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Do EU Funds boost
productivity
and employment? Firm level
analysis for Latvia

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ABSTRACT/RÉSUMÉ

Do EU Funds boost productivity and employment? - Firm level analysis for Latvia

This paper investigates the effects of spending the European Regional Development Fund (ERDF) on productivity, employment and other performance indicators of Latvian firms. After controlling for the fact that more productive and larger firms are more likely to benefit from ERDF resources, we find that participation in projects co-financed by the ERDF increases firms' employment, turnover and capital stock per employee immediately, while it raises their productivity only three years after the launch of such projects. Furthermore, participants that were initially less productive, larger, less capital intensive and more financially leveraged enjoy larger productivity gains. Also, financing capital investment through the ERDF does not result in any productivity gains compared to the case when it is financed through private funding. However, it results in a larger increase in employment, which is possibly partly due to the firm's plan to increase employment being one of important criteria for selecting the ERDF beneficiaries.

JEL code: C14, D22, R11

Keywords: EU funds, productivity, firm-level data, propensity score matching

Les Fonds Européens stimulent-ils la productivité et l'emploi ? Analyse au niveau des entreprises en Lettonie

Ce document examine les effets des financements au titre du Fonds européen de développement régional (FEDER) sur la productivité, l'emploi et d'autres indicateurs de performance des entreprises lettones. Une fois posé le constat que les entreprises plus productives et plus grandes ont davantage de probabilités de bénéficier des crédits du FEDER, on observe que la participation aux projets cofinancés par le FEDER se traduit par des gains immédiats en termes d'emploi, de chiffre d'affaires et d'augmentation du stock de capital par salarié, tandis que la hausse de la productivité ne devient visible que trois ans après le lancement des projets. Il apparaît de plus que les gains de productivité sont plus importants pour les participants au départ relativement moins productifs, de taille plus importante, et qui se caractérisent par une intensité capitalistique moins forte et un endettement plus élevé. Il ressort aussi que le financement des dépenses d'investissement grâce aux fonds du FEDER ne génère aucun gain de productivité, contrairement à un financement sur fonds privés. Le gain en termes d'emploi est en revanche plus marqué, ce qui peut s'expliquer, tout au moins en partie, par le fait que l'engagement à créer des emplois figure parmi les principaux critères d'éligibilité à un financement par le FEDER.

Classification JEL: I24, I25, I28, J31, J61, J62, J68

Mots clefs: fonds européens, productivité, données sur les entreprises, appariement par score de propension

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Do EU Funds boost productivity and employment? - Firm level analysis for Latvia

By Konstantīns Beņkovskis, Oļegs Tkačevs, Naomitsu Yashiro¹

Introduction

Between 2007 and 2013, the European Union spent 340 billion euros on regional support programmes aimed at narrowing gaps in regional development across the EU. This, so called, Cohesion Policy was implemented via several Structural Funds, namely, the European Regional Development Fund (ERDF), the European Social Fund (ESF) and the Cohesion Fund (CF)². It is of utmost importance to understand whether and how the EU regional support programmes improve the economic performance of lagging countries and regions.

However, the empirical evidence on the impact of the EU funds is mixed at best. Because the objectives of Cohesion Policy are wide in scope, part of its impact may not be captured correctly by economic performance indicators (Fratesi, 2016). Furthermore, the effect of regional support programmes on the performance of lagging regions is often difficult to isolate from other forces acting. For instance, regions eligible for support programmes usually have lower per capita income. They are thus likely to enjoy faster growth as they converge to advanced regions, even in the absence of policy support. Also, the effect of regional support programmes can be complicated by economic geography. The infrastructure investment intended to connect lagging regions to advanced regions may end up accelerating the concentration of economic activities in core regions, lowering economic growth in lagging regions (Hagan and Mohl, 2010).

This paper provides one of the first firm-level analyses on the effects of Cohesion Policy. By estimating the impact of the EU regional support programmes on the performance of actual recipients, this paper avoids the complexity associated with the regional studies. Furthermore, following the above criticism by Fratesi (2016), the paper focuses on the ERDF which is specifically intended to boost the economic performance of lagging regions through improved entrepreneurship and business innovation. We exploit a large dataset of Latvian firms to assess whether participating in ERDF co-financed projects improves their productivity, employment and other measures of performance. Latvia is a suitable country to examine the effectiveness of Cohesion Policy, as it is one of the largest recipients of the Structural Funds (including the ERDF) in terms of relativity to GDP.

¹ The authors are respectively from the Economics Department of Stockholm School of Economics in Riga and Bank of Latvia; Bank of Latvia and OECD Economics Department. They are grateful for valuable comments by Rudiger Ahrend, Alexander Lembecke, Lenka Wildnerova (OECD/CFE), Tadas Gedminas (Stockholm School of Economics), Emmanuel Dhyne (National Bank of Belgium), Nicola Brandt, Peter Jarrett and Volker Ziemann (OECD/ECO), and participants at the OECD Economics Department Brown Bag Seminar, the 6th Annual Lithuanian Conference on Economic Research and the Annual Workshop “Medium- and long-run challenges for Europe” of the ESCB Research cluster in Madrid. The views expressed in this paper are those of the authors and do not necessarily reflect the stance of the Bank of Latvia, the Stockholm School of Economics in Riga or the OECD. The authors assume responsibility for any errors and omissions.

² The European Commission refers only to the ERDF and the ESF as to the Structural funds. In our study, for the sake of simplicity, under the term “Structural Funds” we mean all three of the mentioned Cohesion Policy instruments, including the Cohesion Fund.

We employ a non-experimental matching approach, which has been widely used to examine the effectiveness of various policy measures, such as active labour market programmes. This method isolates the impact of the ERDF by controlling for the self-selection of firms with initially superior performance into the ERDF co-financed projects. For instance, it is found that Latvian firms that are initially more productive, larger and more capital intensive have a higher probability of participating in ERDF co-financed projects. Such *ex ante* differences between the participants in the ERDF projects and non-participants are likely to be the result of large sunk costs associated with participation in the ERDF projects. After controlling for such self-selection, we find that participating in an ERDF co-financed project immediately increases a firm's turnover, size and capital intensity. However, it increases its productivity only three years after launching the project. Furthermore, we find that firm-level characteristics such as initial productivity level, size, age, capital intensity and indebtedness shape the effectiveness of the ERDF in boosting firm performance.

This paper is related to Bachtrögler and Hammer (2018), which explored the impact of participation in Cohesion Policy projects on the performance of manufacturing firms in six OECD countries using similar methodology. This paper covers Latvia, a catching-up economy where the EU funds play an important role in economic development. Furthermore, this paper uses a national dataset which contains a larger number of observations and richer firm-level information than the ORBIS dataset used by Bachtrögler and Hammer (2018). This allows us to observe a wider range of performance and characteristics over a larger number of firms, which helps us understand the nature of the contribution of EU structural funds. For example, we document that the ERDF has a negligible impact on raising the export intensity of Latvian firms, which seem consistent with the absence of short-run productivity improvement.

The remainder of the paper is organised as follows. The next section provides a concise review of the previous literature that explored the effectiveness of the EU regional support programme. Section 3 briefly explains the goals and priorities of the ERDF in general as well as the programme setup in Latvia in the 2007–2013 programming period. Section 4 introduces the dataset used in the analysis. Section 5 describes the empirical strategy employed in this study. Section 6 presents the estimated treatment effects of the ERDF on firm performance and some extensive analysis. Finally, Section 7 concludes and provides policy implications.

Literature on effectiveness of EU regional support programmes

The effects of EU Cohesion Policy on convergence or economic performance have been examined extensively. The results of this body of literature have thus far been mixed, as the positive effect of EU funding on economic growth appears to be far from certain (see Hagen and Mohl, 2011; Pienkowski and Berkowitz, 2015; and Fratesi and Wishlade, 2017 for a review). This is at least partly due to the fact that objectives of Cohesion Policy are wide-ranging, including socio-political goals that are not linked to short-run economic performance (Fratesi, 2016). This calls for a more granular evaluation that maps suitable performance indicators according to each type of regional support programme.

Most empirical studies rely heavily on regional data to estimate the impact of the Structural Funds on GDP per capita, GDP growth or productivity. Early studies estimated the impact of regional support programmes within the framework of income convergence in a neoclassical growth model. For example, Boldrin and Canova (2001) argued that the Structural Funds did little to accelerate income convergence since the distribution of GDP

per capita among regions receiving ERDF supports changed only slightly between the late 1980s and the mid-1990s. Rodriguez-Pose and Fratesi (2004) regressed regional growth in GDP per capita on Structural Fund commitments controlling for the initial level of GDP per capita and reported that the contribution of the Structural Funds was statistically insignificant, except for expenditure on education and human capital.

Later studies made various attempts to go beyond the standard neoclassical growth framework by incorporating complex factors that can affect the contribution of regional support programmes. For instance, Hagen and Mohl (2010) and Le Gallo et al. (2011) controlled for possible inter-regional spillovers of the impact of the Structural Funds by including weighted growth rates of nearby regions in the regression. Other studies highlighted the characteristics of receiving regions. For instance, Rodriguez-Pose and Garcilazo (2015) showed that the quality of government is an important determinant of the Structural Funds' contribution to growth. Becker et al. (2013) and Percoco (2017) explored the role of local economic structure such as the size of the services sector.

