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Unleashing the Potential of Estonian Firms: An Empirical Analysis of the Impact of ERDF Grants

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Abstract

In this paper, we explore the effect of obtaining grants from the European Regional Development Fund (ERDF) on the performance of Estonian firms. We utilize a rich firm-level dataset derived from the Estonian E-Business Register and the State Shared Services Centre. The study is conducted for the entire European Union (EU) budgetary period of 2014–2020. We employ a combination of propensity score matching (PSM) and difference-in-differences (DiD) techniques, along with standardized mean difference tests, heterogeneity assessments, and robustness checks. The results demonstrate a significant positive effect on revenue, employment, and wages, but no meaningful impact on labor productivity. The effect on leverage remains ambiguous. Our study indicates that initially younger, and lower-income firms gain from the grant to a larger extent in terms of revenue, employment, and labor productivity. The research concludes that obtaining an ERDF grant has an important role in expanding the workforce and providing financial resources for further earnings increase, especially for less-established firms. The further implications refer to more specific research in understanding management decision-making processes, particularly in regard to the complex mechanisms underlying grant utilization and the anticipation effects. Furthermore, our study calls for better action in assisting smaller-scale companies and examining the implications for stakeholders on a broader level.

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1. Introduction

The European Union (EU) allocated 546 billion euros under the European Structural and Investment Fund (ESIF) in the most recently completed budget period of 2014–2020 (European Commission, n.d.-a), contributing to over 200,000 unique business projects per annum (European Commission, n.d.-b). Under the ESIF programs, Cohesion Policy is a fundamental principle, seeking to narrow the disparities between member states by enhancing economic development and competitiveness (Baun & Marek, 2014). The policy framework includes several funds, the European Regional Development Fund (ERDF) standing out for its pronounced support for entrepreneurship and contribution to the competitiveness of less developed regions (European Commission, 2014).

Examining the implications of the Cohesion Policy at the microeconomic level is applicable since regional assessment can depend on country-specific development level and qualification for grants (Beņkovskis, Tkačevs, & Yashiro, 2019). Therefore, choosing the case of Estonia for our analysis allows us to utilize rich administrative firm-level data of companies in a single country. The primary source of aid for Estonia stems from the European Regional Development Fund (ERDF) which has been of pivotal importance in improving the innovation and development of small-scale companies (European Commission, 2014). Estonia is particularly contingent on EU support, considering that the country was classified as a less developed region at the outset of the 2014–2020 budgetary period (European Commission, n.d-d), consequently receiving substantial assistance from the ERDF and providing a relevant case for examination.

The academic literature generally agrees that the effect of European structural funds is beneficial to firms' performance in terms of revenue, employment, and capital intensity (Banai et al., 2020; Campos & Cabral, 2023; Šelebaj & Bule, 2021). The examination of commonly investigated measures also includes the positive impact on exports and value-added (Beņkovskis, Tkačevs ,& Yashiro, 2019; Campos & Cabral, 2023). However, mixed results remain regarding the effect on productivity as some identify a positive impact immediately (Hartšenko & Sauga, 2013) or in the long run (Beņkovskis, Tkačevs, & Yashiro, 2019), yet others detect no effect at all (Biagi, Bondonio, & Martini, 2015; Criscuolo et al., 2012), warranting further analysis.

Consequently, we arrive at our research question: **What is the effect of receiving European Regional Development Fund (ERDF) grants on the performance of Estonian firms?**

The propensity score matching (PSM) technique is employed to match control firms to companies who received a grant, using the nearest-neighbor and caliper methods. The matching process is followed by the difference-in-differences (DiD) approach that fosters determining the changes in performance for companies who received a grant during the period compared to those who did not. We enrich the quantitative analysis with heterogeneity and robustness tests. Furthermore, we employ the most recently suggested balance assessment methods via standardized mean differences and variance ratios.

We aim to bring novelty to the field by investigating the effects of receiving a grant based on the whole EU budgeting period of 2014–2020, which to our knowledge, has not been analyzed similarly to the full extent with regard to Estonian firms. The financial reports spanning over a notable period of 9 years (2013–2021) are utilized for this purpose. Furthermore, we conduct a comprehensive examination of various firm characteristics, drawing from a broad range of previous literature and supplementing the field by examining efficiency and leverage.

We find that receiving an ERDF grant results in a strong and positive effect on revenue, employment, and wages; yet, we do not discover any meaningful impact on employee productivity. The effect on leverage remains ambiguous. Analysis of firm heterogeneity patterns reveals that initially smaller, younger, and lower-income firms benefit more in terms of revenue, employment, and labor productivity after obtaining the grant, which could be explained by a higher potential for expansion. We conclude that the ERDF grant has an important role in expanding the workforce and providing financial resources for further sales increase, pronounced for less-established firms.

Estonia serves as a pertinent country of study due to being a small nation that relies substantially on external funding and the findings could constitute an improved understanding of why supporting less-developed regions is crucial to the economic growth of the EU. Hence, investigating the effectiveness of grants is relevant given that demonstrating a positive impact on a firm's performance could serve as a catalyst for individual firms to seek and obtain grants that further could stimulate economic growth.

Our work is divided into six core parts. First, Section 2 performs a thorough review of the literature to map out the ecosystem of participants involved in the process

of grant giving, develop a deeper understanding of the EU funding aid, and determine which findings the academics have jointly reached and where discrepancies emerge. Thereupon, we motivate our choice of methodology and measures in Section 3 and investigate thoroughly the propensity score matching and difference-in-differences techniques. The data analysis in Section 4 highlights the main distinctions of our sample, discusses the results of PSM and DiD analyses, and describes robustness and heterogeneity checks. Lastly, we discuss the limitations encountered in Section 5, as well as provide insights into the implications and conclude all findings in Section 6.

2. Literature Review

2.1. The Funding Framework of the European Union

The European Structural and Investment Funds (ESIF) are financial tools for supporting the economic development of the European Union, Estonia included. The European structural funds allocated to the countries help to carry out the EU's regional policy via objectives set by the European Parliament and the Council of the European Union. The European Commission is accountable for implementing the EU budget and managing its funding programmes. For the EU budget to become into force, the European Commission has to get approval from the Council of the European Union and the European Parliament by proposing a draft budget. (European Commission, n.d.-c) The objectives under the ESIF are part of the long-term EU budget, which provides financing for various programmes to support regional policy in accordance with the EU's priorities (GSC, 2022).

The EU contributes to more than 200,000 different business projects every year. For a company to receive financing from EU funds, the business must follow the rules set by the EU and satisfy the chosen grant application criteria. If the grant proposal meets the requirements, the selection process is pursued by specialists in the corresponding field who score candidates against selection criteria. The applicable funding programme depends on the nature of one's business, and the affirmative funding decision creates a beneficiary – that is the grantee in the financial aid distribution process. (European Commission, n.d.-b)

2.1.1. The Structure of the EU Budget and ESIF

This paper analyses the ESIF funding data about Estonian companies based on the 2014–2020 long-term EU budget that is in line with the multiannual financial framework (MFF). The MFF creates the structure for effective policymaking and goal-setting within the region and outlines the maximum amount of finances that can be allocated to a specific policy area. The functioning of the EU depends on its long-term budget planning which usually is designed over a five to seven-year period. (GSC, 2022)

More than half of the funding under the 2014–2020 EU budget came from the five ESI Funds – European Regional Development Fund (ERDF), European Social Fund (ESF), Cohesion Fund (CF), European Agricultural Fund for Rural Development (EAFRD), and European Maritime and Fisheries Fund (EMFF) (European Commission, n.d.-d). All of the ESI Funds aim to operate together to sustain economic development within the EU and facilitate its economic growth. Under the long-term EU budget, financing the member states' regional policies helps to create an investment framework for the EU that supports its policy objectives. (UNESCO, n.d.)

There are three possible management types of the EU budget – direct, shared, and indirect – whose implementation depends on the fund. The administration of the ESIF is achieved through shared management, which involves the creation of Partnership Agreements (European Commission, n.d.-e). Shared management accounts for 80% of the EU budget expenditure management methods, and is the focus of this research. The functioning of structural funds is contingent on the interaction between the European Commission, which manages the funds, and the member state authorities, as both entities jointly govern the funding. (European Commission, n.d.-b)

Partnership Agreements assist the optimal use of EU structural funds. The objective of the agreement and the corresponding funding allocated to Estonia during 2014–2020 was to facilitate sustainable economic growth, bolster human resources development, and enhance employment opportunities. (European Commission, 2014) The Partnership Agreement for Estonia was supported by the ESIF to help the country achieve the selected thematic objectives, explored further in Section 2.1.3.

The architecture of the 2014–2020 financing programmes in Estonia included all of the five funds under ESIF: Cohesion Policy was financed by ERDF, CF, and ESF; the Rural Development Programme by EAFRD; and the Fisheries programme by EMFF. The 4.4. billion budget for Estonia was allocated accordingly: €3.58 billion to Cohesion Policy, €725.8 million to EAFRD, and €100.9 million to EMFF. (European

Commission, 2014) The EU budget for Estonia was planned and divided between the funds in the following way: 42.5% of the resources came from ERDF, 24.1% from CF, 20.5% from EAFRD, 11% from ESF, and 2% from EMFF (European Commission, 2023a). Among the aforementioned funds, ERDF contributed the most to national programmes objectives funding. Hence, the paper will proceed further with the breakdown of the Cohesion Policy – including ERDF and its policy objectives.

2.1.2. The European Union Cohesion Policy

One of the key strategies in the European Union is the Cohesion Policy which has been evolving since the 1980s. The general purpose of the policy is to lessen disparities between the EU countries and enhance the social, economic, and territorial cohesion of the region. The aim to advance the EU's economic development and competitiveness is performed through planned investments. (Baun & Marek, 2014) The Cohesion Policy funding to specific projects is accomplished through a complex procedure, where operational programmes enable the determination of further priorities and strategies necessary for the funding (Kondor-Tabun & Staehr, 2015).

The 2014–2020 Cohesion Policy operational programmes received funding from four different sources – European Regional Development Fund (ERDF), Cohesion Fund (CF), European Social Fund (ESF), and Youth Employment Initiative (YEI). Among the Cohesion Policy Funds in 2014–2020, European Regional Development Fund (ERDF) constituted more than half of its budget. The ERDF formed 59.7% of the 2014–2020 budget, thereupon 26.5% stemmed from ESF, 13.6% from CF, and 2% from YEI. (European Commission, 2023b) Estonia received funding from three of them – most from the ERDF and none from YEI. The Cohesion Policy in Estonia amounted to €3.58 billion, with ERDF contributing approximately 52.3%, CF accounting for 30%, and ESF for 16.4% of the fund's total allocation. (European Commission, 2014).

2.1.3. The European Regional Development Fund (ERDF)

This paper examines particularly the effect of ERDF on grant recipients in Estonia. The fund was established in 1975 and it aims to help less developed countries by promoting entrepreneurship, supporting public infrastructure, and strengthening social and economic unity within the EU (EsFondi, 2020). In the period of 2014–2020, there were 11 thematic objectives for the ESI Funds, which all applied to ERDF programmes. Additionally, ERDF divided nine of the thematic objectives into 38

investment priorities, which were the basis for qualifying projects under financing programmes (keep.eu, n.d.).

