and non-treated regions. Firm-level evidence reveals some facts that are unobservable at the aggregate level, e.g. a large heterogeneity in the competitiveness of firms within the same industry. Heterogeneity of firms and varying absorptive capacity of regions can also explain the observed heterogeneity in the regional policy effects.

In our study, we enrich the relevant empirical literature by testing the impact of the ‘cohesion policy’ and its tools on the performance of 273,500 EU manufacturing firms, after estimating their total factor productivities (TFPs) according to the most recent semi-parametric econometric technique proposed by Akerberg et al. (2015). Our purpose is to assess the short-term impact of both the Business Support and

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<sup>1</sup>For details on the core-periphery model and its consequences, see the seminal work by Krugman (1991).

<sup>2</sup>One of the priorities of the EU ‘cohesion policy’ and a key component of the renewed Lisbon Strategy Europe 2020 concern the support to firms (European Commission, 2010). Grants to firms across Member States are mainly used to support private investment to improve private capital stock (European Commission, 2017).

the Research, Technology and Development (RTD) financing from ERDF on the firm-level TFP growth in the period 2007-2015. In the Single Market, increasing economic integration is thought to have a positive impact on productivity due to stronger competitive pressure coming from the elimination of national borders. Firms compete on an EU-wide basis, and so we estimate firms' productivity using elasticities computed by industries across the whole sample of EU members. The EU-wide approach allows for a comparison of each firm with its peers within and across the national borders of the integrated market. Finally, we also control for a selection bias possibly coming from uneven missing information in some countries, due to different national regulations for financial accounts. To this end, we make our results robust to a Heckman (1979) correction.

First, we find a positive and statistically significant impact of Research, Technology and Development (RTD) by ERDF<sup>3</sup> on productivity growth. In fact, the firms that seem to benefit more from the RTD measure are the ones in the first quartile of the productivity distribution, i.e. the less efficient in a region. By contrast, the Business Support vehicle by ERDF has a negative and statistically significant impact on productivity growth in the short term. Also, in this case, the first quartile of the firms' productivity distribution is where a stronger impact can be detected. On the one hand, our results suggest that the aim of RTD is on average reached, as direct investments in R&D activities seem to improve firms' overall performance, possibly thanks to developing new products and processes. On the other hand, a general Business Support<sup>4</sup> funding appears to have unintended consequences, although at this stage we cannot exclude that a positive future impact can still be revealed in the longer run, given the diverse priority themes.

This paper is organised as follows. The next section collects the state of the literature on the evaluation of *Structural Funds Programme* and the total factor productivity estimation. Then, Section 3 provides a thorough description of firm-level data and the TFP sample, which then we combine with regional policy data. Section 4 presents the empirical strategy, and Section 5 discusses the benchmark results and the robustness checks. The last section offers the summary of key findings and concluding remarks.

## 2 Related Literature

A large body of literature evaluates the regional and national effects of the EU regional policies, motivated by the relevant size of the budget and the supranational role of the European Commission in developing the policy agenda. Among others, Boldrin and Canova (2001) find little evidence that regional policies of the EU-15 were effective in terms of promoting economic growth and fast convergence in per capita income during the period until 1997. They conclude that transfers towards poorer regions had mostly a redistribution purpose. On the same line, Dall'Erba and Le Gallo (2008) find no significant effects of structural funds on the convergence of 145 European regions over the period 1989-1999. Ederveen et al. (2003) reveal that poorer regions caught up with richer regions; however, the extent to which this was due to the cohesion policy is ambiguous. They state that cohesion support has a positive impact in lagging member states if their economies are open. Conversely, Cappelen et al. (2003) find a significant and positive impact of EU regional support on the growth of the European regions after the major reform

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<sup>3</sup>The RTD's priority themes for the period 2007-2013, laid down in Commission Regulation (EC) No 1828/2006, were: 01. R&TD activities in research centres; 02. R&TD infrastructure and centres of competence in a specific technology; 03. Technology transfer and improvement of cooperation networks between small and medium-sized businesses (SMEs), between these and other businesses and universities, post-secondary education establishments of all kinds, regional authorities, research centres and scientific and technological poles; 04. Assistance to R&TD, particularly in SMEs; 07. Investment in firms directly linked to research and innovation; 09. Other measures to stimulate research and innovation and entrepreneurship in SMEs.

<sup>4</sup>The Business Support's priority themes for the period 2007-2013, laid down in Commission Regulation (EC) No 1828/2006, were: 05. Advanced support services for firms and groups of firms; 06. Assistance to SMEs for the promotion of environmentally-friendly products and production processes; 08. Other investment in firms; 63. Design and dissemination of innovative and more productive ways of organising work.

of structural funds in 1988. Nevertheless, their results show that the effect of the funds was stronger in regions with a favourable industrial structure and with an emphasis put on R&D. Similarly, Leonardi (2006), using sigma- and beta-convergence argues that as a result of the ‘cohesion policy’ from 1989 on, the gap between core and peripheral areas in the EU shrank. Assessing the impact of the ‘cohesion policy’ is challenging because it addresses different economic and social objectives. Thus, aggregate analysis can be misleading, in fact, the average effect hides impacts of varying intensity and time span related to the diverse policy fields.

A relatively meagre body of literature assesses the impact of this funding system on firms’ outcomes. Bernini and Pellegrini (2011) consider subsidies to Southern Italian regions over the period 1996-2004 and find a positive effect on output, employment and fixed assets in subsidized firms, but slower growth in the TFP than in non-beneficiaries firms. Additionally, Hartsenko and Sauga (2012) positively assess the effectiveness of different types of grants on Estonian firms net sales. While these studies are restricted to specific European regions, De Zwann and Merlevede (2013) propose a EU-wide investigation combining regional data with firm-level data for the period 2000-2006. Their preliminary results show that there is no evidence of average treatment effect on employment and productivity. In this framework, we argue that there is a lack of EU-wide studies of regional policy across the distribution of firm’s outcomes.

In the regional economics literature, there are several empirical analysis studying the impact of public subsidies on total factor productivity at the firm level. Bergström (2000) examines the effects on TFP of public capital subsidies to manufacturing firms in Sweden between 1987 and 1993. The study shows that subsidisation can impact on growth in the first year the support is granted, but thereafter TFP growth deteriorates. Harris and Trainor (2005) use detailed micro panel data distinguishing firms that receive assistance and those that did not for the manufacturing industry in North Ireland. They find that public subsidies to firms throughout the 1983-1998 period have a positive and significant impact on the level of production, and capital transfers are more likely to affect TFP than other forms of financial support positively.

Further, we also relate to the literature on the firm-level total factor productivity (TFP) dispersion as a measure of heterogeneity. Syverson (2011) surveys recent empirical works, and the common finding is that productivity differences among firms within an industry are large and robust to alternative estimation methods. Using data from the 1977 Census of Manufactures (CM), Syverson (2004b) find that establishments at the 90<sup>th</sup> percentile of the within 4-digit-SIC productivity distribution are nearly twice as productive as those at the 10<sup>th</sup> percentile. Also, Syverson (2004a,b) shows that the productivity variation across industries and geographic areas is persistent and it can be related to indicators of product substitutability, market structure, and competition. Hsieh and Klenow (2009) show that under certain assumptions about technology and demand, dispersion in revenue productivity reflects market distortions. In addition, using micro-data on manufacturing, they quantify the potential extent of dispersion as an indicator of misallocation in China and India versus the United States. Recently, Foster et al. (2016) explore the current interpretations of firm-level dispersion in revenue-based productivity measures. Their empirical evidence suggests, under iso-elastic demand, that dispersion may indicate either distortions or variation in demand shocks and/or technical efficiency.

The kinds of literature that we briefly reviewed above are lacking an appropriate assessment of regional policies of the EU on the performance of firms across the whole Single Market. Therefore, the contribution of this paper is twofold. First, we contribute to the existing literature by estimating the firm-level TFP in a ‘continental’ approach encompassing 32 countries across the Wider Europe using recent methodological techniques. Second, identifying the location of firms within NUTS-2 regions, we assess the impact of European Regional Development Funds (ERDF) on the growth of firms’ TFP during the period 2007-2015. The results of the study may provide insightful information and implications for policy-makers at the EU-level and in general across the advanced economies.

## 3 Data

### 3.1 Firm-level data

In the recent decades, the interconnected and complex global economy has called for an in-depth analysis of micro-agents which from the bottom shape the macro dynamics (Mayer and Ottaviano, 2008). Firm-level data have become a valuable tool for structural analysis and empirical evidence on several issues: assessing and comparing the productivity at different levels of aggregation, investigating innovation and entrepreneurship, understanding the effects of globalisation, moreover, linking the financial and employment decisions of firms to aggregate economic outcomes, among others.

Firm-level data are usually sourced from national and/or local public agencies (e.g. business registers, production survey, tax returns), but their public access is often restricted mostly because of the risk of disclosing confidential information. As an alternative, commercial databases gather firm-level information about firms located worldwide, when confidentiality is handled. For the purpose of our analysis, the reliability of firm-level balance sheet data is related to the coverage and the quality of information for each firm. We use the ORBIS database by Bureau Van Dijk (BvDEP), which contains financial and ownership information on millions of mostly private companies around the world, organised in a standard format after integration and harmonisation.<sup>5</sup>

Because of its broad coverage regarding statistical units<sup>6</sup> and time, and international comparability, it is possible to investigate firm's behaviour by industry, size, country and region over time. Coverage of small firms and balance sheet variables changes from country to country according to the filing requirements by business registers in each country (Kalemli-Ozcan et al., 2015), contributing to measurement errors, classification biases, selection biases, etc..<sup>7</sup> Hence, there is a trade-off between coverage (i.e. the number of firms, variables and countries) and the accuracy of the conducted analysis. For instance, the contemporaneous presence of some balance sheet information, namely turnover, material cost, fixed assets and employees, necessary to compute the total factor productivity reduces the available initial sample significantly.<sup>8</sup>

As a starting point, we briefly present the coverage and quality of the sample we end up to compute total factor productivity estimations. Table 1 provides information about European firms operating in manufacturing (sectors 10-33 in second revision *Nomenclature générale des activités économiques dans les Communautés européennes*, NACE), for which complete data are available over the period 2007-2015. We show the coverage on the population of firms provided by the Structural Business Statistics of Eurostat for each country and NACE rev.2 2-digit sector, as total economy percentages for the year 2013.<sup>9</sup>

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<sup>5</sup>There is an increasing number of studies from different empirical literatures using ORBIS data. For instance, recent OECD research has used cross-country firm-level data from ORBIS to measure total factor productivity, see Gal (2013).