Empirical research using regional data is subject to criticism on several grounds. Among the most serious problems is the endogeneity between a region's eligibility for regional support programmes and its economic performance. Regions eligible for convergence objective funding (which is mostly the ERDF) have substantially lower GDP per capita than the EU average. However, such initially less developed regions may enjoy faster growth due to the convergence process, regardless of the support programmes (Cappelen et al., 2003). On the other hand, there are incentives for poor regions not to outgrow the threshold in order not to lose their eligibility for convergence objective funding (Fratesi, 2016). This may hold back growth despite the potential growth effects of the Structural Funds. Some studies have tried to address this issue by employing novel econometric methods such as the Regression Discontinuity Design (for example, Becker et al., 2010; 2018; Pellegrini et al., 2013) or Generalized Propensity Scores (Becker et al., 2012). Another difficulty involves the effect of economic geography. For instance, the Structural Funds that strengthen transport infrastructure across several regions can accelerate the agglomeration of economic activity in established core regions at the expense of receiving regions at the periphery. While ignoring such factors could lead to unreliable estimates, only a few studies such as Midelfart-Knarvik and Overman (2002), Dall'Erba and Le Gallo (2008) have incorporated the aspect of economic geography into their assessment.

Employing firm-level data would mitigate some of the problems mentioned above. However, mostly due to data limitations, few studies have examined the effects of the EU Structural Funds by applying a micro-econometric approach to firm-level data. Moreover, these studies have analysed specific EU policies and focussed on a narrow set of performance indicators. For instance, Pufahl and Weiss (2009) reported a positive effect of enrolment in EU farm programmes on the sales of German farms. Moral Arce and Paniagua (2016) found a positive effect of EU support on the R&D investments and employment of Spanish firms. More comprehensive analysis was conducted by Bachtrögler et al. (2017) that matched the dataset of over two million individual projects with firm-level information obtained from the ORBIS database and reported that Structural Fund projects are implemented mostly by very large firms.

Recently, Bachtrögler and Hammer (2018) conducted a more comprehensive assessment of the impact of participating in Cohesion Policy projects on the performance of manufacturing firms in six countries, of which four are advanced OECD countries. Their results vary substantially across countries and types of EU funds (ERDF, ESF and the Cohesion Fund). While they found that EU funds increase firms' turnover and capital stock

in all six countries, significant gains in total factor productivity and employment were reported for only two or three countries. This paper differs from Bachtrögler and Hammer (2018) in several ways: first, it focuses on the ERDF whose objective is more aligned with improvement in firm performance. Second, it uses more comprehensive data of Latvian firms collected by the national authority, which contain richer information on recipients of EU funds than the ORBIS dataset used by Bachtrögler and Hammer (2018). Third, owing to such high-quality data, this paper goes beyond Bachtrögler and Hammer (2018) in covering a wider range of firms such as those in the services sector, documenting the impact of the ERDF on a larger set of performance indicators, and conducting more granular analysis. It is especially worth noting that this paper explores the impact of the ERDF on the internationalisation of recipient firms, an important dimension for a small open economy.

The allocation of ERDF in Latvia

The European Union's Cohesion Policy is aimed at narrowing substantial regional gaps in wellbeing, thus rendering the EU a more developed and economically balanced entity. The main instruments of Cohesion Policy are: the European Regional Development Fund, the European Social Fund and the Cohesion Fund (CF). The first two funds finance investment in growth-enhancing infrastructure projects, business innovation, communication (the ERDF) and social policies (the ESF). The CF finances large, transport-related networks and environmental projects (European Commission, 2014). As this study focuses on the effect of EU regional support on firm performance, including productivity and competitiveness, we specifically analyse the projects financed by the ERDF. Such projects are intended to support entrepreneurship and foster the competitiveness of enterprises in the least developed EU regions.

We analyse the multiannual financial framework 2007–2013, which provided total financing amounting to 340 billion euros (including 200 billion euros for the ERDF). The framework envisaged three broad objectives of Cohesion Policy: 1) convergence of living standards, 2) strengthening regional competitiveness and employment and 3) promoting European territorial cooperation.³ Over 80% of ERDF funding was allocated to the convergence objective in such areas as research and innovation, local development, environment, education, health and social infrastructure.⁴

To be eligible for the convergence financing from the ERDF, a region's GDP per capita must be less than 75% of the EU average.⁵ While more prosperous EU regions not eligible for the convergence priority may also receive funding under the objective of regional competitiveness and employment, the bulk of the ERDF is dedicated to the least developed regions, thus constituting a tool for redistribution of welfare across EU Member States.

There are various conditionalities attached to the disbursements of the ERDF. First, ERDF funding has to be complemented by national resources (public or private, depending on the entity implementing the respective project). The required rates of national financing vary for each project, ranging between 15% and 50% for projects in the regional competitiveness

³ See Council Regulation No. 1083/2006 for details of the multiannual financial framework 2007–2013.

⁴ See Council Regulation No. 1080/2006

⁵ More specifically, a region's GDP per capita should be less than 75% of the average GDP of the EU25 during the period 2000–2002.

and employment objective. Second, the ERDF funding should not replace existing national spending in the project area. Third, the committed ERDF must be absorbed by two years after the end of the programming period, i.e. in the case of the multiannual financial framework 2007–2013 funding had to be drawn upon by the end of 2015.

Latvia, with its GDP per capita at 64% of the EU28 average⁶, is one of the largest recipients of EU regional support. The disbursement of the Structural Fund amount to around 3.0% of GDP every year, half of which are from the ERDF.⁷ Most of the EU fund projects in Latvia fall under the convergence priority and are designed along three operational programmes (see Figure A1 in the Appendix 1). Two of these programmes are funded by the ERDF. One is “Entrepreneurship and Innovation”, which includes activities that are focused on the promotion of high value added investment and supports to entrepreneurship. Another programme (which is considerably larger) is “Infrastructure and Services,” which includes broad activities aimed at improving infrastructure and the business environment as well as developing the transport network.

The activities in the ERDF programmes are managed by national authorities, which are also in charge of selecting grant applicants. Each activity is governed by specific regulations, which include a set of criteria for selecting applicants. For instance, applicants for activities like “Acquisition of external markets” and “Development of new products and technologies” are assessed based on their export intensity.⁸ Labour productivity, measured as value added per employee, is one of the key selection criteria for activities such as “High value added investments”.⁹ Employees’ wage level is also a criterion for activities such as “Development of new products and technologies” and “High value added investments”. Some activities, for instance those related to the organisation of international conferences on export promotion, also require applicants to have a level of turnover above a certain threshold.¹⁰ However, the selection criteria vary greatly across activities and include many qualitative parameters. For example, one important criterion for the activity “Promotion of international competitiveness” is whether the applicant has “planned measures for the comprehensive promotion of international competitiveness of Latvia in foreign markets.” It is therefore difficult to characterise *a priori* the Latvian firms that receive ERDF funding.

The sectoral and regional composition of ERDF co-financed projects as well as total ERDF funding received by private firms in Latvia are summarized in Figure A2 and Figure A3, respectively.¹¹ Around half of the projects are implemented in the manufacturing sector,

⁶ <http://ec.europa.eu/eurostat/tgm/table.do?tab=table&plugin=1&language=en&pcode=tec00114>.

⁷ This figure does not account for funding available from the European Agricultural Fund for Rural Developments and the European Maritime and Fisheries Fund, which are EU regional support instruments in agriculture and fishing, respectively.

⁸ <https://m.likumi.lv/doc.php?id=194223> (Chapter 47.1), <https://likumi.lv/doc.php?id=219070> (Annex 3).

⁹ <https://likumi.lv/doc.php?id=238461#p46&pd=1> (Annex 4).

¹⁰ <https://m.likumi.lv/doc.php?id=194223> (Chapter 21).

¹¹ We do not account for projects that are implemented in the Government sector S13, i.e. by public institutions because this is outside the scope of this study. We also exclude projects that fall under the activity “Access to finance”. These projects consist of guarantees and loans (rather than grants) to companies. The distribution of guarantees and loans is managed by the Latvian Mortgage and Land Bank and its successor - Governmental agency Altum. Unfortunately, we have no information on final beneficiaries in the private sector, their sector and regional affiliation.

while in the services sector quite a large number of projects are related to professional and administrative services. There is a fairly small number of relatively large projects in construction and water supply, a large number of which fall under the activity "Development of water supply infrastructure". Regarding the regional dimension, around 65% of the projects accounting for approximately 50% of total financing are implemented either in Riga or in the greater Riga district. Despite the declared goal of the Government to facilitate regional development in Latvia, Latgale, which is Latvia's poorest region, gets only 5% of the projects and 7% of total ERDF financing in the private sector. However, this may also reflect the low capacity of the Latgale region to absorb the ERDF, due, for instance, to fewer firms having the ability to propose and co-finance good projects.