During 2014–2020, ERDF's focus areas known as 'thematic concentration' were: "innovation and research, the low-carbon economy, the digital agenda, and support for small and medium-sized enterprises" (European Commission, 2023c). The list of 2014–2020 thematic objectives for the EU can be found in Appendix A. Among cohesion funds, the ERDF supported all of the 11 objectives with a main focus on the first four, the CF followed the goals between 4–7, and ESF set the priorities on 8–11 of the thematic objectives.

The Government of the Republic of Estonia set a country-specific Operational Programme strategy in line with the EU's regional development priorities for the period of 2014–2020. The strategy was set in force with the Partnership Agreement indicating Estonia's development needs, with a focus on the following overall objectives: "(1) high-quality and accessible education based on the needs of students and society, (2) high employment rate and high-quality working life, (3) A knowledge-intensive and internationally competitive economy, (4) a clean and diverse natural environment and efficient use of resources, and (5) sustainable connections and mobility options, satisfying the population's needs and supporting entrepreneurship."(European Commission, 2014) The ERDF-specific grants allocated to the companies in Estonia are based on the following priorities under the first four thematic objectives: "Strengthening research, technological development and innovation," "Enhancing the competitiveness of SMEs," and "Promoting social inclusion, combating poverty, and any discrimination" (European Commission, 2014).

The allocation of funding from the ERDF depends on the category of the region and the number of priorities set in the area. The category is derived by using the gross domestic product (GDP) per capita criteria that is adjusted for purchasing power standard (PPS). The calculated regions are divided into three categories based on GDP per capita PPS – less developed regions (> 75% of the EU average), transition regions (75 and 90 percent of the EU), and more developed regions (< 90% of the EU average) – which are then compared to the EU averages. The total sum of ERDF aid for a country is based on the sum of financing to the regions. (Kondor-Tabun & Staehr, 2015) According to the European Commission and Structural Funds 2014–2020 (ERDF and ESF) eligibility in the period, Estonia was placed under the *Less Developed Regions* list,

meaning that the GDP per capita was smaller than 75% compared to the EU-27 average. (European Commission, n.d-f)

The Cohesion Policy finances are a significant source of revenue for Estonia and its public and private investments, fostering innovation, research, and the development of small and medium-sized enterprises (Kondor-Tabun & Staehr, 2015). During the EU budget periods of 2007–2013 and 2014–2020, the bulk of the finances allocated to Estonia originate from the ERDF. Hence, our paper aims to see the effect on the Estonian economy by analyzing the performance of firms that received support from ERDF during the EU 2014–2020 budget period.

2.2. The Ecosystem of Giving Grants in Estonia

The process of obtaining grants from the ESIF for Estonian companies commences at the European level with the European Commission, which formulates a corresponding legal framework. Thereupon, the construction of the national system is delegated to the managing authority of the member state – that is the State Shared Service Centre (SSSC) in Estonia – and giving out grants is performed on the basis of the specific operational programme. (SSSC, 2022a)

The SSSC acts as a leading participant in giving grants. It is a government agency and is authorized for managing the distribution of all EU structural and investment funds as well as regional grants. The SSSC collaborates closely with the Estonian Ministry of Finance whose primary task is to plan the state budget, decide where and how it is allocated, and prepare relevant policies (SSSC, n.d.). However, since 2018, SSSC has had full authority to organize the programmes and application process, as well as pay out the grants (SSSC, 2021b).

In the Estonian grant ecosystem, the 1st and 2nd level intermediate bodies represent the subsequent entities involved in the process. The function of the 1st level intermediate body lies in fulfilling the goals declared by the Estonian Government through engaging in a specific priority or measure (SSSC, 2022a). According to the 2014–2020 Structural Assistance Act (2014, § 7), the obligations encompass designing preconditions for grants, monitoring their fulfillment, governing the 2nd level intermediate body in legislation implementation, and proposing recommendations to the Ministry of Finance with regard to the Operational Programme and the Partnership Agreement. Moreover, the 2nd level intermediate body is mainly responsible for the execution of the grant application process, approving the beneficiaries, and further

monitoring support for specific projects (SSSC, 2022a; 2014–2020 Structural Assistance Act, 2014, § 8).

To receive a grant, the company must first fill out the grant application. After the positive funding decision, the applicant is considered the beneficiary, and consequently, must follow pertinent rules and regulations – the most prominent being the reporting obligation and admission to carry out inspections. (SSSC, 2022a) In case of violation of the rules specified in the Structural Assistance Act, the 2nd level intermediate body has the entitlement to suspend the grant payments (2014–2020 Structural Assistance Act, 2014). A complete overview of the Estonian grant ecosystem can be found in Appendix B.

2.3. The Procedure of Allocating 2014–2020 ESIF Grants in Estonia

Estonia started to receive support from the European Structural and Investment Funds (ESIF) after joining the European Union in 2004. The assistance provided to Estonia from EU funds has exhibited an upward trend over time as evidenced by a comparison of the preceding budgetary periods; specifically, the financial allocation from the ESIF amounted to 3.4 billion euros between 2007–2013, whereas it increased to 4.4 billion euros for the 2014–2020 budgetary period. (European Commission, 2023c; SSSC, 2021a)

For a firm to receive ESI funding, its application and project description needs to be in accordance with the investment priorities indicated under the EU performance framework. Three specific programme priorities are considered relevant for this paper because our sample and further empirical research are based on the programmes that received funding under the following priority axes: ‘Growth-capable entrepreneurship and internationally competitive RD&I’, ‘Development of SME and strengthening the competitiveness of regions’, and ‘Increasing social inclusion’ (SSSC, 2022b). The funding was provided by the ERDF for all of the programmes, and companies that obtained this financing were required to link their projects' implementation to an EU initiative or carry out a policy established by the EU (European Commission, n.d.-b).

The most extensive list of the projects in our sample followed the ‘Growth-capable entrepreneurship and internationally competitive RD&I’ priority that was listed under the thematic objective of ‘Strengthening research, technological development and innovation’. The EU aimed to encourage firms to develop high-value products and services, with the objective of enhancing resource productivity and advancing the

transition of Estonia's economic position towards more knowledge-intensive activities. The investment priorities related to business-specific activities were stimulating R&D and fostering cooperation among private sector entities, research and development institutions, and the higher education sector. (RTK, 2014) The performance indicators for firms under this priority axis were resource productivity and revenue (SSSC, 2019), which are further applicable to our data analysis section.

The 'Development of SME and strengthening the competitiveness of regions' priority was the second most targeted one among all firms in our sample and was listed under the thematic objective 'Enhancing the competitiveness of SMEs'. Beneficiaries sought to boost their export and growth, and moreover, increase their business operations outside the biggest cities in Estonia – Tartu and Tallinn – to foster the growth potential at the regional and international levels. These objectives were evaluated based on the share of GDP created outside of Harju and Tartu County. Additionally, the goals were evaluated by measuring the value added per employee among SME beneficiaries and considering the number of exporting companies in Estonia. (SSSC, 2019)

'Increasing social inclusion' was the third most common priority among our treatment group firms. The established thematic objective pertained to "Promoting social inclusion, combating poverty and any discrimination," with a particular focus on projects and businesses associated with the healthcare sector. Firms that obtained funding under this objective were required to show interest in creating services or products that boost social inclusion, providing improved access to social, cultural, and entertainment services. (SSSC, 2019) Numerous prior studies have suggested a positive correlation between heightened levels of social inclusion and increased employee productivity throughout the organization (for reference Leber et al., 2018; Romi, Cook, & Dixon-Fowler, 2018; Sun & Yu, 2015; Tunio et al., 2021). Therefore, we posit that employee productivity can be construed as a potential favorable impact of grants for the corresponding performance evaluation.

2.4. The Effect of Grants on Firm Performance

There is various literature available regarding the effect of grants on the social welfare of a country as well as the performance of individual firms. Beņkovskis, Tkačevs, and Yashiro (2019) study the impact of ERDF aid on the productivity of firms, employee numbers, and other financial health measures. Their work is conducted on the basis of Latvian firm-level data. The authors control for bigger firms being more likely

to receive a grant, and thereupon, conclude that partaking in the ERDF support programmes leads to a higher number of employees, revenue, and capital stock. In contrast, productivity is only positively affected later – in two years. (Beņkovskis, Tkačevs, & Yashiro, 2019) Similarly, Šelebaj and Bule (2021) find comparable results on the same variables for Croatia, which received EU funds between 2012 and 2018; the only difference is that the authors omitted the export indicators and included the positive effect on operational profits.

Campos and Cabral (2023) examined the ERDF distributed within the COMPETE project during 2006–2019 in the example of Portuguese companies and deduced that firms with projects which received such support in contrast to the control group showed increased employee numbers, capital-to-assets ratio, exports, revenue, and gross value added as well as better employee productivity, most of which are affected by up to 5 to 7 years after grant decision. The authors bring additional value to the field by incorporating unsuccessful applicant firms in their control group, which is something out of the scope of this bachelor's thesis due to Estonian law not allowing the disclosure of unsatisfied applications until the year 2028 (Campos & Cabral, 2023; 2014–2020 Structural Assistance Act, 2014, § 39).

Banai et al. (2020) study Hungarian firms in a similar way and find that whilst firm revenue, operating profit, employment, and gross value added increase after receiving grants from the Structural and Cohesion Fund during the period of 2007–2013, labor productivity remains unchanged. Nevertheless, they point out that without such funding aid, many of the projects would not have come into force at all, and thus, take an overall positive stand on the ability of EU grants to improve capacity expansion. Muraközy and Telegdy (2022) investigate the impact of the EU Structural and Cohesion Fund grants on Hungarian firms too but they have a clear focus on SME support in 2004–2014. Notably, they found conflicting results with the aforementioned study, as their data indicates an effect on higher labor productivity (Muraközy & Telegdy, 2022).

The literature regarding productivity remains somewhat inconclusive. Hartšenko and Sauga (2013) prove in the case of Estonian SMEs that the grant obtainment can increase employment and labor productivity, consequently bettering Estonian economic development. However, Dvouletý, Srhoj, and Pantea (2021) examine 30 papers from 13 different countries to provide an overview of the effect of EU financial support on SMEs, starting from the year 2000. While reviewing various works over 20 years, the authors demonstrate that the positive effect of grants spills over to firm survival,

employee numbers, assets, and revenue; yet, the effect on labor and total factor productivity remains inconclusive (Dvouletý, Srhoj, & Pantea, 2021).

Further, Biagi, Bondonio, and Martini (2015) study the effect of investment subsidies allocated to Italian firms. They analyze various outcomes, including labor productivity, and find no empirical evidence for changes in productivity, which they are examining to assess the incentives regarding the quality of newly established workplaces. Similarly, Criscuolo et al. (2012) denote no significant effect on productivity measures when assessing the impact of business support policies on UK firms that initially was thought to be raising productivity. Thus, it becomes evident that further research in the field may be needed, to get more united results regarding the effects.

Works regarding Estonian enterprises and grant acquisition are mostly done on the basis of older EU grant policies such as the research of Vildo and Masso (2009) which observes the period of 2002–2003 and finds a positive influence on employment and revenue, but a negative impact on productivity. An exception regarding Estonian-based papers is the very recently published work of Ferraro, Männasoo, and Tasane (2023) who analyze the positive effect on employment and labor productivity during the 2014-2020 EU Cohesion Policy Programme period; however, a somewhat differing set of covariates was chosen, and the final observation year was 2018, motivating the continuation of our research in the similar field. Altogether, not so many analyses have been published that would consider the latest 2014–2020 EU budget allocation to Estonia to the extent that this work aims to achieve.