<sup>6</sup>Some shortcomings may arise when defining the unit of analysis: firms that operate in more than one country have at least one unit counted in each country; only in some countries the business register keeps track of organisational changes (i.e. mergers and acquisitions) within and between firms, and also the definition of legal units may vary across countries.

<sup>7</sup>It is well-known that limited liability companies, although they are required to register their formation, may not report complete balance sheet information in compliance with the national law which differs across countries. Moreover, official business surveys have administrative thresholds (e.g. VAT), below which some businesses are excluded. Therefore, concerns about possible sample selection by country and/or by size must be carefully addressed. Besides, a wider coverage of countries implies the lack of certain variables, i.e. value-added and intermediate inputs which are necessary to measure TFP. Another weakness is the availability of employment information, which is not a mandatory item in balance sheets but rather reported in a memorandum.

<sup>8</sup>Many researchers have experienced a large number of unique firm identifiers, but many missing values for financial values, as reported in Kalemli-Ozcan et al. (2015). It appears that there is a reporting lag of about two years on average, so for instance information about a firm in 2010 may fully appear in 2012.

<sup>9</sup>Structural business statistics (SBS) data is collected using statistical surveys, business registers or from various administrative sources across the European Union (EU). Starting in 1995, the SBS provides information on many key variables, such as turnover, value-added, employment, the number of business units, etc., broken down by industries and size for each country. Notice that changes in the specific purposes (e.g. tax collection, government policies, etc.) of the administrative sources may affect the coverage, definition, thresholds, etc., of the data. The sample coverage for the other years in the study is available upon request.

A noteworthy feature of the data is a high coverage of turnover for some countries, although the percentage of operating firms in the year 2013 is much lower. For instance, for Bulgaria, since the percentage of turnover and labour is very good, but the number of firms is lower than the one reported by Eurostat, we can suggest that ORBIS has information on large firms. For Austria and some other countries, the coverage of labour is lower than the one of turnover; one reason could be that firms in ORBIS are less labour-intensive than the ones in Eurostat. First evidence suggests that for most countries there is an over-representation of medium and large firms in our sample, compared to the majority of small and medium-sized enterprises (SMEs) within the European Union.<sup>10</sup> The latter is confirmed in Table 2 where the size distribution regarding the number of firms for each country is reported. For countries like Austria, Belgium, Denmark, Netherlands and the United Kingdom, the highest number of firms in ORBIS is of medium size. However, the sample selection on the size is less severe, in terms of representativeness of the sample, when looking at the percentage of firms within each sector. Table 3 shows that there is a good sector coverage for most countries. Some exceptions are less labour-intensive sectors, such as NACE 13-15 and NACE 16-18, which are overall under-represented.<sup>11</sup>

Table 1: Sample coverage, year 2013.

Country	Turnover			N. of employees			N. of firms		
	Sample	Eurostat	%	Sample	Eurostat	%	Sample	Eurostat	%
<b>Austria</b>	77,724	176,744	43.98	215,039	617,441	34.83	760	25,129	3.02
<b>Belgium</b>	224,957	267,274	84.17	297,804	514,258	57.91	2,732	33,468	8.16
<b>Bosnia-Herz.</b>	5,661	6,635	85.33	111,217	122,089	91.10	3,784	4,440	85.23
<b>Bulgaria</b>	21,742	22,566	96.35	503,980	524,041	96.17	15,607	30,091	51.87
<b>Croatia</b>	13,793	16,044	85.97	181,939	260,534	69.83	7,724	20,673	37.36
<b>Cyprus</b>	693	2,585	26.80	4,312	25,583	16.85	95	4,947	1.92
<b>Czech Rep.</b>	137,125	139,840	98.06	989,866	1,160,215	85.32	14,702	167,688	8.77
<b>Denmark</b>	35,178	93,000	37.83	84,615	351,178	24.09	573	15,062	3.80
<b>Estonia</b>	583	11,142	5.24	80,228	104,565	76.73	3,871	6,381	60.66
<b>Finland</b>	58,559	113,213	51.72	182,904	330,472	55.35	6,369	21,581	29.51
<b>France</b>	471,945	870,241	54.23	1,278,008	2,993,901	42.69	27,953	226,369	12.35
<b>Germany</b>	689,905	1,975,826	34.92	1,830,210	7,220,296	25.35	13,134	202,823	6.48
<b>Greece</b>	23,131	56,478	40.96	134,025	289,187	46.35	4,417	57,736	7.65
<b>Hungary</b>	84,421	93,802	90.00	447,036	664,724	67.25	3,003	47,475	6.33
<b>Italy</b>	661,432	872,479	75.81	2,384,401	3,733,694	63.86	105,399	407,344	25.87
<b>Latvia</b>	5,945	7,517	79.09	98,116	120,761	81.25	5,525	9,535	57.94
<b>Lithuania</b>	7,301	13,508	54.05	90,917	195,701	46.46	1,286	16,120	7.98
<b>Luxembourg</b>	2,480	4,161	59.58	9,137	19,008	48.07	99	733	13.51
<b>Macedonia</b>	1,552	1,805	85.98	74,009	74,009	81.20	4,838	7,135	67.81
<b>Malta</b>	158	383	41.25	2,351	7,786	30.20	52	1,279	4.07
<b>Netherlands</b>	40,741	308,574	13.20	54,109	681,617	7.94	519	60,506	0.86
<b>Poland</b>	51,226	270,727	18.92	350,377	2,347,504	14.93	3,029	174,414	1.74
<b>Portugal</b>	73,470	79,429	92.50	536,092	637,427	84.10	26,797	66,423	40.34
<b>Romania</b>	61,854	65,677	94.18	1,053,333	1,166,313	90.31	30,125	46,761	64.42
<b>Slovenia</b>	18,745	23,848	78.60	124,064	176,175	70.42	6,285	18,148	34.63
<b>Slovakia</b>	58,357	61,104	95.50	357,157	437,796	81.58	6,863	63,185	10.86
<b>Spain</b>	322,576	447,415	72.10	1,115,379	1,736,651	64.23	56,018	168,935	33.16
<b>Sweden</b>	152,804	197,809	77.25	407,280	631,140	64.53	12,633	53,681	23.53
<b>UK</b>	399,185	576,651	69.22	1,278,672	2,368,775	53.98	9,524	127,943	7.44

**Notes:** This table reports variables aggregated at country-level when information by industry is available in the ORBIS and the Eurostat datasets. Turnover is expressed in millions of euros. Firms with consolidated accounts are excluded when considering coverage on turnover and number of employees. Data on Ireland, Montenegro, and Serbia, is not available in Eurostat database.

<sup>10</sup>The over-representation for the largest firms in the ORBIS database is well understood. See Ribeiro et al. (2010) and Kalemli-Ozcan et al. (2015) for more details.

<sup>11</sup>Notice that the primary activity code attributed to each firm may differ in ORBIS and Eurostat. While in the latter the criterion of attributing the activity is based on the initial classification of the firm at the time of its set up, ORBIS classification is based on the current production of the firm, therefore a more accurate information.

Table 2: Size distribution number of firms in the sample and in Eurostat (%), year 2013.

Country	Sample					Eurostat				
	0-9	10-19	20-49	50-249	250+	0-9	10-19	20-49	50-249	250+
Austria	3.3	1.4	6.8	48.1	40.3	72.1	11.6	8.7	5.7	1.9
Belgium	10.7	11.2	30.8	36.0	11.3	81.7	7.6	6.1	3.6	1.0
Bosnia-Herz.	60.4	15.5	12.3	9.6	2.2	n/a	n/a	n/a	n/a	n/a
Bulgaria	50.9	18.4	17.4	11.4	1.9	74.8	9.8	8.6	5.8	1.0
Croatia	66.0	14.4	10.2	7.5	1.8	83.7	7.6	4.8	3.1	0.8
Cyprus	17.5	12.4	39.2	25.8	5.2	90.0	5.9	2.7	1.2	0.1
Czech Rep.	41.0	17.0	18.4	18.1	5.5	92.7	2.7	2.3	1.8	0.5
Denmark	7.5	4.7	10.8	43.1	33.9	71.2	12.4	9.0	6.2	1.2
Estonia	65.9	13.0	11.8	8.1	1.1	74.7	9.3	8.7	6.4	0.9
Finland	55.0	15.9	14.4	11.0	3.7	83.8	6.5	5.3	3.5	0.9
France	58.6	14.4	13.5	10.1	3.4	86.8	5.6	4.4	2.6	0.7
Germany	13.3	13.5	20.3	34.8	18.0	61.4	20.4	8.1	8.1	2.1
Greece	35.0	25.4	23.7	12.9	3.0	95.1	2.0	1.6	1.0	0.2
Hungary	17.8	8.6	19.9	40.2	13.5	84.5	6.5	4.8	3.4	0.8
Ireland	17.8	7.9	17.5	36.7	20.0	n/a	n/a	n/a	n/a	n/a
Italy	52.2	23.8	15.4	7.3	1.4	83.0	9.9	4.8	2.1	0.3
Latvia	66.4	13.3	11.3	8.0	1.0	79.9	8.0	6.6	4.9	0.6
Lithuania	12.4	16.5	28.2	34.4	8.5	82.1	7.0	5.9	4.3	0.8
Luxembourg	3.0	3.0	11.0	43.0	40.0	62.6	12.2	12.6	9.7	3.0
Macedonia	72.2	11.6	8.7	6.6	1.0	n/a	n/a	n/a	n/a	n/a
Malta	14.8	6.6	19.7	42.6	16.4	91.1	6.2	0.0	2.7	0.0
Montenegro	67.4	14.7	10.5	5.3	2.1	n/a	n/a	n/a	n/a	n/a
Netherlands	7.1	3.5	11.4	48.7	29.3	85.8	5.8	4.5	3.3	0.6
Poland	28.4	2.3	27.2	29.1	12.9	86.9	4.6	4.2	3.5	0.9
Portugal	61.3	18.0	13.0	6.8	0.9	82.6	8.2	5.8	3.0	0.4
Romania	58.8	15.4	13.9	9.5	2.3	70.6	11.4	9.7	6.7	1.6
Serbia	65.1	14.7	10.4	7.8	2.0	n/a	n/a	n/a	n/a	n/a
Slovenia	74.7	10.5	7.1	6.1	1.5	88.5	5.0	3.2	2.7	0.6
Slovakia	52.2	16.8	14.2	12.9	3.8	94.0	2.2	1.8	1.5	0.4
Spain	63.7	16.8	12.4	5.8	1.2	83.6	8.1	5.5	2.4	0.4
Sweden	57.3	18.1	13.3	8.7	2.7	87.8	5.3	3.9	2.4	0.6
UK	4.9	4.7	15.4	57.7	17.3	76.4	10.3	7.4	4.9	1.1

Notes: This table presents the distribution of firms according to their size in the TFP sample and as reported in Eurostat database. It shows the percentages computed on the total number of firms in each country. Each row sums up to 100% for the two samples. Data on size distribution of firms about Bosnia and Herzegovina, Ireland, Montenegro, Macedonia, and Serbia, is not available in Eurostat database.