By the end of 2015 Latvia had successfully absorbed the EU funds allocated during the programming period 2007–2013. EU funds are considered to have played a significant role in promoting the recovery and development of Latvian firms after the financial crisis (European Commission, 2016). It provided finance for capital build-up by Latvian firms during the period of tight credit conditions and also encouraged the development of new products and innovation. The European Commission reckoned that the ERDF provided support to more than one thousand start-ups and created more than 3000 jobs (European Commission, 2016).¹² At the same time, significant inefficiencies in the management and implementation of the funded projects, such as the administrative overlap in the selection process, were pointed out. Such difficulties, partly due to the insufficient administrative capacity and experience of the implementing authorities, may have constrained the efficient allocation of the EU funds.

Data

Database of Latvian firms

We combine several types of large anonymised firm-level data provided by the Central Statistical Bureau of Latvia (CSB) and the Bank of Latvia. They contain a myriad of information on the financial statements and business activities of Latvian firms, such as balance-sheet data, the number of employees and exports.¹³ A detailed description of the various data used in this analysis is included in Appendix 2. By matching all these data, we obtain a large, firm-level database spanning from 2006 to 2015, which contains information for 61 159 firms in 2006 and 113 155 firms in 2015. Table 1 compares the aggregate data from the Structural Business Statistics (published by the CSB) with the aggregated number of firms, value added and employment by firms included in our database. It is apparent that the coverage of our dataset is very high, even among small firms.

¹² As is pointed out in the European Commission report job creation was not a goal (but rather a side effect) of ERDF co-financed activities, but things may have changed after the start of the programming period against the background of mounting unemployment. The number of created jobs became an implicit indicator to evaluate project success (European Commission, 2013).

¹³ We exclude firms from agriculture, forestry and fishing (A), financial and insurance activities (K), public administration and defence (O), education (P), health (Q), arts, entertainment and recreation (R), and other services activities (S, except S95, repair of computers and personal and household goods) due to the lack of data or the specific nature of the sector.

Table 1. Comparison of the firm-level database and the Structural Business Statistics (2015)

Size classes (number of employees)	Number of firms			Value added (millions of EUR)			Number of employees (thousands)		
	Structural business statistics	Firm-level dataset	Coverage (%)	Structural business statistics	Firm-level dataset	Coverage (%)	Structural business statistics	Firm-level dataset	Coverage (%)
0–9	100 216	77 944	77.8	2 195.3	2 223.1	101.3	211.9	193.1	91.1
10–19	4 911	2 825	57.5	925.2	730.5	79.0	65.2	38.0	58.3
20–49	2 881	2 195	76.2	1 464.8	1 368.2	93.4	86.9	67.0	77.1
50–249	1 435	1 463	102.0	2 824.5	3 022.3	107.0	139.1	144.1	103.6
250–...	200	222	111.0	3 169.5	3 566.0	112.5	130.2	141.2	108.4
Total	109 643	113 155	103.2	10 579.4	11 091.8	104.8	633.5	583.4	92.1

Note: The sum of variables for the five size classes does not correspond to the number in the last row due to missing data on the number of employees for some firms. The coverage exceeds 100% in several groups due to different definitions of the number of employees. Structural business statistics is based on "1-gada" survey of firms, but the firm-level dataset uses administrative employee-employer data. Employees on maternity/paternity leave are included in the latter, but not in the former.

Source: CSB, Latvijas Banka and authors' calculations.

We eliminate outliers following Lopez-Garcia et al. (2015), by applying a multi-step exclusion procedure based on the values of various ratios (capital, turnover, labour costs, intermediate inputs and value added to labour or capital) and their numerators and denominators.¹⁴ We remove slightly more than 2% of observations as we omit the outliers for value added, turnover, fixed capital and wages, while less than 1% of observations for the number of employees or intermediate inputs. More important data losses come from missing values in key variables such as the number of employees, a problem that is more pronounced for small enterprises. All in all, we end up with a sample size of 10 to 15 thousand firms each year.

Finally, several variables were deflated to obtain real values. We deflate value added and intermediate inputs by industry-specific value added and intermediate inputs deflators obtained from the CSB. Capital stock is deflated by the investment spending deflator. We observe two measures of productivity. One is labour productivity, which is the real value added per employee, and the other is the Total Factor Productivity (TFP) estimated using the approach by Wooldridge (2009) and Petrin and Levinsohn (2012) (see Appendix 3 for a brief description).

Dataset on the recipients of the EU Structural Funds

We use a detailed anonymised dataset of entities (enterprises, state agencies, local governments and other legal entities) receiving EU funding provided by the Ministry of Finance of the Republic of Latvia. We match this dataset with the database above. The EU funds dataset contains information on the amounts received, start and end dates, economic sector and location of each project. The dataset covers the EU programming period 2007–2013. However, the first year when entities systematically started making use of the funds available in this period was 2009 (with a few exceptions of projects having started in 2008), since entities could still use the committed funds of the previous programming period

¹⁴ First, the given ratio is coded as in the case of an abnormal growth – more than two interquartile ranges above or below the median growth in the respective sector and year. Moreover, the procedure identifies the source of the extreme growth (the numerator or denominator) and codes it as missing. Second, the variable is coded as missing if its ratio with respect to labour or capital falls into the top 1 and 99th percentile of the distribution for the respective ratio.

2000–2006¹⁵ until 2008 owing to the so-called N+2 rule. Similarly, entities continued undertaking activities and receiving funding in the 2007–2013 programming period until 2015. Overall, we have 2571 entities obtaining support from the ERDF.

However, around half of ERDF-receiving entities had to be dropped from the analysis, as those recipients were public-sector institutions, which are out of the scope of our analysis. This leaves us with ERDF co-financed projects carried out by 1258 firms.¹⁶ In addition, because we observe the subsequent performance of firms receiving ERDF funding up to two years, the sample of ERDF recipients after 2013 had to be dropped. This reduced the sample size to 975 firms. Furthermore, in order to avoid the effect of other types of the EU funds clouding the effects of the ERDF, we dropped firms that also participate in ESF or CF projects, which reduces the sample size to around 900. Unfortunately, many recipients were also missing essential information needed for empirical analysis, such as the size of employment or capital. Excluding those firms reduced the sample size to 465¹⁷.

Table 2 summarises the characteristics of firms that participated in ERDF co-financed projects in comparison with non-participating firms. The upper panel of the table contains all 1258 firms in our dataset, while the lower panel comprises only 465 firms used in the empirical analysis. Table 2 shows that participants in ERDF co-financed projects are on average older, more productive, larger, to a larger extent foreign owned, have a larger share of employees and managers with experience working on EU co-financed projects and are more export oriented than non-participants. Figure 1 also shows that the productivity advantage of the participants is not driven by a handful of firms, but the productivity distribution of the participants stochastically dominates that of non-participants. Comparing the upper and lower panels of the Table 2, it is worth noting that the ERDF participants included in the sample for the empirical analysis are somewhat older, bigger and are more likely to export than the whole sample of ERDF participants.

¹⁵ Latvia started making use of these funds in 2004 after it joined the bloc.

¹⁶ Around 80% of those firms fall into the operational programme “Entrepreneurship and innovation” (see Table A1 in Appendix 1). Most of the activities included in this programme are aimed to promote the entry of Latvian firms into foreign markets or to facilitate development of micro, small and medium-sized enterprises in lagging regions. About 7% of the recipient firms in our sample implement projects classified under the operational programme “Infrastructure and services”, largely investments in human capital as well as environmental projects. Even though this operational programme is the biggest one in terms of total financing available, the bulk of it is implemented by public institutions, which is outside the scope of this study. Our sample includes firms that implement projects related to the development of water supply infrastructure and heat insulation of dwellings. The remaining 13% of firms participate in more than one activity and therefore cannot be classified into a single one. Interestingly, the share of such firms in the total value of projects implemented by our sample of firms is around 60%. This suggests that such firms are involved in at least one project that is a large infrastructure related activity.

¹⁷ Table A2 in the Appendix 1 summarises the distribution of the final sample across the operational programme. As in the whole sample, the largest share of firms fall into the programme “Entrepreneurship and innovation.”