It must be considered that the effect of the Cohesion Policy may not only be reflected in the financial indicators, or at least not immediately. Due to the diverse nature and differing objectives of the EU policies, some results may be of societal value, like better education or increasing sustainability (Piattoni & Polverari, 2016). Nevertheless, for the scope of this paper, we focus on measurable indicators to estimate concrete effects, as many previous scholars have done, recognizing this as a potential limitation of our work.

3. Methodology

3.1. Sample and Data

For the analysis of the impact of grants on Estonian firms' performance, we use the data provided by the State Shared Service Centre (SSSC) and the e-Business Register of the Estonian state. The list of the companies who received support from ERDF is based on the SSSC data of listed firms under the ESIF financed projects during the period 2014–2020. The initial dataset included 14,158 separate projects financed by ESIF with 4,367 unique grant-receiving entities as of December 12, 2022.

We filtered out all non-profit organizations, government agencies, associations, and other entities that were not joint-stock or limited liability companies, similar to Banai et al. (2020) and Beņkovskis, Tkačevs, and Yashiro (2019), to analyze the effect of grants on financial metrics. Furthermore, we kept companies that received support from the ERDF and considered only the projects in which the support was initially obtained, despite some companies receiving aid multiple times over the budget period. This decision was based on the assumption, supported by prior research, that the most substantial impact is expected to occur following the initial receipt of the support. Thus, our sample was reduced to 1,435 companies that accounted for the treatment group in our analysis. The sample consists primarily of micro firms and SMEs that the EU programmes aim to support the most (European Commission, n.d.-b).

The ESI Funds dataset for Estonian firms contains information about the funding start and end date, project name, project description, project status, its priority direction (in line with the EU goals), intermediate bodies, the region of the project, and details about the financing. Our ERDF grants data is restricted to years 2014–2019 because no grants are reported for the year 2020 and the influence of the Covid-19 pandemic would regardless distort the performance indicators.

The analyzed firms fall under three different priority axes: most companies, around 61%, received grants under projects directed to the 'Growth-capable entrepreneurship and internationally competitive RD&I'; secondly, nearly 37% of the firms were listed under 'Development of SME and strengthening the competitiveness of regions' investment priority; and thirdly, approximately 2% of the companies were categorized under 'Increasing social inclusion' priority.

The data request from the e-Business Register was based on the 1,435 firms' register codes that were applicable for our analysis after rearranging the dataset

provided by the SSSC. The obtained information included the number of employees, financial indicators from companies' balance sheets and profit and loss statements, and the year of first entry into the register for later indication of the firm age.

Additionally, the e-Business Register provided the necessary data to create the control group. The microenterprise and SME-level data were requested because the majority of treatment group companies fell into those firm categories, as well as EU programmes aimed to support these the most. The control group dataset contains the exact same financial indicators as requested for the treated companies. The period concerning the financial statistics remains the same for both groups – from 2013 until the latest year available.

By combining our datasets that were received from the e-Business Register and SSSC separately, our administrative firm-level database contains 2,573 unique firms with more than 25,000 observations between the years 2013–2021. Notwithstanding, the ERDF funding data will be analyzed by the difference-in-differences method applied to the period of 2014–2019 when the grants were actually received. Our constructed dataset follows a panel data setup and will be significantly reduced during the data cleaning process, which is described in further detail in Section 4.1.

3.2. Method Description

Based on the characteristics of our dataset, we use the combination of the propensity score matching and difference-in-differences (DiD) method, in line with the previous literature on the topic (Aerts & Schmidt, 2008; Čadil et al., 2019; Srhoj et al., 2019; Vildo & Masso, 2009). Conformably to the work of Almus (2001), the setting of the analysis is non-experimental since the sample consists of firms with characteristics applicable to the ERDF aid (treatment group) and non-participants (control group). This claim is supported by the EU financing framework, which is not random, as companies receive funding based on the proposed projects. Therefore, we have to try to control for the selection bias to estimate the impact of ESIF programmes and introduce the control group as used in the analyses of Beņkovskis, Tkačevs, and Yashiro (2019). To mitigate the forenamed limitations and overcome the selection bias, propensity score matching and difference-in-differences methods will be employed for the data analysis.

3.2.1. Propensity Score Matching

The propensity score matching method was first introduced by Rosenbaum and

Rubin (1983) and is a widely used methodology for non-randomized experiments. This technique helps to adjust for confounders that otherwise might influence the relationship between the event and the outcome, as well as explain better the true effect – in our analysis, the event of a firm receiving a grant. We apply the propensity score matching technique to identify the closest matches in the control group for each observation in the treatment group. By creating a counterfactual for the ERDF beneficiaries concerning the imagined outcome of non-recipients as if these firms received a grant, we later compare the grant-receiving firms' performance indicators to those not treated but matched to treatment group firms.

For the propensity score matching method, we obtain the following function of the propensity score p(X) for the firm i:

$$p(X)_i = \Pr(D_i = 1|\mathrm{X_i}), \quad (1)$$

where D_i is the treatment variable, that is the dummy indicating receiving a grant or not, and X_i denotes the vector of covariates (Valojerdi & Janani, 2018). The propensity score will be bounded from 0 to 1 in our logit model, as it indicates the probability of a firm receiving a grant. This method is conditional on the given set of variables and should ensure that the estimation is done systematically, upholding the principle of randomness and eliminating possible selection bias (Vicente & Kitsing, 2015).

The propensity score matching relies on two fundamental concepts – conditional independence assumption (CIA) and common support. Rosenbaum and Rubin (1983) regarded that with a propensity score, under the aforementioned conditions, it is possible to eradicate all biases that otherwise arise due to the observable variables. These variables are the selected covariates that may influence the selection process and probability of support but remain unaffected by the treatment itself (Khandker, Koolwal, and Samad, 2009). Hence, the propensity score matching technique enables us to estimate unbiased treatment effects.

The CIA is satisfied if the random distribution for any unobservable variation is the same for both the control and the treatment group (Foreman-Peck, 2013); in essence, receiving a grant does not depend on the outcome of the potentially supported project (Vicente & Kitsing, 2015). This condition helps to eliminate the selection bias and is valid if the following formula holds:

$$(Y_0, Y_1) \perp (\mathrm{D}|\mathrm{X}), \quad (2)$$

where Y_0 and Y_1 indicate the outcomes for unsupported firms and beneficiaries, respectively. D describes the dummy variable of being treated (treatment, D) and $\perp$ refers to the independence assumption. For all the potential participants, X variables define the observable characteristics prior to the treatment, such as financial metrics or employee number. Hence, the condition on observable characteristics denoted as X helps to ensure that any observed differences between our treatment and control group in further analysis can be explained by receiving a grant but not by any biases in the selection process (Oh et al., 2009).

Additionally, the common support condition must hold, meaning that the probability of receiving a grant before the treatment has to stand in the same domain for the firms in the control and treatment groups (Oh et al, 2009; Vicente & Kitsing, 2015). The comparable observations, the firm performance metrics in our case, have to be observable for both the treatment group and control group (e.g. employee number is available for all). Alternatively stated, all the firms included in our sample are required to have equal chances to receive grants, or conversely, not to receive them (Foreman-Peck, 2013; Vildo & Masso, 2009). This ensures that each treated firm in our sample is matched with a similar score from the respective control group firm, allowing us to estimate the effect.

The balancing assumption (3), which follows the specification of propensity score and supposes similar covariate distributions (Ichino, 2007; Vicente & Kitsing, 2015), can be written as:

$$D \perp \mathrm{X}|\mathrm{p}(\mathrm{X}), \quad (3)$$

given the propensity score p(X) and pre-treatment variables X that are independent of the treatment dummy variable D. Essentially, the before-treatment characteristics are statistically similar since these observable variables (X) should not factor into the judgment of whether a firm receives a grant or not. In other words, the likelihood of being treated is independent of the firms' pre-treatment characteristics owing to adequate propensity scores. (Vicente & Kitsing, 2015)

Therefore, the CIA and common support assumptions help us to simulate a randomized experiment, which relies on comparability and randomness conditions.

These conditions imply that the firms in our sample are picked due to a random event and are further divided into the control and treatment groups similarly by coincidence.

The matching is performed given the propensity scores for the firms – that is the probability to receive a grant from the ERDF. Once we control for the calculated propensity scores that depend on the observable variables (X) prior to the grant receiving year (t-1), we have to determine the scores that lie outside the minimum or maximum score range to satisfy the common support assumption (Čadil, Mirošník, & Rehák, 2017). Hence, prior to the matching, the observations without common support will be excluded, similar to the works of Vildo and Masso (2009) and Bachtrögler and Hammer (2018).

The propensity scores are calculated based on the covariates applicable to our analysis (see Section 3.3) using the MatchIt package (Greifer, 2023) in R and further matched among treated and untreated firms by their similarities. For matching the treatment and control group firms, we utilize the nearest-neighbor matching approach, similar to Banai et al. (2020), Beņkovskis, Tkačevs, and Yashiro (2019), Ferraro, Männasoo, and Tasane (2023), and Vildo and Masso (2009). The nearest-neighbor matching will scrutinize the treated firms' propensity scores and match control firms to the closest ones (Greifer, 2023). When no match is found for a firm in the treatment group, it is omitted. In an analogous way to Vildo and Masso (2009) and Beņkovskis, Tkačevs, and Yashiro (2019) we introduce a caliper indicating the maximum allowable distance for matches to be conducted, to subsequently observe the quality of matches.

We match firms in the control group to firms in the treatment group within the same year. The year in which beneficiaries receive a grant determines the reference point for subsequent calculations of conditional probabilities within our sample. Thereupon, we match firms based on the various indicators specified in Section 3.3. The selection of firm characteristics is based on the data availability from the Estonian e-Business Register. After the probabilities are assigned to both groups, the firms from the control group are matched as closely as possible to the treatment group firms. Next, the difference-in-differences method (DiD) is investigated.

3.2.2. Difference-in-Differences

The difference-in-differences (DiD) approach is a popular non-experimental method among many academics for assessing the policy effect on firm-level data over time, allowing us to diminish potential selection bias. Similar to Bachtrögler and

Hammer (2018), Beņkovskis, Tkačevs, and Yashiro (2019), and Srhoj and Walde (2020), we compare the treatment group (D = 1) to the control group (D = 0) to analyze the grant effect on the firms' performance by observing chosen indicators (DiD variables in Table 3). The DiD analysis is conducted for the years 2014–2021, starting from the first grant year and including the periods of t+1 and t+2.

The DiD approach is generally used for observing the treatment effect for two time periods, before and after the treatment, that calculates the mean difference in outcomes across control and treatment groups (Khandker, Koolwal, & Samad, 2009). Angrist and Pischke (2009) proposed a regression model for staggered DiD, where the treatment across units is applied at varying times – in our case over the six-year grant period (2014–2019). This approach incorporates the two-way fixed effect model structure in the following way:

$$Y_{it} = \alpha_i + \lambda_t + \delta D_{it} + \epsilon_{it}, \quad (4)$$

where Y_{it} is the outcome variable of interest, α_i denotes the firm (unit) fixed effects and λ_t the year fixed effects, δ is the treatment effect coefficient, D_{it} is a dummy indicating the treated firms in post-treatment years, and ϵ_{it} is the error term. Therefore, the parameter δ captures the average difference in the change of the dependent variable between the treated and control groups during the post-treatment period relative to the pre-treatment period. A positive estimate of the coefficient indicates that the grant has a positive effect on the performance indicator.