Table 3: Sector distribution number of firms in the sample and in Eurostat (%), year 2013.

Country	Sample										Eurostat									
	10-12	13-15	16-18	19-20,22-23	21	24-25	29-30	26-28,31-33	10-12	13-15	16-18	19-20,22-23	21	24-25	29-30	26-28,31-33				
Austria	12.2	3.5	11.2	17.2	2.6	17.9	5.1	30.2	15.2	6.0	15.0	9.1	0.3	15.7	1.6	37.1				
Belgium	18.2	6.0	10.0	21.5	1.8	16.7	2.7	23.1	20.9	5.7	17.3	8.5	0.3	21.6	1.7	24.0				
Bosnia-Herz.	16.9	9.0	25.0	16.2	0.2	16.3	1.7	14.7	16.8	8.9	25.9	16.0	0.2	15.9	1.4	14.9				
Bulgaria	18.0	14.9	12.8	14.5	0.3	14.0	0.8	24.8	19.4	18.2	11.7	12.1	0.2	12.6	0.6	25.1				
Croatia	16.9	7.2	16.1	14.4	0.3	17.3	2.7	25.2	15.7	8.7	17.5	13.5	0.2	17.0	2.1	25.4				
Cyprus	30.9	2.1	12.4	21.6	4.1	9.3	2.1	17.5	17.2	6.2	23.9	9.0	0.2	23.6	1.6	18.4				
Czech Rep.	8.9	4.7	11.5	13.6	0.4	23.9	3.5	33.4	5.0	8.5	22.2	7.0	0.1	26.0	1.0	30.2				
Denmark	20.1	3.0	8.0	13.4	3.0	11.2	2.6	38.7	10.5	4.9	9.9	8.4	0.6	19.9	1.8	44.0				
Estonia	9.1	11.8	21.4	7.9	0.1	19.0	2.0	28.6	7.7	12.1	23.3	8.5	0.2	18.4	2.0	27.9				
Finland	8.3	3.8	14.1	11.0	0.3	26.8	3.2	32.5	8.1	9.2	15.4	7.6	0.1	22.6	2.9	34.1				
France	28.7	4.7	10.4	9.9	0.6	16.1	2.5	27.0	26.8	8.4	14.6	7.2	0.2	9.9	1.3	31.8				
Germany	7.4	3.2	9.0	15.2	1.4	23.2	3.9	36.8	14.6	3.7	12.4	10.1	0.3	22.3	1.8	34.7				
Greece	28.6	9.4	9.4	20.4	1.7	12.3	1.4	16.8	26.7	15.5	10.8	8.9	0.2	14.7	0.7	22.5				
Hungary	19.3	4.6	8.2	17.1	1.2	19.3	5.5	24.7	14.0	9.1	15.0	9.4	0.2	17.2	1.5	33.8				
Ireland	9.0	3.8	8.5	14.5	11.0	9.0	2.7	41.4	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Italy	9.3	12.5	8.6	13.0	0.4	22.7	2.6	30.9	14.2	15.0	12.6	8.8	0.1	17.0	1.2	31.2				
Latvia	11.3	10.5	28.3	10.8	0.4	12.5	1.3	24.7	10.2	16.9	25.9	9.1	0.3	10.7	1.2	25.7				
Lithuania	15.5	9.9	17.3	14.5	0.2	12.5	2.0	28.0	9.2	20.8	23.0	11.1	0.1	9.2	0.6	26.0				
Luxembourg	12.0	3.0	8.0	24.0	1.0	22.0	3.0	27.0	19.4	4.2	14.5	9.5	0.1	24.1	1.5	26.6				
Macedonia	19.6	18.5	15.6	13.2	0.1	12.3	0.6	20.1	21.5	17.7	14.2	11.9	0.1	12.2	0.5	21.9				
Malta	23.0	4.9	6.6	18.0	8.2	4.9	8.2	26.2	19.5	1.8	10.2	11.0	0.0	17.9	0.6	39.1				
Montenegro	32.6	5.3	16.8	11.6	1.1	16.8	0.0	15.8	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Netherlands	16.6	3.7	7.1	22.2	4.4	9.6	4.2	32.2	9.3	7.9	11.7	7.2	0.3	18.6	3.7	41.3				
Poland	16.1	5.7	10.9	19.2	1.1	18.2	3.6	25.1	7.3	10.6	15.6	11.0	0.2	17.2	1.3	36.8				
Portugal	16.7	21.3	12.5	10.7	0.3	18.2	1.5	18.7	16.0	22.5	13.1	8.8	0.2	18.1	1.4	19.9				
Romania	19.4	14.7	16.4	12.9	0.3	13.6	2.0	20.7	18.3	15.4	17.1	12.9	0.3	12.8	1.8	21.3				
Serbia	19.4	10.0	16.6	14.9	0.4	14.6	2.3	21.8	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Slovakia	10.5	6.6	14.6	14.0	0.3	24.3	2.7	27.1	4.4	8.7	20.4	6.9	0.0	38.6	0.5	20.5				
Slovenia	7.5	5.6	17.1	12.6	0.2	26.3	1.9	28.9	10.7	6.9	18.2	10.0	0.1	23.6	1.5	29.1				
Spain	17.4	8.5	13.9	13.6	0.4	20.4	2.2	23.7	16.1	11.3	15.5	9.6	0.2	21.5	1.4	24.4				
Sweden	9.5	2.8	14.4	9.8	0.6	27.5	4.2	31.3	7.2	8.6	16.7	8.3	0.3	21.1	3.7	34.3				
UK	11.6	4.2	8.2	14.7	2.2	15.1	4.6	39.4	6.4	6.1	17.1	9.4	0.4	20.2	3.6	36.8				

Notes: This table presents the distribution of firms according to the main sector they belong to, in the TFP sample and as reported in Eurostat database. It shows the percentages computed on the total number of firms in each country for classes of sectors at 2-digit NACE rev. 2 (see Table A1 in the Tables and Graphs Appendix A for the corresponding sector name). Each row sums up to 100% for the two samples. Data on sector distribution of firms about Ireland, Montenegro and Serbia is not available in Eurostat database.

## 3.2 Total factor productivity estimation

### 3.2.1 Deflation and international comparability

To analyse and compare the TFP estimations over time, across countries and industries, we deflate nominal values of variables necessary for the computation and hence report all values in a common real currency-year. First, we convert variables in ORBIS from euros to local currencies at the end of the year for countries outside the Eurozone in each period.<sup>12</sup> Then, following Smarzynska Javorcik (2004), we separately deflate output, intermediate inputs, and capital using 2-digit industry producer price index (PPI) for each country-year, with the base year 2010. In particular, the output which refers to turnover is deflated using the total PPI of the focal industry from Eurostat and World Bank (WDI). Capital, that is defined as the value of fixed assets at the beginning of the year, is deflated by the simple average of the deflators for the following 2-digit NACE rev. 2 industries: 26, *Manufacture of computer, electronic and optical products*; 27, *Manufacture of electrical equipment*; 28, *Manufacture of machinery and equipment n.e.c.*; 29, *Manufacture of motor vehicles, trailers and semi-trailers*; 30, *Manufacture of other transport equipment*.

Intermediate inputs, corresponding to material costs, are deflated by the intermediate inputs' deflator that is calculated as the weighted average of PPI of the supplying industries, with technical coefficients (expenditure shares of input industries) as weights retrieved from the WIOD input-output tables (2016 Release).<sup>13</sup> In fact, these weights are representing the proportion of inputs sourced from a given sector.

We deal with missing PPI in several ways, after checking the availability in National Statistic Office tables: if the data are missing for the whole industry, we use the more aggregated PPI on manufacturing; if the data is missing for one or more years, we interpolate using the closest years; if it is not possible to construct the deflator for material cost, we use the aggregate PPI on intermediate goods; also, some adjustments for specific industries' aggregations are done to correspond to WIOD industry groups (e.g. we use NACE 31-32 in WIOD for the aggregation 31-33 in PPI).

Finally, we convert back the deflated variables in the domestic currency to euro, using the relevant exchange rate of the (base) year 2010. This procedure ensures that the change in prices does not distort the level and the growth of TFP.

### 3.2.2 The 'continental' approach and preliminary evidence

Exploiting the unique dataset of 567,405 manufacturing firms from 32 European countries, including the EU28 plus the Western Balkans, for the period 2007-2015, we estimate firm-level total factor productivities applying the most recent econometric techniques.<sup>14</sup> For each firm  $i$  in industry  $j$  (at 2-digit NACE rev.2) located in country  $c$  at time  $t$ , we estimate TFP by industry  $j$  across the whole sample. While there is an ongoing debate about the most appropriate estimating approach of TFP, we rely on firm-level

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<sup>12</sup>The values of the variables in ORBIS are expressed in euro currency at market exchange rate, at the end of the corresponding year.

<sup>13</sup>The extended World Input-Output Database (WIOD) covers 28 EU countries and 15 other major countries in the world for the period 2000-2014. All the details are offered in Timmer et al. (2016). For the year 2015, which is part of our study, we use the weights of 2014.

<sup>14</sup>There is a general consensus on the broad definition of TFP which considers TFP as the efficiency of a firm to turn inputs of production such as capital, labour, and intermediate inputs into products (Hulten, 2001; Katayama et al., 2009; Van Beveren, 2012). According to this literature, the productivity of an individual firm is measured relative to the average ability of all comparable firms within the industry (and/or within a region). The benchmark efficiency and technological level across firms are therefore corrected using econometric techniques.