Table 2. Comparison of ERDF beneficiaries and non-beneficiaries

	Firms not participating in ERDF projects			ERDF beneficiaries			Difference vis-a-vis non-participants (t-statistics)
	Mean	Standard deviation	Number of obs.	Mean	Standard deviation	Number of obs.	
All sample (2008-2015)							
Age	7.402	6.253	513 499	9.167	6.891	1 256	9.99***
Number of employees	9.236	64.937	513 020	59.083	162.244	1 258	27.020***
Log of relative labour productivity#	-0.00163	1.292	396 911	0.600	1.139	1 075	15.252***
Log of relative TFP#	-0.00259	1.238	236 391	0.684	1.142	895	16.565***
Log of relative K/L ratio#	-0.00274	2.093	367 412	0.853	1.860	1 179	14.021***
Exporter of goods or services	0.0663	0.249	513 499	0.432	0.496	1 258	51.840***
Exports of goods to turnover	0.0177	0.0998	504 062	0.173	0.294	1 246	54.349***
Exports of services to turnover	0.00468	0.0604	504 365	0.0207	0.126	1 250	9.327***
Log of turnover	3.965	2.137	504 550	6.365	2.213	1 250	39.651***
Owner from OECD countries	0.0088	0.093	513 499	0.052	0.223	1 258	16.528***
Owner from non-OECD countries	0.0047	0.069	513 499	0.0254	0.158	1 258	10.632***
Liquidity ratio	0.198	0.273	459 638	0.149	0.206	1 240	-6.342***
Indebtedness ratio	9.348	713.554	466 651	0.551	2.996	1 244	-0.435
Share of employees with EU funds experience	0.0374	0.147	513 499	0.314	0.424	1 258	66.353***
Share of managers with EU funds experience	0.0085	0.084	513 499	0.206	0.391	1 258	81.537***
The sample used for empirical analysis (2008-2013, ERDF-only participants, after data cleaning)							
Age	10.596	5.535	72 942	11.551	5.783	465	3.708***
Number of employees	18.121	103.525	72 942	80.456	146.383	465	12.902***
Log of relative labour productivity#	0.338	1.120	72 942	0.716	1.064	465	7.257***
Log of relative TFP#	0.200	1.113	72 942	0.753	1.103	465	10.681***
Log of relative K/L ratio#	0.306	1.671	72 942	0.764	1.661	465	5.892***
Exporter of goods or services	0.135	0.342	72 942	0.553	0.498	465	26.180***
Exports of goods to turnover	0.0306	0.126	72 942	0.221	0.318	465	31.944***
Exports of services to turnover	0.0131	0.0992	72 942	0.0209	0.112	465	1.689*
Log of turnover	5.292	1.824	72 942	7.218	1.734	465	22.704***
Owner from OECD countries	0.0173	0.130	72 942	0.073	0.261	465	9.110***
Owner from non-OECD countries	0.008	0.089	72 942	0.032	0.177	465	5.780***
Liquidity ratio	0.149	0.192	72 807	0.141	0.187	464	-0.860
Indebtedness ratio	0.376	1.107	72 942	0.246	0.260	465	-2.532**
Share of employees with EU funds experience	0.025	0.097	72 942	0.287	0.424	465	55.281***
Share of managers with EU funds experience	0.0062	0.063	72 942	0.211	0.394	465	63.013

Note: # Relative to the average in the sector and year. *(**)[***] denotes significance at 0.1(0.05)[0.01] level.

Source: CSB, Latvijas Banka and authors' calculations.

Figure 1. Distribution of relative productivity of firms receiving ERDF funding compared with other firms

Note: Labour productivity and TFP are reported as relative to the average in the respective sector and year.

Source: CSB, Latvijas Banka and authors' calculations.

Empirical strategy

We employ a non-experimental matching technique used by a vast literature assessing the impacts of various public intervention programmes. The choice of this methodology is motivated by the fact that participation in the EU-funded projects is non-random, which requires addressing potential sample selection bias.

The impact of participating in an ERDF co-financed project can be computed as the difference between the expected value of ex-post change in performance of a participant and that of a hypothetical case where this firm did not participate in the project. Such *average treatment effect on the treated* (ATT; Heckman et al., 1997) can be described as the following difference-in-difference:

$$ATT = E[\Delta Y_{i,t+s}^1 | erdf_{i,t} = 1] - E[\Delta Y_{i,t+s}^0 | erdf_{i,t} = 1] \quad (1)$$

For a firm i that participated in an ERDF project in the year t , the first variable on the right-hand side $E[\Delta Y_{i,t+s}^1 | erdf_{i,t} = 1]$ denotes the difference in its performance indicator Y between time $t-1$ and time $t+s$ (because performance indicators are in logs, such time differences correspond to the growth rate of the indicator). We observe such differences for up to the third year after the launch of a project. When $s = 0$, the variable is the change in the first year of participation compared to the year before participation. When $s = 2$, it is the change between the third year of participation in the ERDF compared to the year before participation. The dummy variable $erdf_{i,t}$, when is equal to 1, indicates that the firm i belongs to the sample of firms that participated in an ERDF co-financed project in the year t . The second variable $E[\Delta Y_{i,t+s}^0 | erdf_{i,t} = 1]$, in turn denotes the counterfactual change in the performance indicator, had the ERDF participant not participated in the ERDF projects. Obviously, this variable is unobservable.

We therefore have to proxy $E[\Delta Y_{i,t+s}^0 | erdf_{i,t} = 1]$ with the change in the performance indicator of a non-participating firm, that is $E[\Delta Y_{j,t+s}^0 | erdf_{j,t} = 0]$. Note that the dummy variable $erdf_{j,t}$ now equals 0, indicating that a firm j belongs to the sample of firms that *did not* participate in an ERDF co-financed project in the year t . However, the change in the

performance indicator of a non-participant cannot be a good proxy for the counterfactual if firms with very different *ex ante* performance self-select into participating in the ERDF project. In order to address such self-selection bias, we employ Propensity Score Matching (PSM; Rosenbaum and Rubin, 1983), which constructs the sample of non-participants with very similar *ex ante* likelihood of participating in the ERDF with the actual participants. This sample is called the *control group*, while the actual participants are referred to as the *treated group*.

The first step is to construct the probability that a firm participates in an ERDF project as the function of *ex ante* firm characteristics. This probability, referred to as the *propensity score*, is estimated as the following probit function:

$$Pr[erdf_{i,t} = 1] = \Phi[X_{i,t-1}, Sec_i, Year_t] \quad (2)$$

where $X_{i,t-1}$ denotes the set of firm characteristics that include some performance indicators in the year $t - 1$, that is one year before participation. They include: labour productivity (measured as value added per employee); firm's age; the number of employees; capital-to-labour ratio; liquidity ratio (the cash-to-assets ratio); indebtedness (the debt-to-assets ratio); and export intensity (the ratio of goods and services exports to turnover); as well as the share of employees and managers with experience in working for firms that have carried out ERDF projects in the past. The function also includes some non-linear terms and interactions, as well as the 2-digit NACE industry fixed effects and year fixed effects. The estimation of the propensity score yields important policy implications by itself, because it describes what kind of firms are more likely to receive EU funds.

The second step is to match each treated firm (ERDF participant) with two control firms (non-participants) that share a very close probability of participation (two nearest-neighbours matching). We use a caliper that requires the control firm j to be chosen within a certain probability distance.¹⁸ Furthermore, we match each participant with non-participants within the same NACE 2-digit industry and the same year. Finally, we impose the common support condition.¹⁹ These are rather standard procedures except limiting the scope of matching to the same year and same industry. This is necessary given the considerable output fluctuations across years and sectors in Latvia.

The third step is to compute the ATT as a difference-in-difference estimator. First, the change in performance indicators is calculated for each firm in the treated group (T) and in the control group (C). Then the average difference in these changes between two groups are calculated as the following:

$$\delta_{DiD,s} = \frac{1}{N_T} \sum_{i \in T} (\Delta Y_{i,t+s} - \sum_{j \in C} w_{ij} \Delta Y_{j,t+s}), s \in \{0,1,2\} \quad (3)$$

The difference-in-difference estimator $\delta_{DiD,s}$ corresponds to the finite sample version of the ATT formulated as equation 1. N_T denotes the number of treated firms and w_{ij} the weight of a matched non-participant j . In practice, the same weight is given to each matched non-participant.

¹⁸ We also perform matching with different numbers of nearest neighbours as well as without a caliper. The empirical results are not fundamentally altered. They are available upon request.

¹⁹ This excludes from the sample treated firm whose propensity score that is lower than the lowest propensity among the control group, as well as control firms with propensity score higher than the highest propensity score among the treated group.

Empirical results

The average treatment effect of the ERDF

The probability of participation in an ERDF project

Table 3 presents the estimation results of the probability function described in equation 2. In the first column the probability function is estimated using the whole sample at hand, while in the second column it is estimated over the period until 2013.²⁰ The probability function in the second column is used to construct the propensity score. One notable finding from column 1 is that labour productivity has a statistically significant positive contribution, implying that more productive firms have *a priori* higher probability to participate in an ERDF co-financed project. The probability of participation is also higher for firms that are initially larger, have higher export intensity and hire more employees and managers that worked previously in firms that participated formerly to the ERDF projects. In the sample used for PSM, the statistically significant coefficient on the productivity squared implies that the positive contribution of labour productivity to the probability of participation is non-linear and increases disproportionately at higher productivity levels.²¹ Such evidence of self-selection of more productive firms into participation in ERDF projects is analogous to the one found for the entry into exports and indicates the existence of large fixed entry costs (Bernard and Jensen, 1999). Such entry costs are likely to be related to the complex application procedures and costly compliance with regulations concerning ERDF projects (OECD, 2018). This is suggested by the positive and significant coefficients on the employment shares of employees and managers with prior experience in working for firms participating in ERDF projects.