3.3. Measures

The present study utilizes a comprehensive list of measures retrieved from prior research. As per the existing academic literature, firms will be matched with the PSM method based on their overall performance, size, and age as potential predictors of prospective results. To quantify the firm size, we will take into account the total assets and equity. The EBIT-to-assets ratio and net profit margin represent profitability, while efficiency is captured by total asset turnover. The first entry year to the Estonian e-Business Register is used to compute the firm age. Total liabilities are incorporated to ensure matching based on similar debt levels. In addition, we consider the number of employees and labor expenses to ensure better comparability across firms.

To investigate the impacts of treatment with the DiD framework, the study will evaluate the effect on revenue, employee number, and wages after receiving grants, as well as two performance indicators (see Table 1). Firm productivity is measured by revenue per employee. The ratio of total liabilities to assets will depict the solvency of a firm. Our DiD regression will also account for potentially confounding factors, controlling for the year when the grant was received, as well as company-fixed and year-fixed effects.

Table 1. Variables Retrieved From the Literature Review for Further DiD Analysis.

Variable	**Specification**	**Sources**
Employment	Number of employees	Banai et al. (2020); Beņkovskis, Tkačevs, & Yashiro (2019); Campos & Cabral (2023); Ferraro, Männasoo, & Tasane (2023); Oh et al., (2009); Vicente & Kitsing (2015)
Revenue	Total sales per year	Banai et al. (2020); Campos & Cabral (2023); Hartšenko & Sauga (2013); Ferraro, Männasoo, & Tasane (2023); Oh et al., (2009); Vicente & Kitsing (2015); Vildo & Masso (2009)
Leverage	Total liabilities to total assets	Banai et al. (2020); Beņkovskis, Tkačevs, & Yashiro (2019); Vicente & Kitsing (2015)
Employee productivity	Revenue divided by employee number	Banai et al. (2020); Beņkovskis, Tkačevs, & Yashiro (2019); Biagi, Bondonio, & Martini (2015); Campos & Cabral (2023); Criscuolo et al. (2012) Ferraro, Männasoo, & Tasane (2023); Hartšenko & Sauga (2013); Oh et al., (2009); Vildo & Masso (2009)
Wages	Wage expense per year	Beņkovskis, Tkačevs, & Yashiro (2019); Oh et al., (2009)

Note. Created by the authors.

4. Analysis of Results

4.1. Descriptive Statistics

Our further analysis is founded on the sample of Estonian firms which received European Regional Development Fund (ERDF) grants within the 2014-2020 period under the EU long-term budget. For the quantitative analysis of the potential effect on grant recipients' financial performance, we include the years 2013 and 2021 to observe the changes between the pre-and post-treatment periods. The sample consists of 'treated firms', and 'non-beneficiaries' or 'control firms' which were chosen randomly, only restricting the data extraction to size class based on the EU programmes application descriptions.

During the period of our study, the characteristics of our firm-level database remain notably inconsistent. Table 2 displays the mean and standard deviation values that indicate the range of variability within our sample. The t-test is employed to explicitly outlay the magnitude of variable differences when comparing the treatment and control group firms. Altogether, the table highlights the heterogeneous nature of the firm characteristics. The values indicated in the table are calculated before the more exhaustive data-cleaning process, giving us proper incentives to explore the combined database further and eliminate false data entries concurrently with outliers.

Table 2. Descriptive Statistics for Treated and Control Firms Between the Years 2013–2021 Before Data-Cleaning.

	Treatment Group		**Control Group**		
Variables of Interest	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*	*t-test*
revenue	6115	21406	10318	20161	***
employee_number	48.9	145.8	55.8	79.9	**
operating_profit	289	2869	529	2201	***
total_liabilities	3244	38037	3277	16271	
total_assets	7847	81948	8059	31962	
equity	4604	44551	4781	18739	
total_debt	505	5302	426	2096	
firm_age	17.1	7.5	19.6	6.3	***
labor_expense	-857	3578	-1019	2079	**
Number of observations	**732**		**1033**		

*Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1*

Monetary values in thousand EUR. The t-test explains the difference between treated and control firms.

Note. Data from SSSC, Estonian e-Business Register. Created by authors.

Table 2 displays that, on average, the companies in the control group have significantly higher values than those in the beneficiary group in terms of revenue, employee count, operating profit, and labor expenses. Furthermore, the firms in the control group are inclined to be older than grant recipients, showing 2.5 years higher mean difference regarding enterprise maturity. The value of total assets, liabilities, and equity seem to be similar and do not differ significantly, yet exhibit slightly higher means for the control group, consistent with the seniority and larger measures observed for control firms. However, it is noteworthy that these statements are only based on a comparison of means and do not account for the potential variability or distribution of these variables within each group; therefore, further analysis is justified to fully understand the implication.

Henceforth, to ensure the best possible quality of our analysis, we carried out an exhaustive data-cleaning process. The process included data formatting and aligning, the binding of multiple data sources into one systematic data frame (from the SSSC and Estonian e-Business Register databases), and the creation of relevant missing variables such as several dummy variables and financial ratios. Additionally, we took steps to eliminate false data entries and improve the consistency of our sample. Employee numbers and revenue values that displayed zero were treated as missing values (NAs) and hence, removed from the dataset, as these carry great importance in our further analysis. We also improved our sample accuracy by excluding values that appeared to contradict the general accounting practices, for example, labor expense observations with positive figures.

For a more exhaustive financial performance assessment, five new ratios were created and dummy variables were introduced to enable matching the control sample firms to the treatment sample firms using propensity scores. Thereupon, firm age was calculated based on the first entry year. All in all, we were left with 616 firms for the treatment group and 952 firms for the control group, creating a total sample of 1,568 unique entities with 12,246 observations.

For the sample of 616 unique treated firms, 873 projects were introduced that received external financing from the ERDF. The count of projects exceeds the number of firms, owing to some companies receiving funding multiple times for different projects. However, in our core analysis, we do not count for numerous fundings per company but consider only the first year when initial support was obtained; hence, assuming the effect is most significant in the first funding year. Moreover, when

considering subsequent times of funding for a company, which occasionally also overlap, it becomes impossible to distinguish the pre-treatment period since the first aid has already been received; thus, violating the prerequisites for PSM. This approach is consistent with the practices in prior literature (Banai et al., 2020; Beņkovskis, Tkačevs, & Yashiro, 2019; Campos & Cabral, 2023)

Upon completion of data cleaning procedures, the distinct objectives relevant to this study became apparent, showing the final set of EU objectives under which companies received external funding. Appendix C exhibits the three priority axis and the more specific objectives, in line with the particular projects aided by the ERDF explicit to our study. Thus, we were able to calculate that a total of 146.9 million euros of external funding was allocated to these three priorities during the 2014–2019 period; out of 310.7 million of the summed projects cost, which contained state co-financing and other public and private sector finances. The overall external funding budget constitutes 7% of the total 1.9 billion euros allocated to Estonia from the ERDF between 2014–2020. Accordingly, Appendix C illustrates the programme areas, counts, and corresponding sums of finances under which the 873 projects of Estonian companies received grants.

Specific to our dataset, Table 3 represents an overview of the size distributions of analyzed firms. The size classes are calculated based on the employee numbers throughout 2013–2021, showing the general characteristics of our sample. The firms are stratified into five size classes; specifically, three classes for micro firms with employee numbers ranging between 1-9, 10-19, and 20-49, then a subgroup of 50-249 employees for small and medium-sized enterprises (SMEs), and the final group pertaining to firms with 250 and more employees. As the table demonstrates, a considerable portion of firms are microenterprises, and SMEs comprise the second largest segment. Although conformity exists between treatment and control group size classes, the proportions are not identical; moreover, the financial indicators vary significantly. Hence, more sophisticated matching methods will be employed.

Table 3. Sample Structure Based on the Firm Size in the Cleaned Dataset During 2013–2021.

	Treatment Group		Control Group		Total	
Size_class (number of employees)	*Count*	*Share*	*Count*	*Share*	*Count*	*Share*
1–9	270	44%	483	51%	753	48%
10–19	100	16%	28	3%	128	8%
20–49	118	19%	74	8%	192	12%
50–249	108	18%	336	35%	444	28%
250+	20	3%	31	3%	51	3%
Total	**616**	**100%**	**952**	**100%**	**1568**	**100%**

Note. Data from SSSC, Estonian e-Business Register, and authors' own calculations. Created by authors.

4.3. Propensity Score Matching Discussion

Propensity score calculations are based on logistic regression where the dependent variable indicates whether a firm received a grant in the financial year or not. We include all PSM variables specified in Section 3.3 in the regression and perform some logarithmic transformations or add squared terms to account for skewed distributions and capture the non-linear relationships. Table 4 illustrates the variables potentially affecting the probability of receiving a grant, which are later utilized in PSM. The left-hand column specifies the significance of variables in the whole study period from 2013–2021, whereas the right-hand side column depicts the years until 2019. This period restriction is necessary for studying the effect on receiving ERDF grants as the performance of those companies that obtained funding at a later stage cannot be observed in t+1 and t+2 otherwise.

To eliminate any confounding effects resulting from pre-existing differences between the groups, firm matching is performed based on the year prior to the treatment. This allows us to account for any potential positive impacts of the support that may have already arisen during the year of receiving external funding and eliminate the threat of spurious correlation. Thus, propensity score matching will be carried out based on the restricted sample.

Upon comparing the full and restricted samples (refer to Table 4), the statistical significance of most variables remains unchanged, except total liabilities becoming significant at the 99% confidence level in the latter grouping, while the firms' profitability denoted by the EBIT to assets ratio loses its significance entirely. Net profit

margin, equity, and labor expense are not significant at any confidence level, yet are still appropriate to utilize for matching, as potentially better precision and balance can be obtained.

Table 4. Summary of the Variables Affecting the Probability of Receiving a Grant From the ERDF Between 2013–2021 for the Full Sample and 2013–2019 for the Restricted Sample, Using Logistic Regression.

	Full Sample 2013–2021	**Restricted Sample 2013–2019**
	(N=12,246)	**(N=9,481)**
Firm age (t-1)	-0.331***	-0.478****
Firm age squared (t-1)	0.00815***	0.0185***
Log of employee number (t-1)	0.851***	0.848***
Log of employee number squared (t-1)	-0.133***	-0.133***
EBIT to assets ratio (t-1)	0.401*	0.263
Net profit margin (t-1)	0.00175	0.00377
Total asset turnover	-0.301***	-0.171***
Log of total liabilities (t-1)	0.366***	0.224**
Log of total assets (t-1)	-0.456**	-0.404**
Log of equity (t-1)	0.000826	0.114
Log of labor expense (t-1)	0.000380	0.0000403

*Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1*

Natural logarithm of total assets, equity, labor expense and total liabilities were taken in the format of ln(x+1) to account for firms which had zeroes for some of these variables. Lagged values of all variables are included to avoid reverse causality.

Note. Data from SSSC, Estonian e-Business Register, and authors' own calculations. Created by authors.

The findings confirm that higher firm age indicates a decreased likelihood of receiving a grant, with the relation being non-linear. This result is overall consistent with the objectives of the ERDF, which seek to provide support to growth-oriented enterprises with a view to further enhancing their competitiveness. Such objectives are expected to apply significantly to younger firms, thereby accounting for the observed relationship between lower firm age and higher grant receipt probability.