As for the first time noted in Marschak and Andrews (1944) when a firm chooses the number of inputs according to its productivity, not observable by the econometrician, OLS estimation introduces a simultaneity bias. Furthermore, a selection bias emerges in case a firm decides to enter or exit the market according to its observed level of productivity (Olley and Pakes, 1996). More recently, other important issues emerge from empirical applications. Klette and Griliches (1996) demonstrate how price-induced measurement error can bias the production function estimates, generating an omitted price bias. Eventually, Collard-Wexler and De Loecker (2016) face the measurement error in the capital coefficient, arising from severe errors in recording producer's capital stock.



productivities computed using the production function elasticities estimated with the semi-parametric technique proposed by Akerberg et al. (2015) (ACF hereafter).<sup>15</sup>

We calculate factor elasticities for each industry on a ‘continental’ (Wider Europe) scale to assess the competitiveness of firms horizontally across national borders. In the integrated framework of a Single Market, characterised by increasing economic integration, competitive pressure is usually thought to have a diverse impact on productivity as it is referred in the literature of economic geography (Beaudry and Schifffauerova, 2009). For instance, for the Italian firm "PARMALAT s.p.a." the 2013 productivity computed using elasticities at the country-industry level is quite close to the mean of its industry, while using ‘continental’ estimations it is among the top productive firms within industry NACE 10. This indicates that the Italian manufacturers of food with very high productivity are in general more competitive than other manufacturers in the Wider Europe.

On the contrary, the English firm "LUSH LTD.", operating in industry NACE 20, in 2013 is more productive than the average of its peers using country-industry level elasticities, while using ‘continental’-industry elasticities it is below the European average. This suggests that while this firm is a very competitive producer of chemicals within England, it is not very highly productive in the Wider Europe beside other competitors in the industry. In this context, empirical evidence suggests that looking at firms across all countries provides more insightful information on the position of a country industry’s competitiveness (Altomonte et al., 2010), especially within a Single Market such as the EU.

Table 4 reports the descriptive statistics of the firm-level TFP in logarithm estimated using the ACF method. The most remarkable feature is the overall dispersion of productivity, measured by the inter-quartile range (IQR), in line with the empirical literature reviewed by Bartelsman and Doms (2000) and Syverson (2011).

Table 4: Descriptive statistics of TFP (in log) distribution using ACF, 2007-2015.

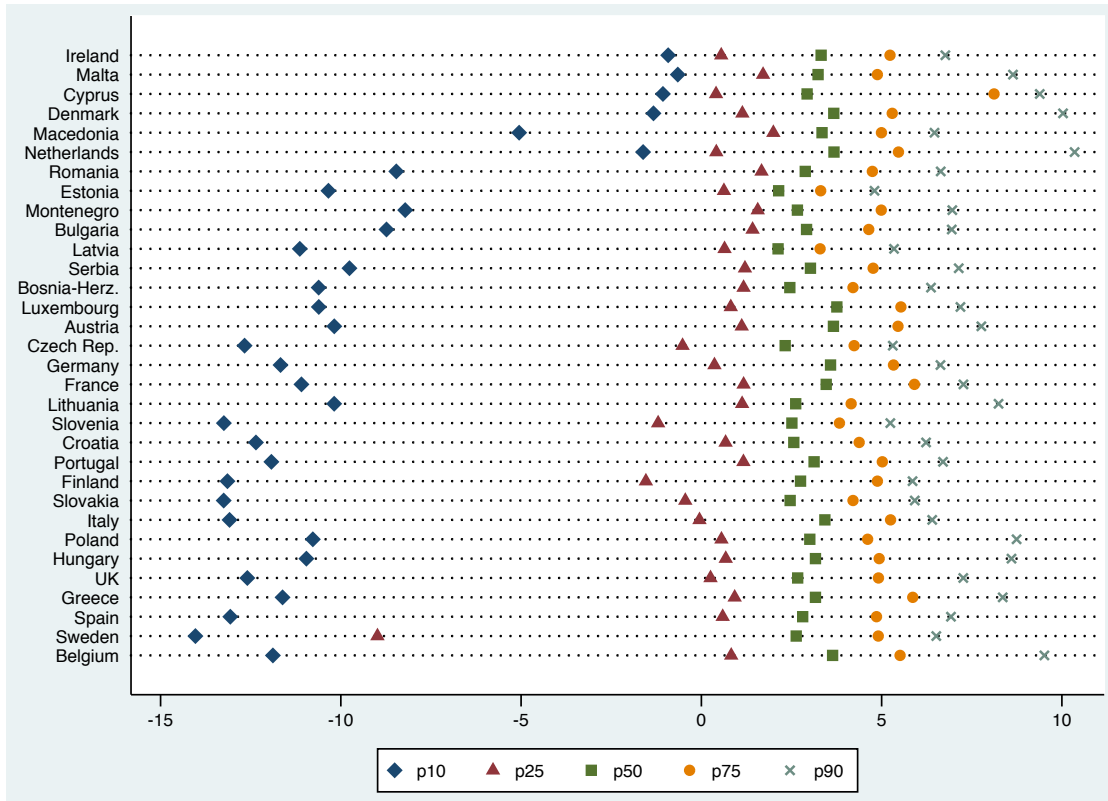
	Mean	Median	sd	IQR	Observations
<b>Akerberg-Caves-Franzer</b>	0.91	2.99	6.73	4.40	3,010,154

Figure 1 shows the percentiles of the firm-level log TFP by country. Heterogeneity in firm performance is widely spread across countries in the sample, and it is linked to some extent to the heterogeneity in the size of firms observed within industries (Bartelsman et al., 2013). Nevertheless, there are some empirical regularities. For instance, the median value of productivity is quite similar across countries, and the distance between the 25<sup>th</sup> and the 10<sup>th</sup> percentile is in most cases high, meaning that there are few firms in each country with productivity close to zero which is in line with the under-representation of micro firms in our sample. On the other hand, if we look at the 90<sup>th</sup> percentile only Denmark and Netherlands exhibit high firm-level productivity.

Firms are heterogeneous along many dimensions and their distributions have power-law right tails. Our case is slightly more sophisticated. Take the case of Figure 2, where we compare an assumed normal (Gaussian) distribution with the same average of the actual distribution that we find for the TFP of EU firms. At first glance, we observe an asymmetric bimodal distribution. In other words, there are two different sets of firms. On the left side of the actual TFP distribution, there is a bunch of firms significantly less productive than the ones on the right side of the distribution, yet active on the market

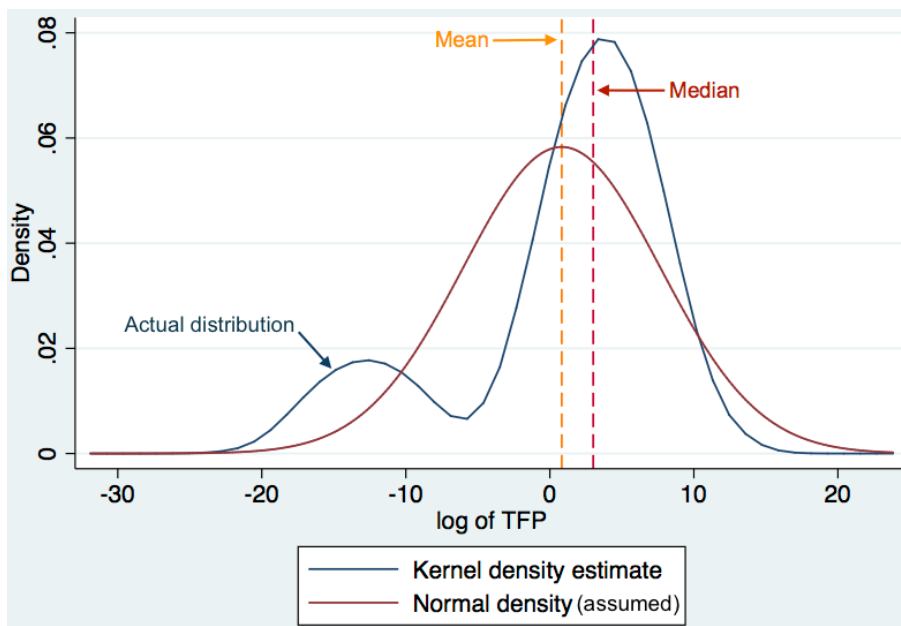
<sup>15</sup>ACF argue that the optimal labour allocation is also a deterministic function of TFP and therefore the elasticity of labour is not identified using the semi-parametric estimator of Olley and Pakes (1996). A solution is the identification of the labour coefficient in a second stage, assuming a conditional intermediate inputs demand function. Also, Wooldridge (2009) propose an advantageous approach to circumvent the identification problem by estimating all the coefficients in a single GMM step and using earlier outcomes of both capital and variable inputs as instrumental variables. However, although the latter is robust to the ACF critique and more efficient with respect to a two-step estimation, in our sample, the short time span lead us to implement the ACF method.

Figure 1: Percentiles (log) TFP by country



**Notes:** This Figure shows the firm-level total factor productivity percentiles for each country in the sample. Countries are presented in ascending order according to the difference between the 90<sup>th</sup> and the 10<sup>th</sup> percentile.  
**Source:** Own elaboration.

Figure 2: Total factor productivity distribution of EU manufacturing firms.



**Source:** Own elaboration.

and far from going bankrupt, like in a world apart. Such a polarisation in productivity on a ‘continental’ level is unexplained, and its origin is not the object of study of the present contribution. In the context of our exercise, we note that the average effect of ERDF financial support on firms’ productivity growth could deliver a distorted picture of what really happens on the field.

To better understand firm-level dynamics, Figure A.1 in Tables and Graphs Appendix A compares the firm-level distributions of TFP at the beginning and the end of the period under investigation. For most countries, the distribution remains unchanged between the two years with the overall tendency towards a high concentration of low productivity firms. Eventually, the shape of the TFP distribution differs across countries, reflecting their structural characteristics.

### 3.3 Regional policy data

We retrieve data on regional policy funding from the report ‘Geography of Expenditure - Work Package 13’ prepared for the European Commission in 2015 (wiiw and ISMERI EUROPA, 2015). The report studies the cumulative allocations to selected projects and the expenditures of European Regional Development Funds (ERDF) and Cohesion Fund (CF) over the programming period 2007-2013 for all 28 EU countries. Most of the transfers are assigned at the NUTS-2 level.<sup>16</sup> Overall, the *Structural funds Programme* distinguishes transfers by objectives: Convergence (Objective 1), Regional competitiveness and employment (Objective 2), and European territorial cooperation (Objective 3). We restrict our analysis to the Objective 1 which aims at accelerating the economic development of lagging EU regions and it accounts for more than two-thirds of the programme’s total budget. The objective covers regions whose GDP per capita in PPP is less than 75% of the EU average. In this work, we focus on the ERDF established in 1975, in particular on two thematic areas which may have a direct impact on firm’s productivity: Business Support, and Research, Technology and Development (RTD).