Some of the regularities observed in Table 2 and Figure 1 are confirmed by the estimation of the probability function. Thus, the estimation results also reveal that firms that are larger and more capital intensive are more likely to participate in an ERDF co-financed project. However, the probability decreases for firms with very high capital intensity, possibly because those firms do not need the ERDF to finance further investment. Higher export intensity is also positively associated with participation. One interpretation is that the access to larger market through exports increases the return to investment (Aw et al., 2011), which in turn rationalises participation in an ERDF co-financed project. Another is that higher export intensity is just one of the criteria in the selection process of applicants to the ERDF. Although we expect a higher liquidity ratio to facilitate participation as firms are required to co-finance the investment in the ERDF project, the coefficient, even though positive, is not statistically significant. The coefficient on the indebtedness ratio is also insignificant, contrary to our prior that highly leveraged firms that face heavy borrowing

²⁰ The number of observations decreases considerably for two reasons. First, the number of very small enterprises rapidly increased after 2011 due to the introduction of the micro-enterprise tax that created incentives for establishing micro enterprises and for bigger companies to split. Thus, the number of firms in 2014-2015 significantly exceeds the number of firms at the beginning of our analysis. Second, we also excluded those firms that started an ERDF project in 2013 or earlier, but have some missing observations in the subsequent years that precluded us from analyzing subsequent performance.

²¹ The interpretation of the interaction and square terms is not straightforward in probit models, as stressed by Ai and Norton (2003). However, since we are interested in the effect of productivity (or age, employment, capital-to-labour ratio) itself, the marginal effect can be expressed as $\partial \Pr[erdf_{i,t} = 1] / \partial x = (\beta_1 + 2\beta_{11}x)\Phi'(\cdot)$, where β_1 and β_{11} are coefficients before the linear and square term respectively.

costs are more likely to apply for ERDF funding. Finally, firms affiliated with multinational enterprises from the OECD countries are less likely to participate in an ERDF project, possibly because they can draw on parent firms' resources.

Table 3. Estimation of the probability of participating in an ERDF co-financed project

Variables	Full sample	PSM sample
	(1)	(2)
Log of labour productivity ($t-1$)	0.0644***	0.0238
Log of labour productivity squared ($t-1$)	0.00340	0.0238***
Age ($t-1$)	-0.0422***	-0.0559***
Age squared ($t-1$)	0.0146***	0.00190***
Log of employment ($t-1$)	0.270***	0.348***
Log of employment squared ($t-1$)	-0.000152	-0.0583
Log of capital-to-labour ratio ($t-1$)	0.0804***	0.0675***
Log of capital-to-labour ratio squared ($t-1$)	-0.0113***	-0.0134**
Liquidity ratio ($t-1$)	0.112	0.117
Indebtedness ratio ($t-1$)	-0.0238	0.0129
Exports of goods to turnover ($t-1$)	0.586***	0.570***
Exports of services to turnover ($t-1$)	0.0939	-0.137
Owner from OECD countries (dummy, $t-1$)	-0.256***	-0.346***
Owner from non-OECD countries (dummy, $t-1$)	0.0183	-0.0914
Share of employees with EU funds experience ($t-1$)	0.315***	0.370
Share of managers with EU funds experience ($t-1$)	0.256**	0.476**
Year effect	Yes	Yes
Sector effect	Yes	Yes
Number of observations	247 643	73 407
Pseudo R ²	0.217	0.237

Note: The full sample is comprised of all observations in the dataset, while the PSM sample is restricted to firms that started to receive EU funds prior to 2013. *(**)[***] denotes significance at 0.1(0.05)[0.01] level. All variables are lagged one period to reduce the possible reverse causality from participation in an ERDF project to performance.

Source: CSB, Latvijas Banka and authors' calculations.

Matching using the nearest neighbour approach

Matching of each ERDF participant with two non-participants was performed using the propensity scores estimated above (column 2 of table 3). Table 4 summarises the difference in firm characteristics between ERDF participants and non-participants before and after the matching. It is apparent that the large and statistically significant difference between participants and non-participants is eliminated in the matched sample. This indicates that the quality of matching is satisfactory and that the change in performance indicators of matched non-participants can be used as a proxy for counterfactual performance of ERDF participants.²²

²² We also observed if omitting any of the variables included in the estimation of the propensity score alters the quality of matching. Surprisingly, excluding labour productivity (as well as its square term) from the probit model did not worsen the quality of matching, while excluding age, employment, capital-to-labour ratio or export intensity variables results in the model unable to eliminate the difference in firms characteristics between the treated and control firms. This indicates the importance of the latter variables for the matching procedure. Results are available upon request.

Table 4. Quality of matching

Variables	Pre-treatment (t-1) difference in means of characteristics of treated and control groups (%)	
	Unmatched	Matched
	(1)	(2)
Log of labour productivity ($t - 1$)	40.8***	0.7
Log of labour productivity squared ($t - 1$)	39.0***	2.5
Age ($t - 1$)	16.9***	3.2
Age square ($t - 1$)	18.4***	3.0
Log of employment ($t - 1$)	114.6***	3.2
Log of employment squared ($t - 1$)	104.3***	5.1
Log of capital-to labour ratio ($t - 1$)	30.5***	-0.2
Log of capital-to-labour ratio squared ($t - 1$)	10.3**	-0.1
Liquidity ratio ($t - 1$)	-8.6*	1.8
Indebtedness ratio ($t - 1$)	-15.8**	-0.7
Exports of goods to turnover ($t - 1$)	75.7***	-4.2
Exports of services to turnover ($t - 1$)	7.2	-12.7
Owner from OECD countries (dummy, $t - 1$)	20.8***	-5.4
Owner from non-OECD countries (dummy, $t - 1$)	15.9***	-6.0
Share of employees with EU funds experience ($t - 1$)	11.9**	1.9
Share of managers with EU funds experience ($t - 1$)	21.1***	3.3
Number of treated firms	465	447
Number of control firms	72 942	794

Note: *(**)[***] denotes significance at 0.1(0.05)[0.01] level. The matched control group was constructed using two nearby neighbour matching with caliper set to 0.05. All the variables are from one year before launching the ERDF project (year $t - 1$).

Source: CSB, Latvijas Banka and authors' calculations.

Difference-in-difference estimators

The ATT of ERDF is estimated by taking the average difference in the change in performance indicators between the ERDF participants and matched non-participants. Table 5 summarises the estimated ATT. For each performance indicator, we report the treatment effect in the first (t) up to the third year of participation ($t + 2$), each corresponding to the change in performance from one year before the participation ($t - 1$). Column 1 reports the ATT using our baseline matching, whereas column 2 presents an alternative matching process in which five instead of two non-participants were matched with a participant.

It is apparent that the participation in an ERDF co-financed project results in an immediate increase in capital intensity and employment as well as turnover, which lasts until the third year. In the baseline matching in column 1, ERDF participation increases the capital stock per employee by 27% by the third year, while increasing turnover and employment by 20% and 17%, respectively. The significant increase in capital stock, which is implied by the rise in capital intensity in spite of the employment increase, is not surprising, considering that many ERDF projects are aimed to support investments. The significant increase in firm size in term of employment and turnover suggests that newly acquired capital is increasing the competitiveness of participant firms, allowing them to expand market shares. There is also a possibility that firms start investing and recruiting ahead of the actual participation in ERDF projects if they learn in advance that they will be granted the co-financing.

On the other hand, the impact of the ERDF on the productivity of Latvian firms seems muted in the short run, regardless of whether we observe total factor productivity or labour productivity. The ERDF results in a significant increase in labour productivity by 12% only over three years following the participation. Alternative matching in column 2 suggests a statistically significant increase in TFP by 15% again only in the third year. Participation in a ERDF project also boosts the average wage by 5% to 7% in the two years after the launch of a project.

Table 5. Difference-in-difference estimators

Performance Indicator	Period	2 nearest neighbours matching with a caliper	Alternative: 5 nearest neighbours matching with a caliper
		(1)	(2)
Log of TFP	t	-0.076	-0.019
	$t + 1$	0.005	0.058
	$t + 2$	0.110	0.148***
Log of labour productivity	t	-0.078	-0.020
	$t + 1$	0.10	0.064
	$t + 2$	0.119*	0.154***
Log of the average wage	t	0.003	0.001
	$t + 1$	0.050*	0.050**
	$t + 2$	0.065**	0.063**
Log of the capita- to-labour ratio	t	0.088*	0.112***
	$t + 1$	0.171***	0.210***
	$t + 2$	0.270***	0.285***
Log of employment	t	0.088***	0.082***
	$t + 1$	0.140***	0.125***
	$t + 2$	0.169***	0.167***
Log of turnover	T	0.067**	0.070**
	$t + 1$	0.144***	0.138***
	$t + 2$	0.195***	0.208***
Exports-to-turnover ratio	T	-0.002	0.003
	$t + 1$	0.009	0.010
	$t + 2$	0.013	0.014
Number of treated firms		447	447
Number of control firms		794	1801

Note: *(**)[***] denotes significance at 0.1(0.05)[0.01] level. The control groups are constructed by nearest neighbour matching with a caliper set to 0.05. The bootstrap procedure with 250 replications is used to test the statistical significance of the difference-in-difference estimators.

Source: CSB, Latvijas Banka and authors' calculations.