Next, the output suggests that the participation probability of receiving a grant is positively associated with a larger number of employees in the company. Therefore, we suppose that greater employment may signify a superior capacity to execute proposed

projects; alternatively, smaller firms with fewer employees may be in greater need of financial aid. The contradicting incentives warrant further analysis of employment. Additionally, the squared term may suggest that there is an optimal firm size for receiving a grant, beyond which the likelihood of receiving funding can decrease.

In contrast to the positive association with a larger number of employees, firms with larger asset sizes have a lower probability of receiving a grant. This finding may be attributed to perceptions of greater stability and access to resources, perceived as a reduced need for additional funding. Yet considering the liabilities side on the balance sheet, a loftier level of liabilities indicates a higher probability of receiving a grant, evidently signaling a necessity for additional aid.

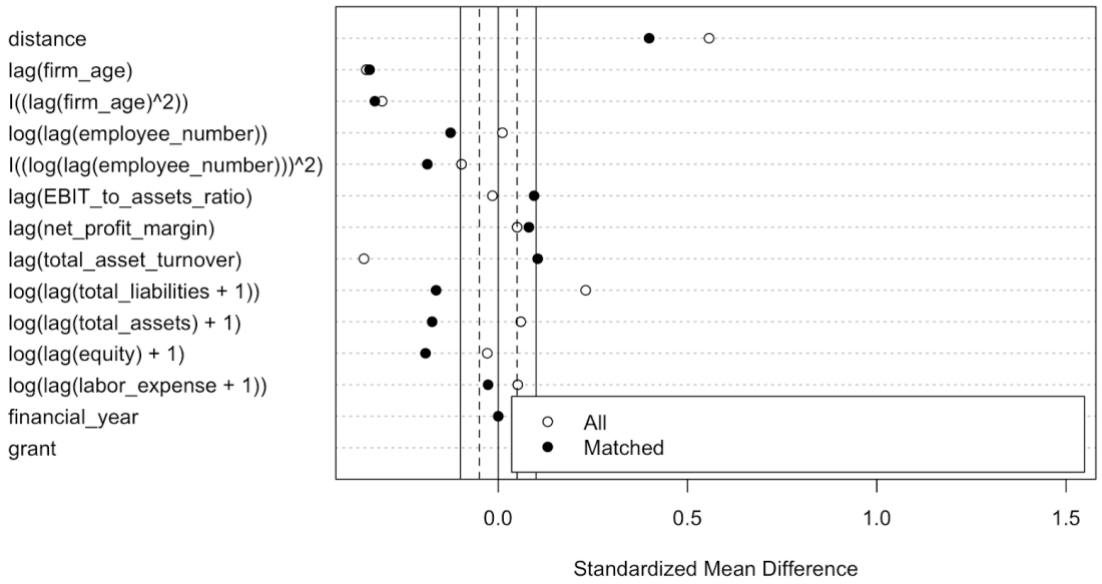
Further, the efficiency and profitability ratios give slightly contradicting signals. A negative association is observed between total asset turnover and grant participation probability, referring to less efficient firms' greater need for grants to support their operations, while more established ones seek less external funding. Yet, the EBIT-to-assets ratio displays that a more profitable firm may have a higher probability of getting ERDF support, likely demonstrating the competency to carry out grant projects. However, the EBIT-to-assets ratio is significant only for the full sample at the 95% confidence level; thus, the efficiency ratio may be more pronounced for advocating the notion that less efficient companies may be more reliant on receiving grants to improve their performance.

Hereinafter, matching based on the nearest neighbor method is executed, adhering to the common support argument in the process. As a result of the nearest-neighbor matching within the exact financial year with each control firm matched exactly once, a total of 582 company pairs obtained a match. Evaluating the balance of matched units is imperative to ascertain the quality of the matching procedure. Balance refers to how similar the distributions of independent variables are in the treated and non-treated firm groups, following the definition of Harder, Stuart, and Anthony (2010).

Figure 1 implies that a substantial difference is evident between the covariates of matched and unmatched samples. After matching, the standardized mean differences fail to demonstrate significant improvement and in some instances, even display worsening. A standardized mean difference of 0.1 is often used in the literature as the maximum threshold indicating a sufficient balance (Austin, Grootendorst, & Anderson, 2007; Nguyen et al., 2017). Only the EBIT-to-assets ratio and net profit margin, and labor expense of the explanatory variables fit the 0.1 criteria after standard nearest-

neighbor matching. We decided not to employ a significance test for assessing balance as its usage has been discouraged in the academic sphere in the latest years due to undue biases created by dependence on sample size (Ali et al., 2015; Ho et al., 2007), instead applying the graphical balance assessment approach.

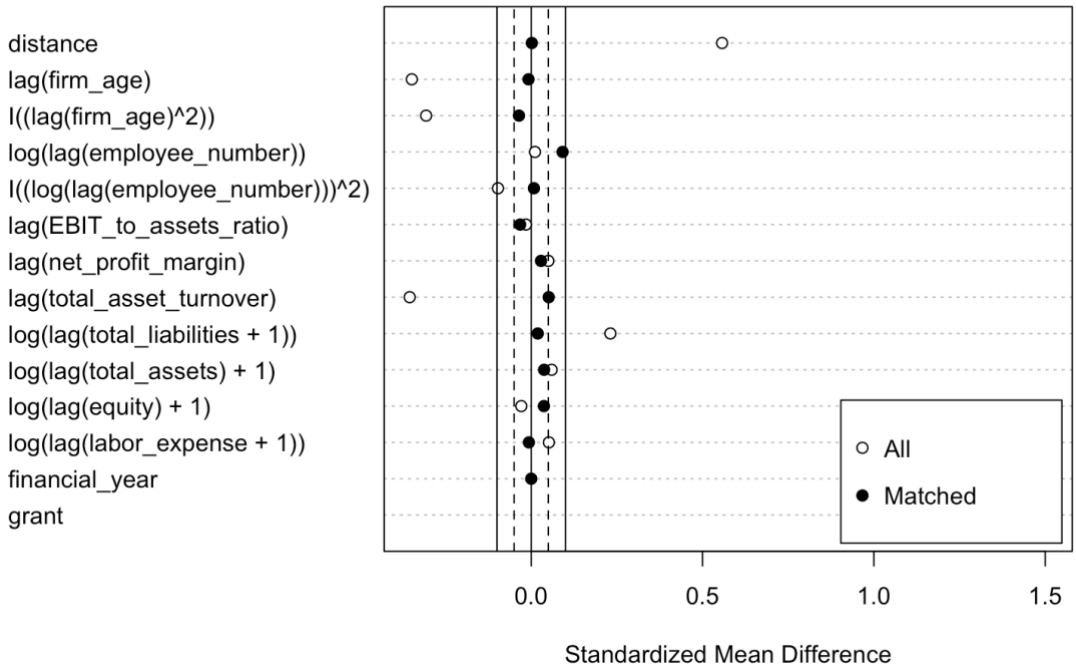
Figure 1. Standardized Mean Differences Before and After Nearest-Neighbor Matching.



Note. Created by authors. The vertical lines on the plot denote the 0.1 standardized mean difference threshold.

Thus, to improve the quality of matches, we employ nearest neighbor matching with a caliper of 0.04 and determine from Figure 2 that the balance has significantly improved, as the differences of all covariates remain in the 0.1 threshold. This finding is presumably due to the caliper setting a boundary of the maximum allowed difference between control and treated firms, and omitting 147 matches that do not fulfill the criteria. Hence, we are left with 435 matched pairs and are faced with the predicament that the quality of matches is ensured by reducing the sample, retaining a lower number of matches, yet favoring the validity of our further analysis.

Figure 2. Standardized Mean Differences Before and After Nearest-Neighbor Matching With a 0.04 Caliper.



Note. Created by authors. The vertical lines on the plot denote the 0.1 standardized mean difference threshold.

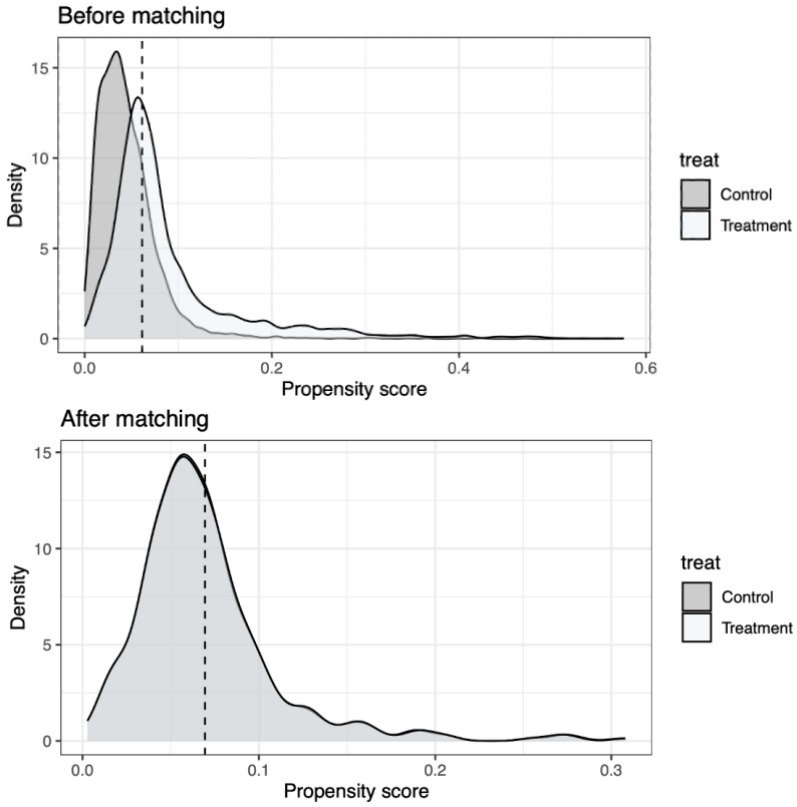
Furthermore, a variance ratio below two is commonly suggested as an acceptable threshold for adequate balance assessment to ensure enhanced comparability (Zhang et al., 2019). The variance ratios of the variables among matched firms after both the NN method without and with a caliper of 0.04 meet the criteria (see Appendix D). In the case of both methods, variance ratios range from approximately 0.4 to slightly above one, with the only exception being the ratio of net profit margin which falls to 0.087 after introducing the caliper. Although a variance ratio near one is commonly regarded as the most optimal (Zhang et al., 2019), we observe that the inclusion of a caliper leads to improved ratios for some variables, while degrading them for others. Additionally, given that the threshold of below two is met and standardized mean values are significantly reduced, we determine that the introduction of a caliper is warranted.

For the purpose of ensuring robustness, we conducted an additional test by investigating various calipers, which are based on those used in various research. The outcomes of this test are presented in Appendix E and reveal that continuing to use a caliper of 0.04 is appropriate since the implementation of alternative options did not

lead to a fundamentally better balance with regard to the standardized mean difference and variance ratio.

Further, it is relevant to compare the distribution of propensity scores before and after matching to check the nearness of the scores. Figure 3 depicts the overlap of propensity scores, showing a substantial improvement after conducting the optimal matching procedure. This implies that similar propensity scores subsist for the treated and control firms and that the distribution of observable variables is comparable inter the grant recipients and non-beneficiaries. Matching in the pre-treatment period ensures that the conditional independence assumption is not violated and that we have successfully completed the matching procedure.

Figure 3. Distribution of Propensity Scores Before and After Matching.



Note. Created by authors.