Figure 3 provides insights on the distribution of payments across NUTS-2 regions for the two priorities mentioned above. The total value of projects subsidised over the whole programming period 2007-2013 by the ERDF Business Support summed up to roughly EUR 21 billion, compared to EUR 35 billion from the ERDF RTD. In a regional approach, the amount of transfers for Business Support varied from EUR 53,987 in Schwaben (Germany) to over EUR 842 million in Andalusia (Spain), with an average of about EUR 82 million per region. Financial aid for research, technology and development ranges from EUR 295,576 in South East England to more than EUR 1.5 billion in the Warsaw region (Poland). On average, every region received EUR 132 million for projects involved in innovation and development activity. In the populous and usually rich regions such as those in England, Belgium, the Netherlands, parts of Germany, Austria and Northern Italy, ERDF payments usually do not exceed 0.1% of the regional GDP over the entire period of financing. The regions with the highest ERDF payments as a share of regional GDP are Észak-Magyarország in Hungary with 0.54% (ERDF Business Support) and Alentejo in Portugal with 0.47% (ERDF RTD), respectively.

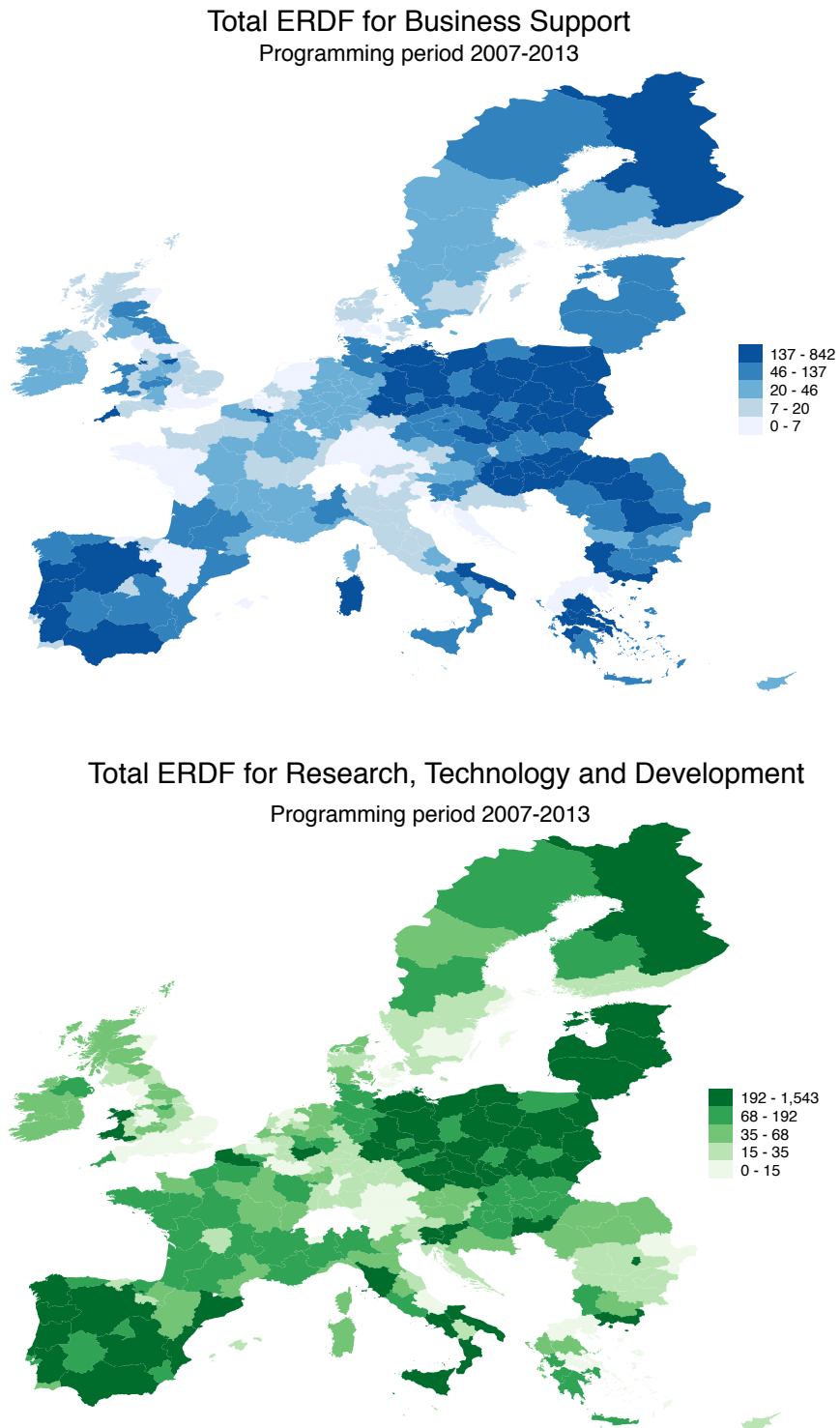
We combine the regional policy data on ERDF with the firm-level data for which we are able to estimate total factor productivity and to identify a firm’s location by postal codes and then corresponding it to NUTS-2 regions using concordance tables from Eurostat.<sup>17</sup> It is important to note that while the programme’s commitment is in the period 2007-2013, the allocation of funds usually takes 1-2 years longer ending in 2015 for some regions. Moreover, there are some overlaps of the allocated funds from the previous programme in the period 2000-2006. However, there are some disparities in the priorities

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<sup>16</sup>NUTS is the acronym for *Nomenclature des Unités Territoriales Statistiques* and it is a hierarchical system to for dividing the economic territory of the EU. The highest level of aggregation (NUTS-1) corresponds to major socio-economic regions (e.g. the United Kingdom’s regions of England/Scotland/Wales); NUTS-2 refers to basic regions for the application of regional policies (e.g. Italian regions); and NUTS-3 identifies small regions for specific diagnosis (e.g. *Départements* in France).

<sup>17</sup><http://ec.europa.eu/eurostat/tercet/flatfiles.do>

Figure 3: Payments by NUTS-2 region from the European Regional Development Fund.



**Note:** Values in EUR million.

**Source:** 'Geography of Expenditure – Final Report, Work Package 13', wiiw and ISMERI EUROPA, 2015, own elaboration.

of the two programs. Here we mainly focus on the allocated funds in the program 2007-2013, while the results of the analysis are consistent even after including the total overlapped funds of the two programs, the results of which are available upon request.

## 4 Empirical strategy

Our contribution aims at investigating the short-term impact of regional policy spendings on the firm-level TFP growth for the 28 EU member states for the period 2007-2015. We make our results robust to the Heckman (1976, 1979) correction accounting for the sample selection on size in our sample.<sup>18</sup> We use maximum likelihood estimation using the following equations.

The outcome equation is:

$$\Delta(tfpi_{ijrt}) = \beta_0 + \beta_1 tfpi_{ijr,t-1} + X_{ijrt}\beta + Z_{jrt}\beta + R_{rt}\beta + \delta_t + \mu_{ijrt} \quad (1)$$

where the dependent variable  $\Delta(tfpi_{ijrt})$  is the growth of total factor productivity<sup>19</sup>, in logarithm, of firm  $i$  operating in industry  $j$  located in region  $r$  at time  $t$ . On the other side of the equation, we include the TFP level at time  $t-1$ , testing for the absolute conditional convergence and the main variables of interest contained in  $R_{rt}$ , i.e. the ERDF fund of categories Business Support and RTD. Then, we refine this specification adding some control variables at firm, industry and regional level. In particular, at the firm-level, in  $X_{ijrt}$  we include the number of employees and the size based on turnover. Among the industrial covariates grouped in  $Z_{jrt}$ , we also test the impact of agglomeration, specialization, diversification and competition externalities.<sup>20</sup> Whereas, regional GDP and the percentage of the regional population aged between 25 and 64 in education levels 3-4 and 5-8, contained in  $R_{rt}$ , capture regional peculiarities that may affect the TFP growth. Moreover, we include time dummies and we cluster by region.

The dependent variable  $\Delta(tfpi_{ijrt})$ , however, is not always observed. Missing information on one of the variables needed for the estimation of TFP leads to the exclusion of some firms from the final analysis. Therefore, we use a selection equation to estimate whether a firm is included in the sample for which TFP was computed. The selection equation is the following:

$$Y_{ijrt} = \beta_0 + W_{ijrt}\beta + \varepsilon_{ijrt} \quad (2)$$

where we assume that

$$\begin{aligned} \mu_{ijrt} &\sim N(0, \sigma) \\ \varepsilon_{ijrt} &\sim N(0, 1) \\ \text{corr}(\mu_{ijrt}, \varepsilon_{ijrt}) &= \rho \end{aligned}$$

We denote whether or not we observe the value of the depend variable  $\Delta(tfpi_{ijrt})$  in the outcome equation (1) by a binary variable, i.e.,  $Y_{ijrt}$ . In fact, the observation of the dependent variable  $\Delta(tfpi_{ijrt})$ , when  $Y_{ijrt} = 1$ , is a function of the value of the selection equation in (2), which relates a latent variable  $Y_{ijrt}$  to some observed characteristics  $W_{ijrt}$ . The latter is a set of time varying firm variables including:  $age_{ijrct}$ , a variable computed as the observation year (2015) minus the registered start year;  $size_{ijrt}$  representing the firm's size according to the turnover amount;  $foreign_{ijr}$ , a dummy variable which distinguishes domestic from foreign firms; and  $\varepsilon_{ijrt}$ , the error term.

<sup>18</sup>For instance, young firms might not be experienced enough to afford the publication of their complete financial statements. Due to high economies of scale at the firm-level relative to plant-level, multinational enterprises (MNE) might have incentives to produce and offer detailed financial accounting in the headquarters instead of their subsidiaries, reducing the probability of detailed financial statements at the subsidiaries. Legislation on providing complete statements to the designated authorities could be very diverse across countries with different business legal environments. Aforementioned could also lead to the heterogeneity in firm's size for reporting. This heterogeneity could be even more diverse across industries and years.