The absence of any short-run improvement in productivity is somewhat puzzling, considering the rapid capital deepening, firm growth and increase in average wage. It is a phenomenon that was also reported by Bachtrögler and Hammer (2018) for some countries. One interpretation is that new capital acquired through the ERDF is not fully utilised until the third year, in spite of the rapid growth in turnover. For instance, the ERDF participants may need time to build the knowledge that allows them to fully exploit the new capital. If this is indeed the case, we should be able to observe significant productivity improvement in the longer run. However, the difference-in-difference estimators based on a smaller sample of participants for which we can observe the performance after the third year suggest that this is not the case. Indeed, the significant productivity gains by the participants do not last beyond the third year (see Appendix 4).

Alternatively, Latvia's small domestic market may be constraining the utilisation of capital enhanced by the ERDF. Rapid internationalisation may be important for the ERDF participants to appropriate the full return on their investment. Export entry is often associated with a short-run boost in productivity as it increases capacity utilisation (De Loecker, 2007). To this end, the results reported in Table 5 indicate that the ERDF does not increase the export intensity of Latvian firms. Therefore, the higher export intensity by the participants in ERDF projects compared to non-participants observed in Table 2 is driven entirely by the self-selection of firms with higher export intensity into ERDF projects (Table 3).

Robustness analysis

We perform two robustness checks. The first one is related to the timing of launching an ERDF project. When a firm launches the project closer to the end of the year, the ERDF will most likely not improve the firm's performance in that year. Therefore, we perform an alternative matching where the ERDF beneficiaries that launch an ERDF project during the last three months of the year are matched with non-beneficiaries in the next year. The quality of matching appears satisfactory, and the results of DiD estimation confirm our baseline estimation results (see Table A3 in Appendix 5).

Another analysis addresses the possibility that while treated and control firms may share similar initial levels of productivity, their productivity growth may be quite different. For instance, if a treated firm experienced a more pronounced productivity growth in the past and caught up with the control firm in the year $t - 1$, it should not come as a surprise that its productivity would grow faster thereafter, resulting in higher productivity level than that of the control firm after few years. To account for such a scenario, we search for the nearest neighbours that are similar in terms of productivity in both the year $t - 1$ and year $t - 2$, so that at least in the year $t - 1$ they experience similar productivity growth. This indeed results in a weaker impact of the ERDF on productivity. However, we still observe a positive effect after two years when the treated firms are matched with five nearest neighbours (see Table A4 in Appendix 5).

Extensions

Heterogeneity of the treatment effect

While the previous sections observed the average treatment effect of the ERDF on the performance of the participants, the impacts of ERDF are likely to vary across the participants depending on their room for potential growth, capabilities to make best use of the acquired funds, and also the type of a project in which they participated. We therefore follow the approach by Lechner (2002) to examine whether the difference-in-difference estimate on the impact of the ERDF project for each participant depends on its initial characteristics and the type of project. We specifically run the following cross-sectional regression:

$$(Y_{i,t+s} - \sum_{j \in C} w_{ij} Y_{j,t+s}) = \alpha_0 + \alpha_1 F_{i,t-1} + \alpha_2 Z_i + \alpha_3 Year_i + \alpha_4 Sec_i + \alpha_5 Reg_i + e_{i,t-1} \quad (4)$$

The dependent variable on the left hand side is the estimated treatment effect of the ERDF on various performance indicators of the firm i , s years after it participated in the project. The equation assumes that this is the function of $F_{i,t-1}$, which is the vector of the

characteristics of firm i one year before its participation ($t-1$)²³ and Z_i , which is the vector of the characteristics of the ERDF project in which the firm i participated, such as the size of the project in terms of value, associated risk and the length of the project²⁴, as well as the dummy variable that indicates the programme the project belongs to (such as “Support to science and research,” or “Acquisition of external markets” etc.). We also include dummy variables for the year when it launches the ERDF project ($Year_i$), the sector the firm belong to (Sec_i)²⁵ and the geographical areas (Reg_i) where the project was implemented.

Table 6 summarises the estimated coefficients on $F_{i,t-1}$ and Z_i for the treatment effects in the third year after the launch of the ERDF project (that is, the year $t + 2$). It is found that the positive treatment effects on TFP and labour productivity are larger for initially less productive firms, possibly due to a larger room for catch-up. They are also larger for initially younger and larger firms with higher indebtedness ratio. The positive treatment effect on capital intensity is larger for firms that are initially less capital intensive and highly leveraged. These findings suggest that firms facing high borrowing costs due to their high indebtedness benefit more from the ERDF, as it helps them finance the investment needed for growth. The ERDF also boosts the employment of initially younger and smaller firms faster. Most of initial firm characteristics included in the regression do not explain the individual treatment effect on export intensity, except the initial export intensity, which seems to contribute negatively.

Interestingly, most of characteristics of the ERDF project do not seem to affect the treatment effect on productivity or other performance indicators. The size of the ERDF project contributes positively to the increase in capital intensity, but negatively to the increase in employment and wages. One striking finding from Table 6 is that the coefficient on the dummy variable indicating the project “Acquisition of external markets” is not statistically significant when the dependent variable is the treatment effect on export intensity. This implies that even the participation in projects explicitly aimed at export promotion does not increase the export intensity of Latvian firms.

²³ Some firms participate in several ERDF projects. We cannot distinguish the effect of each individual project as projects may overlap. Therefore, we sum all ERDF projects for such firms. For instance, if a firm launches its first ERDF project in 2009, we analyse how the performance of such firm in 2009, 2010 and 2011 can be explained by the firm characteristics in 2008.

²⁴ Risk associated with a project is the Ministry of Finance assessment on the likelihood that the project is not fulfilled.

²⁵ We classify 2-digit NACE industries into the following 11 broad macroeconomic sectors: (1) mining and quarrying, (2) manufacturing, (3) energy and water supply, (4) construction, (5) wholesale and retail trade, (6) transportation and storage, (7) accommodation and food service activities, (8) information and communication, (9) real estate activities, (10) professional, scientific and technical activities, and (11) administrative and support service activities.

Table 6. The effects of characteristics of firms and the ERDF project on the treatment effect after three years

Explanatory variables: Characteristics of the firm and the ERDF project	Dependent variable: treatment effect on:						
	TFP	Labour productivity	Wage	Capital to labour	Employment	Turnover	Exports to turnover
Initial log of TFP	-0.258**	-0.202*	-0.0443	0.105	0.0316	-0.123*	0.0325
Initial log of labour productivity	-0.367**	-0.438***	-0.00173	-0.0220	0.0827	0.0429	-0.00646
Initial log of employment	0.280***	0.278***	0.0331	-0.0145	-0.124***	-0.0309	-0.0118
Age	-0.0323**	-0.0304**	-0.0126*	-0.0105	-0.0160*	-0.0158*	0.00112
Initial capital-to labour ratio	0.0471	0.0166	-0.0108	-0.235***	0.0385	0.000434	-0.00540
Initial exports-to-turnover ratio	-0.131	-0.206	-0.114	-0.243	0.164	0.0484	-0.145*
Initial indebtedness ratio	0.310**	0.324**	0.0396	0.358*	-0.0426	0.271**	-0.00329
Risk of the project	-0.237*	-0.181	-0.0136	-0.0435	-0.00863	-0.0426	-0.0242
Length of the project	0.0000428	0.0000671	0.0000504	0.0000810	0.0000676	0.000112	0.0000207
Number of different projects	0.00669	-0.00220	0.000138	-0.0223	0.0202	0.00883	-0.00371
Value of the project	-0.0163	0.00458	-0.0173***	0.0961***	-0.0144**	-0.0143*	-0.000171
2.1. Science and innovation	0.172	0.285	-0.0867	0.345	-0.143	-0.139	-0.163**
2.3. Entrepreneurship support (excl. 2.3.1.1)	-0.108	0.00237	0.154	0.407	-0.226	-0.0147	-0.0443
2.3.1.1. Acquisition of external markets	0.154	0.0682	-0.137	-0.666*	-0.167	-0.134	0.0672
3.4. Quality environment	0.146	-0.0971	-0.142	-0.0270	0.118	0.100	-0.0434
Year effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	429	429	429	429	429	429	429
R ²	0.366	0.355	0.0978	0.253	0.207	0.182	0.0939

Note: *(**)[***] denotes significance at 0.1(0.05)[0.01] level. Dependent variables are each treated firm's treatment effect three years after the participation in an ERDF project, computed as a difference-in-difference estimator using two nearest neighbours matching with a caliper = 0.05 (corresponding to column 1 in Table 4).

Source: CSB, Latvijas Banka and authors' calculations.

Is the ERDF superior to private funding?

Despite the principle that the EU Structural Funds must not replace domestic funds in areas of intervention, the EU funds are observed to substitute for private funding to a certain extent (Ederveen et al., 2003). It is therefore useful to observe whether a firm's ex post performance differs when its investment is financed by the ERDF rather than private funding. To the best of our knowledge, this kind of evaluation of the EU funds has not been conducted previously. Compared to private funding through internal cash flow or external borrowing or equity, the ERDF may be associated with weaker pressure to deliver improved performance in a short time span. On the other hand, they are subject to various administrative and monitoring processes, which would require early visible outcomes. Some studies have compared different funding sources in their effectiveness in boosting spending on R&D and innovation. For example, Czarnitzki and Lopes-Bento (2014) compared the effects on innovation activities of German firms between the EU-level subsidies and national subsidies. They found that EU subsidies have a smaller impact on firms' new product sales.