4.4 Difference-in-Differences Discussion

The impact of grants on a company's performance is evaluated by the difference-in-differences model. We evaluate the effect on the following five economic variables: revenue, employee number, revenue per employee, liabilities-to-assets ratio, and wages. The reference point for studying the effect is the year before receiving the

ERDF grant (t-1), which is compared against three consecutive years, noted as t, t+1, and t+2. The results of our matching method are displayed in Table 5, which explains the possible differences in our preliminary values.

Table 5. Difference-in-Differences Estimators Using One Nearest Neighbour Matching and 0.04 Caliper.

Indicator	Period	1 nearest neighbour with a caliper
Log of revenue	t	0.0940***
	t+1	-0.00519
	t+2	0.00454
Log of employee number	t	0.0803***
	t+1	-0.0026
	t+2	-0.00141
Log of productivity	t	0.0133
(revenue per employee)	t+1	-0.00258
	t+2	0.00595
Leverage	t	0.00563
(liabilities to assets)	t+1	0.0152*
	t+2	-0.00962 .
Log of wage	t	0.562***
	t+1	-0.111
	t+2	0.0526

*Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1*

Natural logarithm of total assets and wages were taken in the format of ln(x+1) to account for firms which had zeroes for some of these variables. Lagged values of explanatory variables utilized in interaction terms are included to account for the initial state of firm prior to grant.

Note. Data from. SSSC, Estonian e-Business Register, and authors' own calculations. Created by authors.

4.4.1. Revenue

First, we examine the effect on revenue, which is significant and positive in period t and demonstrates a 9.4 percentage point increase difference, with a higher magnitude for the recipient firms than for the non-treated firms. The lack of a significant treatment effect at both time t+1 and t+2, suggests that the outcome is persistent throughout the observation period. This finding is in line with various studies: Vildo and Masso (2009) show the most robust positive effect on sales growth for the supported firms for all years, Hartšenko and Sauga (2013) find evidence of a positive impact from financial support on treated firms' revenue, Ferraro, Männasoo, & Tasane (2023) reveal similar findings. More specifically, the positive ERDF effect on sales revenue was explicitly displayed in the research of Campos and Cabral (2023) and

Beņkovskis, Tkačevs, and Yashiro (2019), highlighting the higher revenue growth than the counterparts in the control group.

This finding on sales revenue was most prominent in the literature and supports our research objective to explain ERDF's impact on firm performance. More broadly, the research revealed that the Cohesion Policy finances are a significant source of revenue for the Estonian private sector that utilizes external finances substantially; moreover, these funds comprise substantial aid for stimulating entrepreneurship. Thus, the uncovered positive effect on revenue is indeed a relevant finding and reinforces the EU funding objectives and programmes' descriptions in this study. Further, it indicates that beneficiaries are exploiting the resources from ERDF and generating positive returns immediately.

4.4.2. Employment

Secondly, we perceive employment to be significantly affected by the treatment as evidenced by the increase in the number of employees among the grant recipients at time t. The difference in employment appears to be higher by 8 percentage points for beneficiaries, becoming insignificant in the second and third periods. This implies that the effect of receiving a grant on employment is immediate and does not change considerably over time. The finding at time t is consistent with the previously done works (Banai et al., 2020; Beņkovskis, Tkačevs, & Yashiro, 2019; Campos & Cabral, 2023; Vicente & Kitsing, 2015) that all revealed positive significant effects on employment.

The finding concerning employment aligns with the objectives outlined in the Partnership Agreement (as explained in Section 2.1.1), which set the funding aim of facilitating increased employment opportunities and improved conditions for sustainable growth in Estonia. The increased employment could be explained by the need for more labor force to execute newly proposed projects; further, extra resources for the company give good incentives to expand the workforce resulting in an expansion of the company. Therefore, the aim of the EU to foster employment appears to be effective and is in line with our finding of the higher number of employees for the firms that received support.

4.4.3. Employee Productivity

We study the effect on firms' productivity measured as revenue per employee. The impact does not appear significant immediately after the grant, nor one or two years

later. This is somewhat consistent with various studies that report ambiguous effects on productivity. Vildo and Masso (2015) report no significant effect for the first two periods, yet a positive and significant association with grant support appears for the third year similar to the Beņkovskis, Tkačevs, and Yashiro (2019) who find productivity gains only after two years when the projects were launched. Contrarily, the works of Biagi, Bondonio, and Martini (2015), and Criscuolo et al. (2012) did not find any notable effect on firms' productivity, consistent with our findings. Notably, Vicente and Kitsing (2015) find significant but negative effects on firm productivity of grants provided by Enterprise Estonia, and associate it with low levels of regulation in the Estonian labor market that may not accurately reflect the productivity gains coming from the increased labor costs where the expense might arise from higher investments in technology and training programmes.

Nonetheless, the effect on productivity remains insignificant in our case with only the sign varying across the periods. This could be explained by the lack of know-how for the first three periods to exploit and absorb ERDF finances. The training period and learning process may take time; hence, productivity is elevated only in the longer term when employees have time to gain further competency. An alternative proposition could be that the projects' goals and specific objectives do not have a direct impact on productivity. Although an increase in productivity might be anticipated for firms that received the financial support, there might not be an immediate effect, particularly if one of the goals was to enhance social inclusion, which may not have an instantaneous impact on productivity. Additionally, if both revenue and the number of employees increase at the same rate, the change in productivity as measured by revenue per employee may not be apparent.

4.4.4. Wages

Next, the effect on companies' wages is examined. The result is positive and significant in the first period and does not show any substantial effect change for the consecutive periods. The size of the impact of this variable is remarkably larger compared to the effect on any other outcome – 56 percentage points higher wage increase is observed for the grant recipients immediately after receiving the grant. The first conjecture regarding the wage escalation may be ascribed to the simultaneous increase in the number of employees for the treated firms.

The immense surge in wages compared to a modest increase in the number of employees, relative to control firms, could support the EU objective of assuring improved working conditions and internationally competitive RD&I. As higher wages help to attract and retain more talented employees and provide innovation to the region, the R&D of a company may be indirectly strengthened via the wage increase. The grant could also provide more finances to retain high-skilled employees by providing a more competitive salary. This can also help to boost social inclusion and reduce poverty.

The analysis of wages is less prominent in the literature compared to the assessment of revenues or employment, yet some parallel can be drawn. Beņkovskis, Tkačevs, and Yashiro (2019) similarly examine the impact on wages for Latvian firms and find significant positive effects, but only starting from the second period of their study. Additionally, Oh et al. (2009) studied credit guarantee policy and also proved that the effect of treatment was significantly positive for the wage level of the treated firms. Ultimately, the positive effect on wages refers to the supporting act for regional growth and facilitating competitiveness.

4.4.5. Leverage

Finally, we examine the impact on firm leverage explained through the liabilities-to-assets ratio. The effect is positive for the first two periods and becomes significant only for the second term at the 5% level; furthermore, the effect shifts to negative for the third period but is statistically significant only at the 10% level. Therefore, the impact of ERDF on firm leverage varies throughout the years and does not give one uniform signal. This finding could imply that the effect of receiving a grant was not pronounced for the first two periods, yet firms managed to successfully improve their balance sheet for the third term and reduce their liabilities. The output suggests the difference of a 0.01 decrease in leverage between the treated and non-treated firms at t+2, referring to the lower liabilities-to-asset ratio and improved financial position for the beneficiaries in the longer term.

Yet, financing grants can also have an impact on the company's liabilities. Pursuant to Guideline No. 12, point 10 of the Estonian Accounting Board, grant financing received, in which the conditions for recognition as income are not met, is recognized in the balance sheet as a liability. The corresponding obligation is recorded in the balance sheet as short-term or long-term. (Riigiteataja, 2018) This knowledge is consistent with the second-period finding that treated firms report an increased leverage

ratio compared to non-treated ones, displaying a difference of 0.015 increase in leverage.

Additionally, the leverage effect is not profoundly explored in the literature, and hence, no certain patterns can be observed. Some studies used the ratio to estimate propensity scores. The study by Vicente and Kitsing (2015) analyzes the asset-to-liabilities ratio for grant recipients – that gives similar insights to the interpretation of our leverage ratio – and finds that a lower asset-to-liabilities ratio is observed for the treated firms relative to control firms. Beņkovskis, Tkačevs, and Yashiro (2019) also look at leverage as a potential predictor of the probability of receiving a grant and find that ERDF beneficiaries are usually more leveraged. Both of these researches conclude that firms with elevated leverage have a higher likelihood of receiving a grant; further, referring to these firms being as more financially viable and attractive to the institutions with the intention to choose economically successful companies that can even further facilitate growth and increase competitiveness.

Notably, the leverage ratio itself is contradicting at times, pointing to easier access for borrowing as a positive sign for financial health, but concurrently referring to financial distress if the ratio displays too high. We aim to see the potential outcome of more sound companies after receiving a grant, especially, whether the recipients were more leveraged prior to the treatment. As the effect remains ambiguous and does not give sufficient insight into how the grant could impact firms' leverage, further research is required, especially regarding the longer term.

4.4.6. Heterogeneity of Treated Firms

Given that the treatment effect may be contingent upon the pre-treatment firm characteristics, we utilize interaction terms to examine heterogeneity across the sample. Consequently, four interaction terms are created by combining the after-grant dummy variable with firm age, employee number, total assets, and revenue prior to treatment. Table 6 reveals that companies that are initially smaller, younger, and exhibit lower income attain a higher revenue, number of employees, and labor productivity after receiving a grant. This finding can be attributable to the objectives of the ERDF, which aim to promote firms peculiarly seeking growth – often younger and less established ones – and support entrepreneurship. Aforesaid firms may encounter more barriers to growth and possess limited resources to allocate towards the projects; therefore, it is plausible that the ERDF grant serves as a critical stimulus in terms of financial

resources, allowing these companies to expand their operations, enlarge their workforce, and augment productivity.

Table 6. Difference-in-Differences Estimators for Interaction Terms With Nearest Neighbour Matching With a Caliper in the Period t.

Interaction term	Log of revenue	Log of employment	Log of productivity	Leverage	Log of wage
Firm age : after_grant	-0.0390***	-0.0293***	-0.00972***	0.00136	-0.0704***
Log of employment (t-1) : after_grant	-0.0514***	-0.0199**	-0.0314***	-0.000746	-0.0375
Log of total assets (t-1) : after_grant	-0.0325***	-0.0168**	-0.0158**	-0.00245	-0.0174
Log of revenue (t-1) : after_grant	-0.0239**	-0.00940 .	-0.0145*	-0.00130	-0.0131

*Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1*

Natural logarithm of total assets and wages was taken in the format of ln(x+1) to account for firms which had zeroes for some of these variables. Lagged values of explanatory variables utilized in interaction terms are included to account for the initial state of firm prior to grant.

Note. Created by authors.

Further building on the strong positive significant effect on wages for the treated firms, we find that younger firms are inclined to experience a greater effect on wages, according to Table 6. This phenomenon may be attributed to the greater potential for growth in terms of employment and, consequently, wage expenses among smaller firms.

Conversely, leverage is not conditional on the selected firm attributes at all. One possible explanation could be that the chosen characteristics were not significant determinants of relative liabilities; instead, industry-specific factors such as risk or maturity could play a more essential role in influencing leverage levels. The impact of firm characteristics on leverage might also have been already accounted for in the matching process, as the sufficient balance achieved reduces additional differences.