<sup>19</sup>We use total factor productivities computed following the semi-parametric techniques proposed by Akerberg et al. (2015).

<sup>20</sup>Based on the economic geography literature, knowledge spillovers can impact upon productivity when economic agents are located nearby from each other. For the details about the construction of these measures of externality see the Data Appendix B.

## 5 Results

Table 5: Heckman selection model for TFP.

Dep. Var.: $\Delta(tfp_{ijrt})$	(1)	(2)	(3)	(4)	(5)	(6)	(7)
<i>tfp<sub>ijrt,t-1</sub></i>	-0.0092*** (0.00074)	-0.0091*** (0.00074)	-0.0092*** (0.00074)	-0.0092*** (0.00074)	-0.010*** (0.0010)	-0.010*** (0.0010)	-0.0092*** (0.0010)
<b>ERDF Business support</b>	0.00093*** (0.00034)	0.00069* (0.00038)	-0.000087 (0.00030)	-0.000074 (0.00029)	-0.0015*** (0.00050)		
<b>ERDF Business support<sub>t-1</sub></b>						-0.0017*** (0.00051)	
<b>ERDF Business support<sub>t-2</sub></b>							-0.0016 (0.00099)
<b>ERDF RTD</b>	-0.00066 (0.00055)	0.00013 (0.00063)	0.00072 (0.00055)	0.00046 (0.00056)	0.0012* (0.00069)		
<b>ERDF RTD<sub>t-1</sub></b>						0.0017** (0.00068)	
<b>ERDF RTD<sub>t-2</sub></b>							0.0014 (0.0011)
<b>Firm size</b>	0.0041*** (0.00062)	0.0041*** (0.00061)	-0.0069*** (0.0019)	-0.0073*** (0.0020)	-0.0071*** (0.0021)	-0.0070*** (0.0021)	-0.0050** (0.0022)
<b>N. of employees</b>			0.017*** (0.0023)	0.018*** (0.0024)	0.020*** (0.0023)	0.020*** (0.0023)	0.019*** (0.0024)
<b>Regional gdp in millions Euro</b>				0.00037 (0.0014)	0.0053*** (0.0018)	0.0050*** (0.0018)	0.0039* (0.0020)
<b>% Aged 25-64 (Education levels 3-4)</b>				-0.00021** (0.000090)	-0.00029* (0.00016)	-0.00027* (0.00016)	-0.00033* (0.00019)
<b>% Aged 25-64 (Education levels 5-8)</b>				-0.000074 (0.00014)	0.00012 (0.00019)	0.00014 (0.00019)	0.00014 (0.00020)
<b>Agglomeration</b>					-0.0039** (0.0016)	-0.0038** (0.0016)	-0.0035** (0.0016)
<b>Specialization</b>					-0.013 (0.071)	-0.013 (0.071)	-0.073 (0.065)
<b>Diversification</b>					-0.11 (0.098)	-0.11 (0.096)	-0.12 (0.13)
<b>Competition</b>					-0.035 (0.023)	-0.034 (0.023)	-0.018 (0.021)
<b>Constant</b>	-0.049*** (0.011)	-0.044*** (0.012)	0.067*** (0.026)	0.080*** (0.022)	0.035 (0.031)	0.030 (0.031)	0.024 (0.044)
<b>Dep. Var.: <math>Y_{ijrct} = 1</math></b>							
<b>Firm size</b>	-0.0081 (0.0057)	-0.0081 (0.0057)	-0.0081 (0.0057)	-0.0082 (0.0057)	-0.011 (0.0084)	-0.011 (0.0084)	-0.016* (0.0096)
<b>Firm age</b>	0.37*** (0.015)	0.37*** (0.015)	0.37*** (0.015)	0.37*** (0.015)	0.37*** (0.016)	0.37*** (0.016)	0.47*** (0.018)
<b>Foreign</b>	-0.020* (0.011)	-0.020* (0.011)	-0.020* (0.011)	-0.019* (0.011)	-0.022 (0.013)	-0.022 (0.013)	-0.017 (0.015)
<b>Constant</b>	-0.090 (0.070)	-0.090 (0.070)	-0.090 (0.070)	-0.091 (0.070)	-0.19 (0.12)	-0.19 (0.12)	-0.56*** (0.14)
<b>athrho</b>	0.023*** (0.0063)	0.022*** (0.0064)	0.024*** (0.0064)	0.025*** (0.0065)	0.029*** (0.0075)	0.029*** (0.0075)	0.027*** (0.0084)
<b>lnsigma</b>	-0.29*** (0.022)	-0.29*** (0.022)	-0.29*** (0.022)	-0.29*** (0.022)	-0.27*** (0.023)	-0.27*** (0.023)	-0.34*** (0.024)
<b>Observations</b>	2,550,874	2,550,874	2,550,874	2,546,056	2,120,853	2,120,853	1,771,665
<b>NUTS-2 regions</b>	273	273	273	273	273	273	273
<b>Log likelihood</b>	-3524182.4	-3523697.2	-3523341.7	-3517316.6	-2942606.2	-2942605.1	-2317468.8
<b>Rho</b>	0.023	0.022	0.024	0.025	0.029	0.029	0.027
<b>Sigma</b>	0.75	0.75	0.75	0.75	0.76	0.76	0.71
<b>Lambda</b>	0.017	0.017	0.018	0.019	0.022	0.022	0.019
<b>Wald chi2</b>	13.6 (1)	12.0 (1)	13.9 (1)	15.1 (1)	15.0 (1)	15.0 (1)	10.5 (1)
<b>Prob&gt;chi2</b>	0.00022	0.00053	0.00020	0.00010	0.00011	0.00011	0.0012
<b>Year dummies</b>	NO	YES	YES	YES	YES	YES	YES

Cluster by region. Robust standard errors in parentheses \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

Table 5 reports the benchmark results. Overall, we confirm the presence of sample selection in our sample. In particular, results show that the firm’s age positively affects the probability of being in the TFP sample. Moreover, we find evidence of conditional absolute convergence in productivity across our population of firms. In other words, the statistically significant negative coefficient of the lag of firm’s TFP (in logarithm) would indicate that a representative firm with 1% lower TFP in the previous period should have about 0.01% higher TFP growth in the current period.

Then, the Business Support category lagged by one period have a negative and significant (at the 1% level) short-term effect on productivity growth. Interestingly, after introducing regional variables, the coefficient of Business Support by ERDF becomes negative. A possible explanation is that the positive impact is through regional developments rather than direct impact on the firm. Moreover, looking at the priority themes of this funding, it may be the case that EU investments enhance environmental quality stimulating sustainable production which does not necessarily boost firm’s sales or TFP. As mentioned earlier, this result is robust using the previous allocation of this priority in the estimation. Conversely, we find a positive and significant coefficient of RTD by ERDF, at the 10% level in the current period and at the 5% for one year lag. In fact, firms receive payments throughout the year, so their effects on firms’ performance may become clear in the forthcoming years.

Firm size proxied by the turnover correlates negatively with productivity. On the contrary, the coefficient of the number of employees suggests that the growth of TFP is higher for larger firms. In fact, a 1% increase in the employment of the firm leads to about 0.02% higher growth of the TFP. Moreover, we note that the growth of productivity in richer regions as per their GDP is higher. Other regional characteristics, such as the percentage of people aged 25-64 with education levels 3-4 and 5-8 are not significant.

Besides, the coefficient of *Agglomeration* is negative and significant at 5%, meaning that the higher is the geographical concentration of an industry in terms of total employment, the lower is the growth of the firm productivity in that regional industry. This attains similar results to the seminal work by Glaeser et al. (1992) over the US cities and the study by De Lucio et al. (2002) over the Spanish regions that agglomeration hinders the growth of regional industries.

We explore the robustness of the main findings across the percentiles of the distribution of TFP. In fact, the distribution that we find for the TFP of EU firms suggests that the *average effect* of ERDF financial support on firms’ productivity growth could deliver a distorted picture of what really happens on the field. Table 6 shows that the strongest impact of regional policy financing is on firms within the 25<sup>th</sup> percentile, while at the 99<sup>th</sup> percentile the coefficients reduce and lose significance. That is, already efficient firms are not affected by ‘cohesion policy’, whereas low-performing firms seem to experience a downturn in productivity in regions where a significant share of funds is allocated to the category Business Support. By contrast, improvements are observed in the performance of firms with a low initial productivity level when we focus on the share of spending according to the RTD criteria. In addition, we observe that in some percentiles regional-industrial market structures measured as the knowledge spillovers externalities based on the literature on economic geography matter for the growth of TFP. The coefficient of *Agglomeration* is negative and significant at the 95<sup>th</sup> and 99<sup>th</sup> percentiles. Also, the employment density of an industry in the region, i.e. *Specialisation*, decreases the TFP growth up to the 95<sup>th</sup> percentile.

Indeed, the industrial mix within a region, i.e. *Diversification* of other industries in the region, suggests that less industrial diversity is likely to improve the growth of firm productivity positively. This result contradicts the theory of Jacobs (1969) that diversification of various industries resulting in urbanisation potentially fosters the growth of cities. However, it is attaining the results of empirical studies by Glaeser et al. (1992), and by van der Panne and van Beers (2006) on local industrial innovation in the Netherlands.

Table 6: Robustness of findings across the percentiles of the TFP distribution.