We modify our matching procedure by matching each ERDF project participant with non-participant firms that not only display a similar probability of participation but also a similar increase in the log of capital stock during the three years following the participation (from the year $t - 1$ to $t + 2$). The idea is that matched control firms must have financed such capital acquisition through private funding, given that they did not have access to the ERDF.

We follow Iacus et al. (2012) to first sort the participants and non-participants from those with smallest to largest increase in capital and then classify them into five groups each corresponding to the quintiles of the distribution of the increase in capital (in an alternative specification we separate them into 10 groups). We then carry out the nearest-neighbour matching with caliper using the propensity score within the same year, same NACE 2-digit industry and the same quantile in the increase in capital stock.

While such matching reduces the number of observations by around 15%, we obtain a satisfactory quality of match.²⁶ Furthermore, the statistically significant difference in the increase in capital stock over the three-year period between participants and non-participants is eliminated by such matching. We have therefore neutralised any treatment effects of the ERDF on firm performance that could be channelled through an increasing stock of capital.

Table 8 summarises the difference-in-difference estimates of the ATT of the ERDF. The treatment effect on productivity is not statistically significant even in the third year (column 1). The only significant treatment effects are found on employment throughout the three periods as well as on turnover and export intensity in the third period. .

The significant treatment effects on employment and turnover indicates that participation in an ERDF co-financed project results in a larger increase in employment and turnover compared to the case when the investment was financed by private sources. This may be partly due to the fact that the potential to increase employment and turnover is one of the

²⁶ The pairwise t-tests show that the difference in pre-treatment indicators between treated and control firms becomes statistically insignificant when 5 groups are used. However, statistically significant differences for initial employment and capital per capita remain when we use 10 groups. The results of the balance test are available upon request.

important criteria for selecting the beneficiaries for the ERDF.²⁷ In such cases, firms with an intent to scale up their operation may be self-selecting into participating in the ERDF.

Table 7. Difference-in-difference estimators for various methods of matching

Indicator	Period	Classification of firms into 5 groups	Alternative: Classification of firms into 10 groups
		(1)	(2)
Log of TFP	t	-0.114*	-0.039
	$t + 1$	0.016	0.060
	$t + 2$	0.097	0.087
Log of labour productivity	t	-0.126*	-0.063
	$t + 1$	0.008	0.033
	$t + 2$	0.080	0.035
Log of average wage	t	-0.031	-0.020
	$t + 1$	0.041	0.027
	$t + 2$	0.047	0.014
Log of employment	t	0.080**	0.065**
	$t + 1$	0.097***	0.097**
	$t + 2$	0.120***	0.139***
Log of turnover	t	0.007	0.019
	$t + 1$	0.054	0.090**
	$t + 2$	0.118**	0.130***
Exports-to- turnover ratio	t	0.004	0.008
	$t + 1$	0.016	0.024*
	$t + 2$	0.026*	0.039**
Number of treated firms		378	374
Number of control firms		660	652

Note: *(**)[***] denotes significance at 0.1(0.05)[0.01] level. The control groups are constructed by nearest neighbour matching with a caliper set to 0.025 within the same year, same NACE 2-digit sector and the same quintile of increase in the log of capital stock. Column 1 corresponds to the case where firms were separated into 5 groups of different extent of increase in capital. Column 2 corresponds to a finer separation into 10 groups. The bootstrap procedure with 250 replications is used to test the statistical significance of the difference-in-difference estimators.

Source: CSB, Latvijas Banka and authors' calculations.

Conclusions and policy implications

This paper provides one of the first sets of evidence on the impacts of the EU Structural Funds on the productivity and employment of recipient firms. We find that participation in a project co-financed by the European Regional Development Fund (ERDF) immediately increases the capital intensity of Latvian firms and boosts their growth in term of turnover and employment. However, significant increases in labour and total factor productivity are observed only three years later. The time lag between the fast capital deepening and firm growth and the slow materialisation of productivity growth was also reported for other European countries by Bachtrögler and Hammer (2018), one of the very few other works that employed firm-level data to assess the impact of EU structural funds.

²⁷ For example, participation in the activity “Creation or reconstruction of industrial premises” is *inter alia* assessed in relation to future employment prospects (<https://likumi.lv/doc.php?id=257096>). Furthermore, job creation was seen as crucial to overcoming the consequences of the deep economic crisis.

One possible explanation for such a time lag is that recipient firms must build sufficient skill and knowledge to exploit the full potential of new capital acquired in the ERDF project. The significant productivity gains would then materialise in the longer run. However, the additional analysis based on a smaller sample with longer observations does not support this view, as the positive and significant effect of the ERDF on productivity does not last beyond the third year. Another interpretation is based on the finding that the participation in ERDF projects does not boost the export intensity of Latvian firms, even those that are explicitly intended to promote exports. Such a lack of internationalisation may be holding back the improvement in productivity, as Latvia's small domestic market constrains the full utilisation of the increased production capacity.

Owing to the rich firm-level dataset containing granular information, this paper provides several pieces of evidence on the characteristics of recipient firms that were not documented by Bachtrögl and Hammer (2018). For instance, we find that firms that are initially more productive and larger are more likely to participate in ERDF projects, which suggests that the participation is associated with large fixed costs. Also, the probability of participation increases with a higher share of employees or managers with previous experience in working for firms that have previously participated in ERDF projects. This suggests that such fixed costs are closely related to the need to acquire knowledge on the complex application procedures and regulations on the implementation of the ERDF project.

Another novel contribution of this paper is documenting the heterogeneity in the treatment effect of the ERDF among the recipients. For instance, recipients that were initially less productive, larger, less capital intensive and more financially leveraged (and therefore likely to face higher borrowing costs) enjoyed larger increases in productivity and capital deepening. Therefore, a recipient's room for productivity catch-up, initial capital intensity and access to finance shape its ability to benefit from the ERDF. Furthermore, we find that the ERDF is not superior to private funding as a mean to finance capital investment, in the sense that firms financing their capital deepening with the ERDF instead of private funding do not enjoy any extra productivity gains. If anything, the only advantage of the ERDF against private funding may be that firms that are more leveraged can enjoy lower borrowing costs, which seems to contribute to faster productivity gains.

There are several possible ways to develop the current research further. First, the role of human capital in making the most of the Structural Funds should be explored further. Higher skill intensity may also allow firms to sustain productivity gains over a longer run. It may also facilitate the internationalisation of firms by entering export markets or expanding export destinations (Masso et al., 2015). Another important topic that is worth exploring further is the impact of ERDF on the local labour market. Because the ERDF increases participants' employment and wages, the Structural Funds may play a significant role in boosting labour demand, thereby reducing unemployment and poverty. On the other hand, if the participants in ERDF projects mainly increase their demand for skilled workers, the ERDF can intensify the severe recent skills shortages faced by Latvia and many other emerging EU economies (OECD, 2017). It may even crowd out smaller firms from accessing skills needed for growth.

This paper provides several implications for EU regional support programmes. It specifically highlights the need for reforming the operation of EU Cohesion Policy. While our findings overall point to positive impacts of the ERDF on firm performance, firms that are initially more productive and larger are more likely to participate in ERDF co-financed projects. This may be partly due to the fact that many small firms were subject to severe

credit constraints during our sample period and therefore did not have the ability to co-finance the EU fund projects (OECD, 2012). But it also points to the possibility that the complex application procedures and onerous administrative burdens associated with the Structural Funds, widely recognised among the participants in EU-fund projects and by the European Commission (OECD, 2018), are excluding smaller, less productive firms from participation in ERDF projects. Our findings indicate that the ERDF is particularly effective in boosting the productivity of originally less productive firms. The ERDF can thus contribute to the growth of SMEs, which are often lagging behind in productivity. Rigorous efforts to reduce the administrative barriers to accessing the ERDF by both the European Commission and national authorities are needed. The European Commission is envisaging streamlining the regulations on the Structural Funds (OECD, 2018). The authorities in receiving countries could also provide technical assistance to smaller and younger firms on the application for the EU regional support programmes and project management.

Because initially productive and larger firms are more likely to participate in ERDF projects and the ERDF allows those firms to grow in size, the ERDF is likely to contribute to aggregate productivity growth by allowing productive firms to expand their weight in the economy. However, such resource allocation should be primarily realised by well-functioning factor markets and competitive product markets. Any frictions to resource allocation must be removed by structural reforms that enhance the functioning of market mechanisms, while the EU funds should not be considered as a substitute to such reforms. Instead, the EU funds could be targeted toward smaller firms which are often subject to tight credit constraints, in order to finance their innovation efforts to boost productivity.

Finally, granular empirical evaluation of regional support programmes similar to what was accomplished in this paper should be used extensively to improve the design or better target the projects financed by the Structural Funds. Admittedly, this paper focuses on the ERDF and its findings may not be directly applicable to other Structural Funds projects such as the Cohesion Fund. However, we believe that combining rigorous evaluations based on firm-level data for each type of the EU Structural Funds would contribute proportionally more to the improvement in their effectiveness than assessments that bunch all EU funds together and infer their contribution to regional economic growth.