Remarkably, Beņkovskis, Tkačevs, and Yashiro (2019) corroborate the observation that younger firms exhibit greater productivity gains and additionally report that both younger and smaller firms tend to achieve an increased level of employment faster. Campos and Cabral (2023) also confirm that the effect on labor productivity may be heterogeneous across different firm characteristics, but the specific characteristics that drive this heterogeneity are not referenced. Ultimately, few academic papers in a similar field consider examining the heterogeneous patterns in the work.

5. Limitations

We accounted for potential biases by employing common support, incorporating CIA, and adhering to the balancing assumption. To address potential reverse causality, we performed matching on the year prior to treatment. Furthermore, we utilized more contemporary methods to assess the quality of our matches, scrutinizing standardized

mean differences and variance ratios, rather than relying on traditional t-tests which could result in biased outcomes due to their reliance on sample size. Nonetheless, it is imperative to acknowledge that certain limitations may persist despite best efforts to reduce them.

The primary limitations of this study include the presence of numerous zero values across various variables, which significantly reduces the sample size. Furthermore, during the data cleaning process, a number of erroneous zero values and incorrect employee numbers were identified, leading to the exclusion of some potentially influential companies from the dataset. This issue appears to have arisen during the data extraction and transfer processes, resulting in some data loss.

Furthermore, it is incomprehensible whether the companies, especially microenterprises, have done the reporting correctly since smaller firms are not required to employ auditing of their reports but rather may fill out the financial statements as they see fit. Hence, the results of this paper are majorly influenced by external aspects like the accuracy of data providers, but also the accounting methods and practices of individual firms.

Importantly, it is plausible that anticipation effects may arise the year before the grant is received (Malani & Reif, 2015); thus, making treated and control firms less comparable, despite matching being performed prior to the receipt of the grant. This suggests that managers of companies may begin preparing for the grant before it is actually received. For instance, firms may initiate the hiring process in advance when they anticipate additional capacity is needed for the new project. Thus, due to our inability to discern the decision-making processes of management, the exact timing of the causal effects of grant receipt remains uncertain.

Additionally, the econometric methods used in this work could also be complemented with additional means. Propensity score matching is employed in a lot of scientific works; however, it is also criticized for omitting potential critical factors, as missing variables are treated under the assumption to be uncorrelated with the results, and dubious reliability of results in cases of a smaller sample (Crown, 2014; Kwiatkowski et al., 2007; Reiffel, 2020). Furthermore, the difference-in-differences technique might introduce the omitted variable bias since it is highly dependent on measured confounding variables; yet, uncontrolled variables will lead to biased results instead (Lechner, 2011). Thus, to overcome the limitations associated with propensity

score matching and difference-in-differences techniques, such as instrumental variable estimation, regression discontinuity design, or panel data analysis could be employed.

6. Conclusions

Throughout the process of this study, we sought to explore the impact of the European Structural and Investment Fund assistance on companies' performance. The aim of this research was to elucidate more specifically the effect of the European Regional Development Fund finances on Estonian beneficiary firms. We analyzed the EU long-term budget period of 2014–2020 by utilizing administrative firm-level data specific to Estonian ERDF grant recipients. The non-experimental nearest-neighbor approach combined with the difference-in-differences method was employed to ensure robust performance analysis. Our results demonstrate a strong positive effect on revenue, employment, and wages; yet, we do not find any meaningful impact on employee productivity. The effect on leverage remains ambiguous.

We find an immediate improvement in treated firms' revenue and the number of employees, which does not vary in the following two periods. This finding aligns with the EU's objectives of improving employment opportunities and stimulating entrepreneurship. Moreover, the positive effect on wages is likewise conveyed into treated firms' performance immediately and relates to the EU's goal of improved working conditions and internationally competitive RD&I. In light of our discussion, we posit that the insignificant difference in firms' productivity after treatment could be attributed to the prolonged training and learning processes, whose outcome could only be seen in the even longer term.

The inspection of heterogeneity reveals that initially younger and smaller firms, who maintain a lower revenue, experience an elevated effect on earnings, number of employees, and labor productivity after obtaining a grant. One plausible explanation for this phenomenon is the heightened potential for expansion among early-stage companies. We conclude that the ERDF grant can evidently "unleash" the potential of firms, especially the less-established ones, by serving as a critical stimulus in terms of financial resources and the potential to enlarge the workforce.

We see our work as valuable for comprising contemporary data analysis methods in the following ways: employing heterogeneity, assessing balance via standardized mean differences and variance ratios, supplementing NN matching with a caliper, and performing a robustness check for various caliper levels. Further, we bring

novelty to the field by utilizing the most recently available financial data for Estonian firms to assess the whole 2014–2020 budget period.

Through our analysis, we set the ground for further research on explaining the effect on a firm's leverage that currently lacks sufficient explanations in the literature, and additionally, investigating the long-term impact on productivity. Alternatively, further research could undertake the approach to explore the grant anticipation effects and decision-making processes of management both prior to and following grant receipt. Subsequently, examining factors that contribute to successful grant utilization and gaining a better understanding of the challenges faced when applying for grant-funded projects. This could aid to reduce the likelihood of more profitable and higher-employment firms encountering higher grant participation probability while neglecting the less-established firms.

Thus, further policy implications could involve mechanisms like increasing transparency by strengthening monitoring practices for the aid distributors but also stricter progress reporting requirements from the firm's management. Finally, we suggest the assessment of the ERDF impact on a broader level, including other stakeholders and the effect on the environment to understand the full scope of the aid.

7. References

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8. Appendices

Appendix A. The List of the 2014–2020 EU Thematic Objectives.

The exhaustive list of the 2014–2020 EU Thematic Objectives according to the European Commission's webpage keep.eu (n.d.):

(1) "Strengthening research, technological development and innovation",

(2) "enhancing access to, and use and quality of, ICT",

(3) "enhancing the competitiveness of SMEs",

(4) "supporting the shift towards a low-carbon economy in all sectors",

(5) "promoting climate change adaptation, risk prevention and management",

(6) "preserving and protecting the environment and promoting resource efficiency",

(7) "promoting sustainable transport and removing bottlenecks in key network infrastructures",

(8) "promoting sustainable and quality employment and supporting labour mobility",

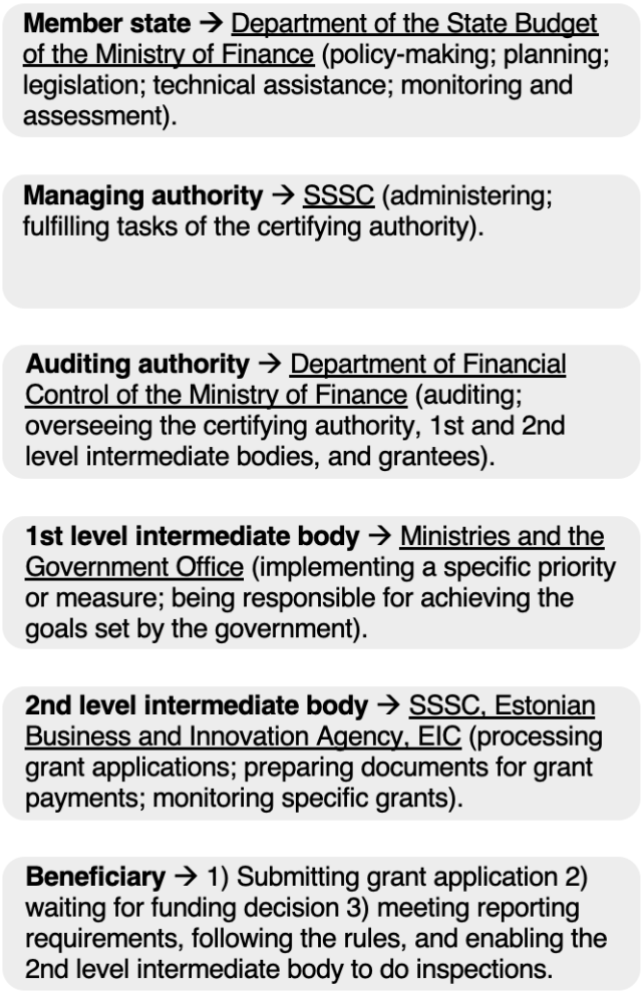
(9) "promoting social inclusion, combating poverty and any discrimination",

(10) "investing in education, training and vocational training for skills and lifelong learning by developing education and training infrastructure",

(11) "improving the efficiency of public administration".

Appendix B. Estonian Grant Ecosystem.

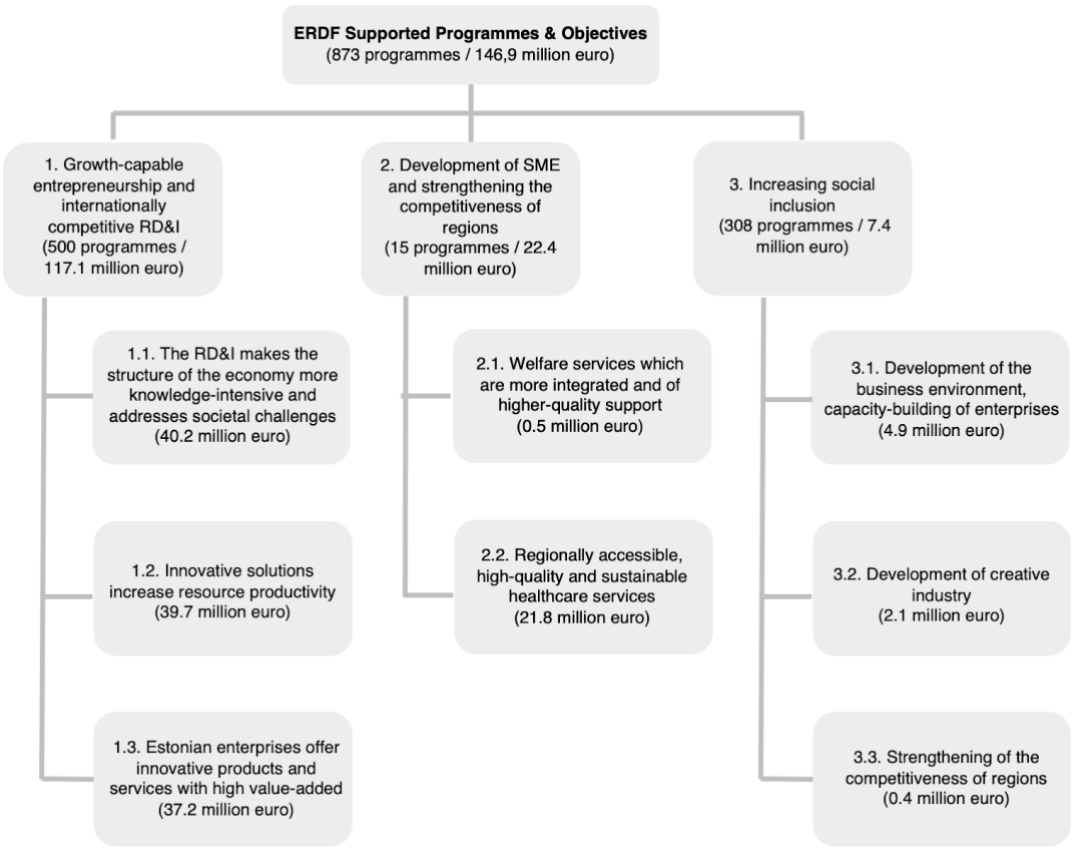
Figure B.1. The Participants of the Estonian Grant Ecosystem.