Dep. Var.: $\Delta(tfp_{ijrt})$	p25	p50	p75	p90	p95	p99
$tfp_{ijrt,t-1}$	-0.075*** (0.0053)	-0.032*** (0.0035)	-0.020*** (0.0022)	-0.013*** (0.0013)	-0.012*** (0.0011)	-0.010*** (0.0010)
ERDF <i>Business support</i>	-0.018*** (0.0047)	-0.0069*** (0.0015)	-0.0041*** (0.00089)	-0.0024*** (0.00065)	-0.0020*** (0.00057)	-0.0017*** (0.00051)
ERDF <i>RTD</i>	0.014** (0.0061)	0.0067*** (0.0021)	0.0044*** (0.0012)	0.0023*** (0.00088)	0.0016** (0.00077)	0.0014* (0.00072)
Firm size	-0.14*** (0.016)	-0.050*** (0.0066)	-0.024*** (0.0039)	-0.013*** (0.0026)	-0.012*** (0.0024)	-0.0081*** (0.0022)
N. of employees	0.22*** (0.016)	0.087*** (0.0078)	0.046*** (0.0042)	0.026*** (0.0029)	0.024*** (0.0026)	0.021*** (0.0024)
Regional gdp in millions Euro	0.049* (0.025)	0.013 (0.0080)	0.0034 (0.0034)	0.0072*** (0.0020)	0.0074*** (0.0020)	0.0057*** (0.0019)
% Aged 25-64 (Education levels 3-4)	0.0015 (0.0019)	0.00040 (0.00053)	-0.00033 (0.00026)	-0.00026 (0.00021)	-0.00030 (0.00018)	-0.00031* (0.00016)
% Aged 25-64 (Education levels 5-8)	0.0023 (0.0027)	0.0022*** (0.00078)	0.00047 (0.00034)	0.000093 (0.00023)	0.000098 (0.00021)	0.000084 (0.00019)
Agglomeration	0.0065 (0.0052)	-0.00031 (0.0026)	-0.00081 (0.0017)	-0.0019 (0.0015)	-0.0037** (0.0017)	-0.0041** (0.0017)
Specialization	-9.36*** (1.32)	-4.83*** (0.80)	-2.60*** (0.44)	-0.78*** (0.17)	-0.32*** (0.11)	-0.065 (0.078)
Diversification	3.07*** (1.04)	1.34*** (0.46)	0.68*** (0.26)	0.16 (0.15)	0.017 (0.12)	-0.11 (0.10)
Competition	-1.17*** (0.28)	0.040 (0.051)	-0.088** (0.038)	-0.073*** (0.028)	-0.057** (0.027)	-0.040* (0.024)
Constant	0.74** (0.37)	0.35*** (0.10)	0.27*** (0.059)	0.098** (0.040)	0.082** (0.036)	0.049 (0.032)
Dep. Var.: $Y_{ijrct} = 1$						
Firm size	-0.015* (0.0089)	-0.016* (0.0081)	-0.011 (0.0078)	-0.012 (0.0085)	-0.012 (0.0085)	-0.011 (0.0085)
Firm age	0.37*** (0.019)	0.38*** (0.018)	0.37*** (0.017)	0.37*** (0.016)	0.37*** (0.016)	0.37*** (0.016)
Foreign	0.011 (0.015)	-0.019 (0.015)	-0.013 (0.014)	-0.021 (0.014)	-0.024* (0.014)	-0.023* (0.013)
Constant	-0.13 (0.12)	-0.13 (0.11)	-0.19* (0.11)	-0.19 (0.12)	-0.19 (0.12)	-0.19 (0.12)
athrho	-0.059** (0.024)	-0.025** (0.012)	-0.014* (0.0072)	0.013* (0.0066)	0.023*** (0.0071)	0.027*** (0.0073)
Insigma	0.22*** (0.024)	-0.045** (0.022)	-0.20*** (0.023)	-0.25*** (0.023)	-0.27*** (0.023)	-0.28*** (0.023)
Observations	534,931	1,060,596	1,591,248	1,908,476	2,014,633	2,099,649
NUTS-2 regions	273	273	273	273	273	273
Rho	-0.059	-0.025	-0.014	0.013	0.023	0.027
Sigma	1.25	0.96	0.82	0.78	0.77	0.76
Lambda	-0.073	-0.024	-0.011	0.0099	0.017	0.020
Log likelihood	-935435.5	-1648000.3	-2297321.7	-2676388.3	-2803628.5	-2907369.3
Wald chi2	5.77 (1)	4.26 (1)	3.73 (1)	3.67 (1)	10.2 (1)	13.4 (1)
Prob>chi2	0.016	0.039	0.053	0.055	0.0014	0.00025

Year dummies in all regressions. Cluster by region. Robust standard errors in parentheses \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .



Finally, we find that competition measured as the inverse of average employment at local units within the regional industry has a negative and statistically significant impact on low-performing firms.

## 6 Conclusions

In this contribution, we introduce a novel firm-level total factor productivity database, where a ‘continental’ approach is adopted in the estimations by industry across the Wider Europe, including the EU28 plus the Western Balkan countries. We find empirical evidence of heterogeneity in firm performance in all countries, regions, and within industries, confirming the existence of considerable dispersion that is well-documented and widely accepted in the corresponding literature.

When discussing policy-making in Europe, the tendency is to refer to aggregate country-, region- or industry-level data as these are easier to calculate, understand, and finally communicate (Altomonte et al., 2012). However, there are actually firms that shape the aggregate statistics through their daily activity of investing, producing, selling and exporting. The last decade of empirical studies on firm-level data shows how no ‘average’ firm within an industry, a region or a country can represent the aggregates (among others, see for example Mayer and Ottaviano (2008)). Firms are heterogeneous along many dimensions, and their distributions have power-law right tails.

Therefore, we enrich the empirical literature with an assessment of the impact of regional policies mandated at the EU level on the productivity of firms. European Regional Development Fund (ERDF) for Business Support, and Research, Technology, and Development (RTD) are the relevant priorities that we take into consideration as main policy variables affecting firm-level TFP growth in the EU. Results show that financing of ‘cohesion policy’ (ERDF) aimed at direct investments in R&D correlates with improvement of firms’ productivity in a region during the period 2007-2015. Conversely, funding designed at overall Business Support correlates with negative productivity growth rates. This might indicate that these funds are not efficiently allocated to the firms with prosperous future. In fact, those funds could be directed to the inefficient firms as their potential saviours. In both cases, we registered an asymmetric impact along the firms’ productivity distributions. Eventually, our contribution showed that a consideration of the heterogeneous characteristics of the potential beneficiaries of EU funds across regions is of paramount importance for the design of effective and efficient policies of regional convergence.

Future research should overcome the policy data limitations at the firm-level. For the programming period 2014-2020, improvements in the administrative capacity and coordination by public administration in member states and regions is expected. Therefore, data on individual projects, such as expenditure, category, and beneficiaries should be available in a more harmonised way across European regions. Then, this detailed information could be integrated with other firm-level characteristics to evaluate the impact of the ‘cohesion policy’ also on the productivity of individual firms.

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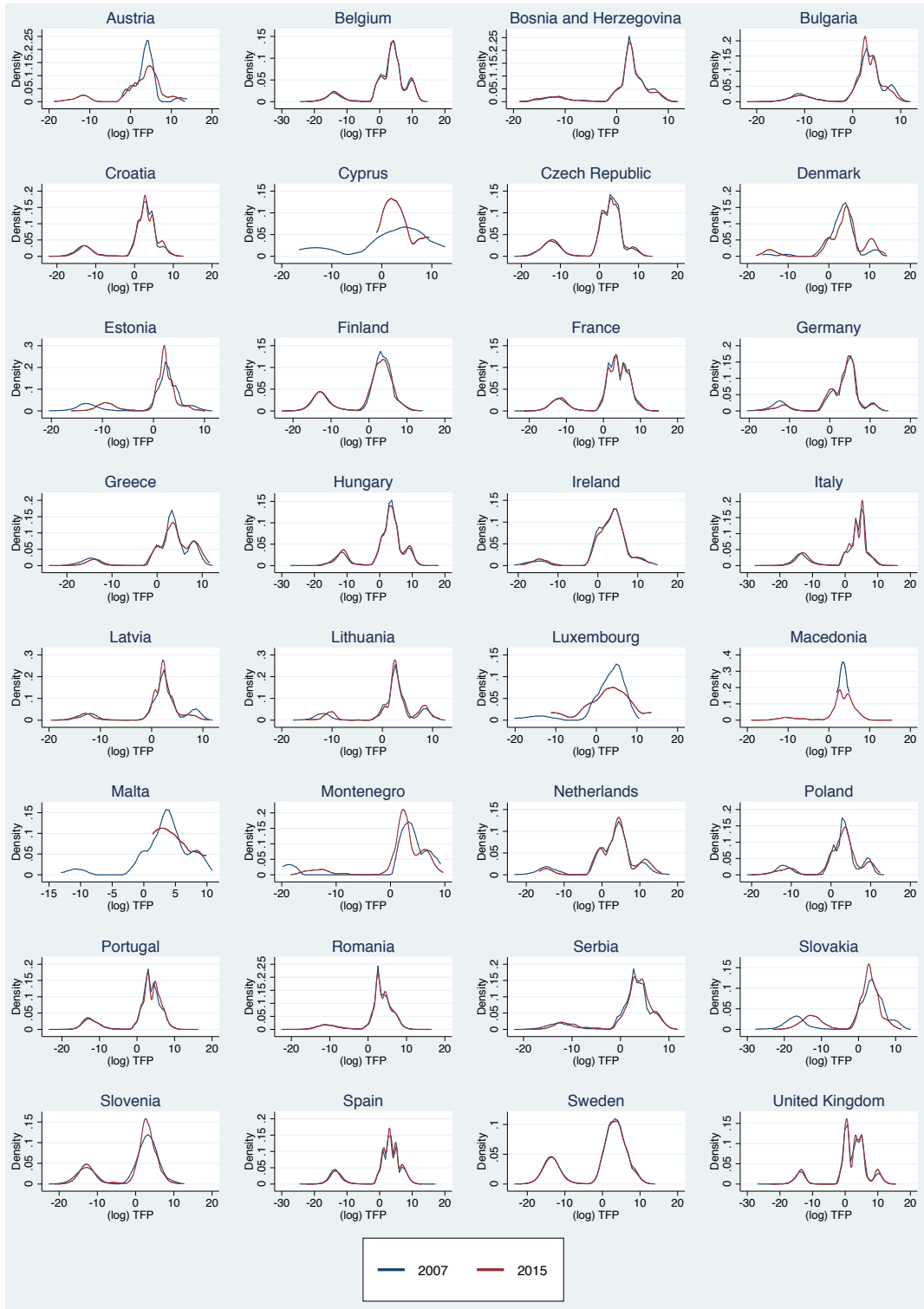
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## A Table and Graph Appendix

Table A1: Industry classification - Manufacturing.