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Annex A. Additional information on EU funds in Latvia

Figure A.1. EU funded operation programmes in 2007-2013

Note: Purple coloured boxes refer to operational programmes and activities financed by the ERDF.

Source: www.esfondi.lv

Table A.1. Main characteristics of ERDF projects by activities (2008–2015, private enterprises only)

Activity	Number of firms	Value of projects (millions of EUR)	Length (years)	Value per firm (thousands of EUR)
2. Entrepreneurship and innovation				
2.1. Science and innovation				
2.1.2.2. Development of new products and technologies	76	11.1	1.3	146.1
2.1.2.4. High value added investments	60	66.6	1.6	1109.4
2.3. Entrepreneurial support				
2.3.1.1. Acquisition of external markets	806	11.5	1.7	14.3
2.3.2.2. Support to investments in special zones	63	8.1	0.8	145.0
3. Infrastructure and services				
3.4. Quality environment				
3.4.1.1. Development of water supply infrastructure	39	32.2	2.5	825.9
3.4.4.1. Heat insulation of dwellings	49	26.8	2.8	546.7
Mix of various activities	165	221.6	4.3	1342.9
Total	1258	377.9	2.0	300.4

Note: This table includes only ERDF projects implemented by private enterprises and excludes projects implemented by state agencies and local governments.

Source: CSB, Latvijas Banka and authors' calculations.

Table A.2. Main characteristics of ERDF projects by activities (sample used for the empirical analysis)

Activity	Number of firms	Value of projects (millions of EUR)	Length (years)	Value per firm (thousands of EUR)
2. Entrepreneurship and innovation				
2.1. Science and innovation				
2.1.2.2. Development of new products and technologies	45	8.1	1.3	181.0
2.1.2.4. High value added investments	12	19.7	2.6	1645.7
2.3. Entrepreneurial support				
2.3.1.1. Acquisition of external markets	285	5.8	2.5	20.4
2.3.2.2. Support to investments in special zones	24	6.0	0.9	248.7
3. Infrastructure and services				
3.4. Quality environment				
3.4.1.1. Development of water supply infrastructure	12	8.9	2.5	744.3
3.4.4.1. Heat insulation of dwellings	25	19.4	3.2	776.1
Mix of various activities	77	92.6	4.8	1203.1
Total	480	160.7	2.7	334.7

Note: This table includes only those ERDF projects that are used in our DiD analysis, i.e. those implemented by private enterprises over the period 2008-2013 excluding enterprises participating in other EU regional support programmes and enterprises with missing data between $t - 1$ and $t + 2$. Finally, it excludes projects implemented by state agencies and local governments.

Source: CSB, Latvijas Banka and authors' calculations.

Figure A.2. Regional and sectoral affiliation of firms participating in ERDF co-funded projects in 2007-2013

a. By economic sectors

b. By geographical areas

Source: CSB, authors' calculations

Figure A.3. Allocation of the 2007–2013 programming period's ERDF funding in Latvia

a. By economic sectors

b. By geographical areas

Source: CSB, authors' calculations

Annex B. Description of the firm-level data

The following firm-level datasets are combined to construct the database of Latvian firms used in the empirical analysis.

Firms' indicators comprehensive database that contains information on companies' balance sheets and profit and loss statements. It provides data on value added, the number of employees, labour costs, fixed assets, turnover and intermediate inputs. Data are collected by the Central Statistical Bureau (CSB) and the State Revenue Service.

Goods external trade database that includes data on merchandise flows (exports and imports) where merchandise is classified according to the 8-digit Combined Nomenclature (CN8) classification. This data comes from two sources: INTRASTAT surveys for Latvia's trade with other EU Member States and custom declarations for trade with countries outside the EU.

Services external trade database compiled by Latvijas Banka provides data on export and import flows for all types of services apart from travel, construction, insurance and government services.

Firms' foreign assets and liabilities dataset, also compiled by Latvijas Banka, provides information on external assets and liabilities of firms. This dataset allows us to detect firms with foreign capital and the origin of such foreign capital.

Employer-employee data constructed by the CSB based on State Revenue Service data from companies' social insurance declarations allow employees' movement across firms to be tracked. We use this data to identify whether a firm hires workers who previously worked for firms that participated in ERDF projects.

Annex C. Estimation of Total factor productivity

We follow the approach by Petrin and Levinsohn (2012), which is the elaborated version of Wooldridge (2009) methodology. Assuming that the production function is of Cobb–Douglas form, we estimate its coefficients by running the following pooled IV regression:

$$\ln VA_{i,t} = \beta_0 + \beta_1 \ln K_{i,t} + \beta_2 \ln L_{i,t} + h^{-1}(\ln K_{i,t-1}, \ln M_{i,t-1}) + \gamma Year_t + \varepsilon_{i,t} + u_{i,t} \quad (A1)$$

where $VA_{i,t}$, $K_{i,t}$, $M_{i,t}$ are real value added, real capital stock and real intermediate inputs respectively for the firm i , $L_{i,t}$ stands for the number of employees, $\varepsilon_{i,t}$ is an unexpected shock to the productivity process that follows a random walk with drift, and $u_{i,t}$ represents an *iid* error term. The function h^{-1} is approximated with a polynomial of order three. Since the number of employees and TFP are determined simultaneously, but capital takes time to build up, the log of employees is instrumented by its own lagged values.

We compute firm-level TFP ($TFP_{i,t}$) as a residual:

$$\ln \widehat{TFP}_{i,t} = \ln VA_{i,t} - \hat{\beta}_0 - \hat{\beta}_1 \ln K_{i,t} - \hat{\beta}_2 \ln L_{i,t} - \hat{\gamma} Year_t \quad (A2).$$

Similar to Lopez-Garcia et al. (2015), the estimation is performed at a 2-digit industry level. However, β and γ coefficients are replaced by estimated values obtained at a corresponding macrosector if the sector has less than 25 observations per year. Estimation results are available upon request.

Annex D. Difference-in-difference estimators for longer horizons with 90% confidence intervals

Annex E. Robustness analysis

Table E.1. Difference-in-difference estimators addressing the end-of-the-year problem

Indicator	Period	2 nearest neighbours with a caliper	Alternative: 5 nearest neighbours with a caliper
		(1)	(2)
Log of TFP	t	0.024	0.060
	$t + 1$	0.053	0.077
	$t + 2$	0.147**	0.175**
Log of labour productivity	t	0.029	0.069
	$t + 1$	0.063	0.088
	$t + 2$	0.141*	0.174**
Log of the average wage	t	0.014	0.020
	$t + 1$	0.044	0.054*
	$t + 2$	0.065*	0.077**
Log of the capital-to-labour ratio	t	0.083*	0.103**
	$t + 1$	0.188***	0.187***
	$t + 2$	0.179**	0.204**
Log of employment	t	0.105***	0.093***
	$t + 1$	0.152***	0.148***
	$t + 2$	0.197***	0.193***
Log of turnover	t	0.112***	0.114***
	$t + 1$	0.180***	0.175***
	$t + 2$	0.239***	0.240***
Exports-to- turnover ratio	t	0.010	0.007
	$t + 1$	0.018	0.017
	$t + 2$	0.018	0.017
Number of treated firms		391	391
Number of control firms		684	1503

Note: *(**)[***] denotes significance at 0.1(0.05)[0.01] level. The control groups are constructed by nearest neighbour matching with a caliper set to 0.01. The bootstrap procedure with 250 replications is used to test the statistical significance of the difference-in-difference estimators.

Source: CSB, Latvijas Banka and authors' calculations.

Table E.2. Difference-in-difference estimators with the control group sharing similar productivity growth in $t - 1$ with the treated group

Indicator	Period	2 nearest neighbours with a caliper	Alternative: 5 nearest neighbours with a caliper
		(5)	(6)
Log of TFP	t	-0.063	-0.027
	$t + 1$	-0.005	0.031
	$t + 2$	0.048	0.109
Log of labour productivity	t	-0.042	-0.013
	$t + 1$	0.027	0.054
	$t + 2$	0.083	0.142*
Log of the average wage	t	0.013	0.006
	$t + 1$	0.065*	0.060**
	$t + 2$	0.060	0.072**
Log of the capital-to-labour ratio	t	0.160***	0.153***
	$t + 1$	0.266***	0.261***
	$t + 2$	0.306***	0.302***
Log of employment	t	0.080***	0.078**
	$t + 1$	0.124***	0.126***
	$t + 2$	0.165***	0.162***
Log of turnover	t	0.072*	0.070**
	$t + 1$	0.173***	0.158***
	$t + 2$	0.239***	0.231***
Exports-to-turnover ratio	t	0.009	0.006
	$t + 1$	0.017	0.014
	$t + 2$	0.026	0.025*
Number of treated firms		351	351
Number of control firms		625	1311

Note: *(**)[***] denotes significance at 0.1(0.05)[0.01] level. The control groups are constructed by nearest neighbour matching with a caliper set to 0.004. The bootstrap procedure with 250 replications is used to test the statistical significance of the difference-in-difference estimators.

Source: CSB, Latvijas Banka and authors' calculations.