Note. Data from SSSC. Created by authors.

Appendix C. ERDF Support Allocation.

Figure C.1. Objectives and Programmes That Received ERDF Financial Support in Our Sample During 2014–2019.



Note. Data from SSSC, and authors' own calculations. Created by authors.

Appendix D. Variance Ratios.

Table D.1. Comparing Variance Ratios of NN Matches With and Without Caliper**.**

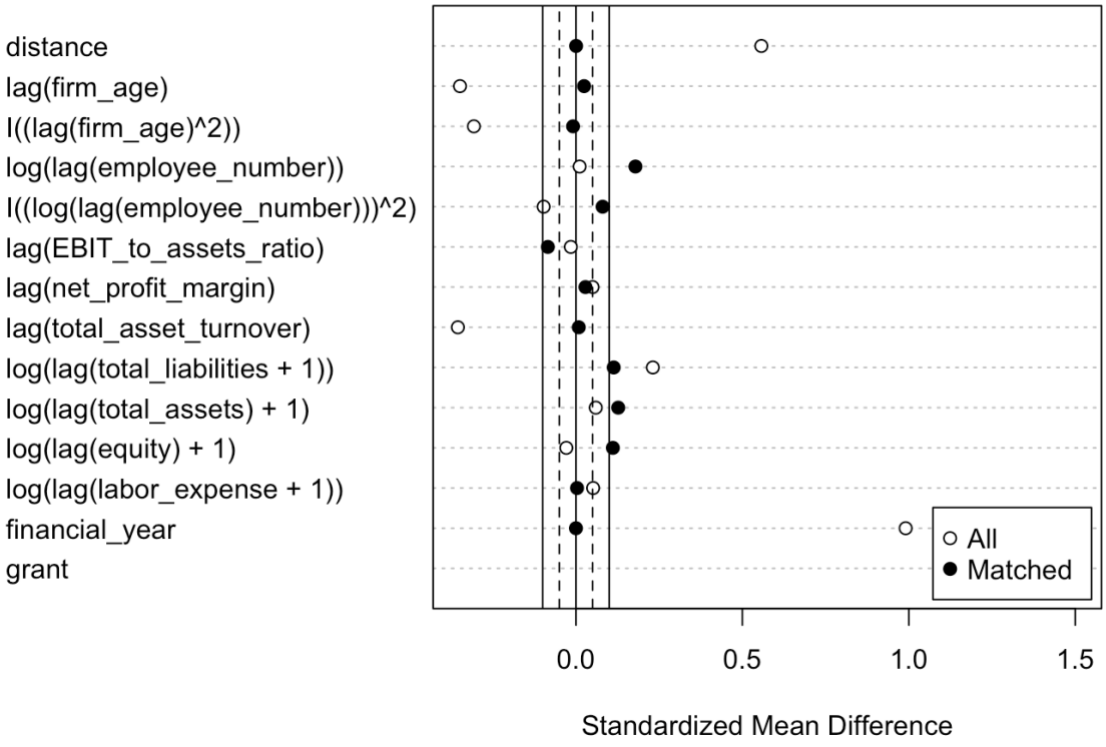
Variables (t-1)	**NN matching**	**NN matching with a caliper**
Log of firm age	1.235	0.860
Log of firm age squared	0.997	0.806
Log of employee number	0.791	0.761
Log of employee number squared	0.943	1.022
EBIT to assets ratio	0.790	0.602
Net profit margin	0.740	0.087
Total asset turnover	1.073	0.967
Log of total liabilities	0.451	0.480
Log of total assets	0.503	0.492
Log of equity	0.685	0.600
Log of labor expense	0.880	1.034

Note. Created by authors.

Appendix E. Robustness Check With Calipers of 0.01, 0.02, and 0.05.

Following the methodology adopted by Foreman-Peck (2013), a caliper of 0.01 is implemented, which results in 388 matched control and treated firms in our sample. The standardized mean differences of logged employee number, total liabilities, total assets, and equity exceed the 0.1 threshold (see Figure E.1). No significant improvement in variance ratios is observed either. The lack of improvement in balance and a significantly reduced number of matches allude to rejecting the use of this caliper.

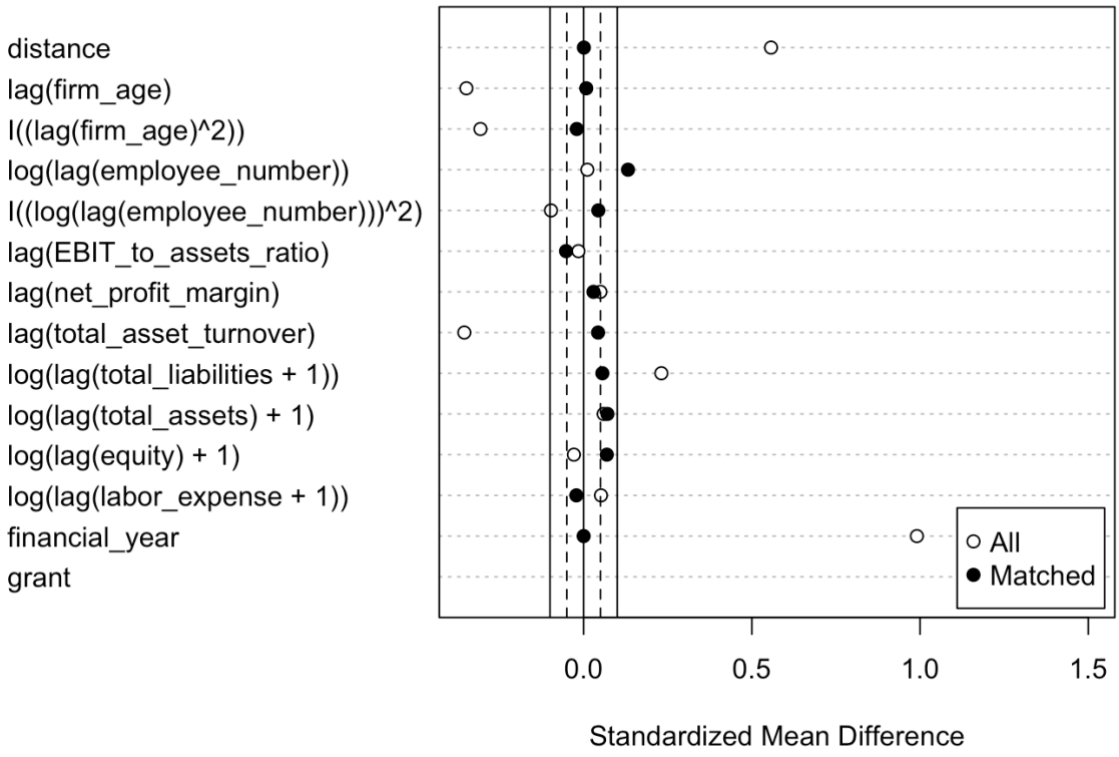
Figure E.1. Standardized Mean Differences Before and After Nearest-Neighbor Matching With a 0.01 Caliper.



Note. Created by authors. The vertical lines on the plot denote the 0.1 standardized mean difference threshold.

Banai et al. (2020) utilize a caliper of 0.02 in their PSM analysis and arrive at 411 matched pairs. In accordance with this approach, we fail to observe any enhancement in balance, given that the logarithm of employment surpasses the 0.1 threshold and the variance ratios demonstrate no significant dissimilarity from matching with a caliper of 0.01 or the previously utilized 0.04, both falling within the same range (refer to Figure E.2).

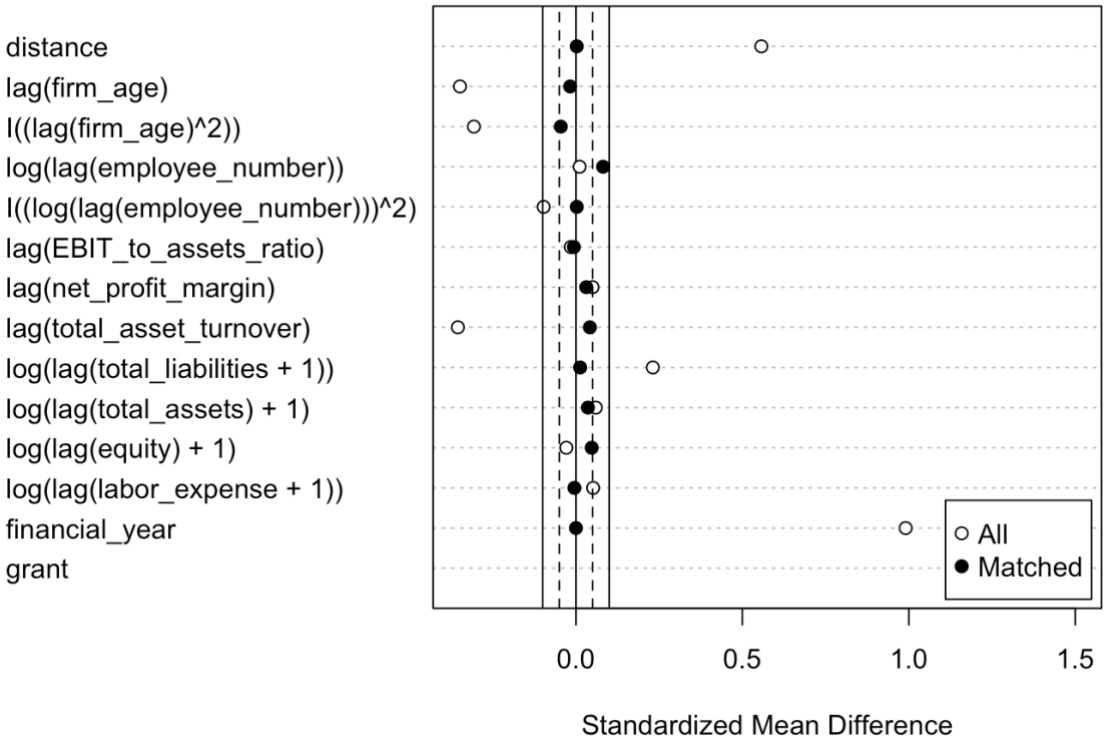
Figure E.2. Standardized Mean Differences Before and After Nearest-Neighbor Matching With a 0.02 Caliper.



Note. Created by authors. The vertical lines on the plot denote the 0.1 standardized mean difference threshold.

Finally, we attempt to improve the balance of matches by employing a caliper of 0.05, as done by Šelebaj and Bule (2021). 441 company pairs obtain a match and all variables used for matching achieve a standardized mean difference smaller than 0.1 (see Figure E.3). While some mean differences show improvement, others deteriorate in comparison to matching with the 0.04 caliper. There is no considerable enhancement in variance ratios. Given the preference to use the smallest feasible caliper for the PSM analysis, in order to increase the possibility of obtaining the most precise matching, we find insufficient grounds to prefer the 0.05 caliper. Therefore, we will persist in implementing a caliper of 0.04 for subsequent DiD analysis.

Figure E.3. Standardized Mean Differences Before and After Nearest-Neighbor Matching With a 0.05 Caliper.



Note. Created by authors. The vertical lines on the plot denote the 0.1 standardized mean difference threshold.

Appendix F. The Declaration of Using AI-Based Tools.

Hereinafter, we are addressing the use of ChatGPT in this study for the purpose of fixing errors in R Studio codes and corrections in grammar. We would like to point out that ChatGPT is not employed for content generation in our text, but only utilized as an assisting tool for paraphrasing practices.