<b>Code</b>	<b>2-digit NACE rev.2</b>
<b>10</b>	Manufacture of food products
<b>11</b>	Manufacture of beverages
<b>12</b>	Manufacture of tobacco products
<b>13</b>	Manufacture of textiles
<b>14</b>	Manufacture of wearing apparel
<b>15</b>	Manufacture of leather and related products
<b>16</b>	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
<b>17</b>	Manufacture of paper and paper products
<b>18</b>	Printing and reproduction of recorded media
<b>19</b>	Manufacture of coke and refined petroleum products
<b>20</b>	Manufacture of chemicals and chemical products
<b>21</b>	Manufacture of basic pharmaceutical products and pharmaceutical preparations
<b>22</b>	Manufacture of rubber and plastic products
<b>23</b>	Manufacture of other non-metallic mineral products
<b>24</b>	Manufacture of basic metals
<b>25</b>	Manufacture of fabricated metal products, except machinery and equipment
<b>26</b>	Manufacture of computer, electronic and optical products
<b>27</b>	Manufacture of electrical equipment
<b>28</b>	Manufacture of machinery and equipment n.e.c.
<b>29</b>	Manufacture of motor vehicles, trailers and semi-trailers
<b>30</b>	Manufacture of other transport equipment
<b>31</b>	Manufacture of furniture
<b>32</b>	Other manufacturing
<b>33</b>	Repair and installation of machinery and equipment

Figure A.1: Distribution (log) TFP- ACF by country, 2007 vs. 2015.



**Notes:** This Figure presents the firm-level total factor productivity distributions in logarithm for each country in the sample at the beginning and at the end of the sample period. Empirical densities are estimated adopting Epanechnikov kernel, as suggested by Silverman (1986).

**Source:** Own elaboration.

## B Data Appendix

**ERDF Business Support:** Data sourced from the report ‘Geography of Expenditure - Work Package 13’ prepared for the European Commission in 2015 (wiiw and ISMERI EUROPA, 2015). It is a specified thematic priority of the regional operational programme aimed at supporting firms with the European Regional Development Fund. Financed projects in this category should help firms or groups of firms, in particular, SMEs, with services and investments in innovation and sustainable production. We use payments by NUTS-2 region for the programming period 2007-2013.

**ERDF RTD:** Data sourced from the report ‘Geography of Expenditure - Work Package 13’ prepared for the European Commission in 2015 (wiiw and ISMERI EUROPA, 2015). It is a specified thematic priority of the regional operational programme aimed at supporting firms with the European Regional Development Fund. Financed projects in this category should stimulate research and innovation activities through investments in research centres, promoting technology transfers and cooperation between businesses and the scientific environment. We use payments by NUTS-2 region for the programming period 2007-2013.

**Firm size:** Computed from ORBIS data. It is the turnover in log of the firm  $i$  operating in industry  $j$  located in region  $r$  in year  $t$ .

**N. of employees:** Computed from ORBIS data. It is the number of employees in log of the firm  $i$  operating in industry  $j$  located in region  $r$  in year  $t$ .

**Firm age:** Computed from ORBIS data. It is the age in log of the firm  $i$  operating in industry  $j$  located in region  $r$  in year  $t$ .

**Foreign:** Computed from the ORBIS data. It is a dummy variable equal to 1 if the firm  $i$  is a foreign-owned subsidiary and 0 otherwise.

**% Aged 25-64 (Education levels 3-4):** Data sourced from the Education and Training database by Eurostat. It is the percentage of people aged 25-64 with upper secondary and post-secondary non-tertiary education (International standard classification of education (ISCED) 2011 levels 3 and 4) by NUTS-2 region.

**% Aged 25-64 (Education levels 5-8):** Data sourced from the Education and Training database by Eurostat. It is the percentage of people aged 25-64 with tertiary education (International standard classification of education (ISCED) 2011 levels 5-8) by NUTS-2 region.

**Agglomeration:** Computed using Structural Business Statistics (SBS) data from Eurostat database. It represents the geographical concentration of the economic activity of the regional industry. It is measured using the ratio of regional industrial employment to the total local area, following Henderson et al. (1995).

$$Agl = \frac{L_{jrt}}{Area_{rt}} = \frac{\sum_i L_{ijrt}}{Area_{rt}}$$

**Specialisation:** Computed using Structural Business Statistics (SBS) data from Eurostat database. It captures the level of concentration of the industry in the region. It is measured using the ratio of regional industrial employment to the total regional employment, following Henderson et al. (1995).

$$S = \frac{L_{jrt}}{\sum_j L_{jrt}} = \frac{\sum_i L_{ijrt}}{\sum_j \sum_i L_{ijrt}}$$

**Diversification:** Computed using Structural Business Statistics (SBS) data from Eurostat database. It shows the within-regional concentration of industries other than the one under investigation. It is

measured by the Hirschman-Herfindahl Index, and it is defined as the sum of squares of the share of other industries' employment in the region relative to the total employment in the region except for the respective industry in question. The value of this index becomes larger when there is a concentration of another activity in the region. It becomes smaller reaching the inverse of many other industries in the region when employment is equally distributed across other regional industries.

$$D = \sum_{j' \neq j} S_{j'rt}^2 = \sum_{j' \neq j} \left( \frac{L_{j'rt}}{\sum_{j' \neq j} L_{j'rt}} \right)^2$$

**Competition:** Computed using Structural Business Statistics (SBS) data from Eurostat database. It captures the competition within the local industry according to the number of local units resulting in the inverse average employment of the local firms.

$$C = n_{jrt}/L_{jrt}$$

where  $n_{jrt}$  is the number of local units (firms) in the region  $r$  at time  $t$ , operating in industry  $j$ .

## C Robustness Check Appendix

In this appendix we run a robustness check to the estimation of equation (1) presented in Table 5. In this new specification, firms in the European Union are only included in the sample. Few variables are added to the regression to draw macro-level policy conclusions. These variables comprise growth of real GDP per capita in year  $t$  in the country  $c$  where the firm  $i$  operates  $GDPpc_{ct}$ ; regulatory quality  $rq_{ct}$ , share of government expenditure in GDP of the country  $gov_{ct}$ , real effective exchange rate  $REER_{ct}$  calculated based on unit labour costs of 37 industrial trading partners and volatility (standard errors to the mean) of monthly nominal effective exchange rate  $seNEER_{ct}$  of 37 industrial trading partners in a given year  $t$ .

Real GDP per capita and government expenditure are collected from the World Development Indicators (WDI) of the World Bank (WB); regulatory quality is compiled from the World Governance Indicators (WGI) of the World Bank; data on exchange rates are collected from the Eurostat.

Additionally, in this specification, in addition to control for the sample selection bias, we control for the firm-specific effects using firm-fixed effects and technological change using time-fixed effects. The standard errors are clustered by firms to control for the within firm shocks.

*Table C1: Regression on growth of TFP of manufacturing firms in the EU – 2007-2015*

Dep. Var.: $\Delta(tfpi_{ijrct-1})$	No Selection	Sample Selection control
$tfpi_{ijrct-1}$	-0.79*** (0.0043)	-0.79*** (0.0043)
ERDF Business Support	-0.0011*** (0.00039)	-0.00052 (0.00042)
ERDF RTD	0.0012*** (0.00047)	0.00096** (0.00047)
Firm Size	-0.045*** (0.0065)	-0.054*** (0.0067)
N. of employees	0.25*** (0.0058)	0.26*** (0.0059)
Regional GDP in millions Euro	-0.087*** (0.025)	-0.11*** (0.026)
% Aged 25-64 (Education levels 3-4)	0.0037*** (0.00050)	0.0028*** (0.00052)
% Aged 25-64 (Education levels 5-8)	0.0060*** (0.00068)	0.0060*** (0.00068)
Agglomeration	-0.014*** (0.0035)	-0.014*** (0.0034)
Specialization	-0.21* (0.11)	-0.21* (0.11)
Diversification	0.16** (0.068)	0.026 (0.086)
Competition	0.27*** (0.073)	0.27*** (0.073)
Regulatory quality	-0.034*** (0.0077)	-0.035*** (0.0079)
Growth of real GDP per capita	1.03*** (0.047)	1.02*** (0.047)
General government final consumption expenditure (% of GDP)	0.0085*** (0.0014)	0.0078*** (0.0015)
REER	0.0037*** (0.00029)	0.0041*** (0.00031)
Volatility of monthly NEER	0.021*** (0.0050)	0.022*** (0.0051)
Inverse Mills Ratio of the sample selection		0.075** (0.031)
Observations	1494274	1471176
R-squared	0.506	0.505
AIC	2316431.7	2269389.0
BIC	2316639.4	2269608.6
Firm dummies	Yes	Yes
Year dummies	Yes	Yes

Cluster by firms. Robust standard errors in parentheses \*\*\* p < 0.01, \*\* p < 0.05, \* p < 0.1.



As it is observed from the results of the robustness checks, the signs of the coefficients remain similar to the results presented in Table 5 in the text. Because of the inclusion of firm-fixed effects, the conditional convergence is now closer to 1. In other words, a representative firm with 1% lower TFP in the previous period should have about 0.79% higher TFP growth in the current period.

The positive impact of ERDF RTD is still significantly positive while the negative impact of ERDF Business support loses its significance when controlling for both the sample selection bias and the heterogeneity of firms.

The regional structures of industries now become statistically significant. Both specialisation and regional agglomeration of employment in the sector in the industry are negatively correlated with the growth of firms' productivity. The coefficient of diversification is statistically significant only when not controlling for the sample selection bias, and based on the construction of this index, it indicates that less equal distributions of other industries' employment in the region are better for growth of firms within a given industry. Moreover, in this new specification, competition measured as the inverse of average employment at local units within the regional industry has a positive and statistically significant impact on productivity growth of firms.

The results of the new additional variables are also interesting. Regulatory quality that is defined as 'perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development' has a strong negative correlation with the growth of firms' TFP.

Growth of a country is positively correlated with the growth of firms' productivity as the coefficient of the real GDP per capita growth is statistically significant and positive. In other words, when a country grows by 1% its firms' productivities are growing by a bit larger pace of 1.02%.

Government fiscal policy also has a positive impact on growth of firms' TFP. According to the model controlling for both sample selection bias and the firm heterogeneity, when a government increases its final consumption expenditure relative to total GDP of the country by 1 percentage point, efficiency gains of firms measured in growth of TFP are expected to increase by about 0.78%.

The real effective exchange rate of a country also has a statistically significant positive relation with its firms' TFP growth. In other words, it works as a productivity whip meaning that when the REER appreciates this makes it necessary for the firms to increase productivity as they would otherwise be kicked out of the market, hence, they innovate and increase TFP. Moreover, firms are growing faster when the volatility of the nominal effective exchange rate of a country measured in standard errors to the mean of the monthly exchange rates is larger. This could be interpreted to mean that in order to be able to respond to the volatilities of the exchange rates, firms need to increase their productivity to sustain their profitability.



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