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Sustainable development: EU Policies and the role of private investment incentives

PhD Thesis

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Ioannis Kostopoulos

Dedicated to my mother, Niki, and my father, Giorgos.

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Executive summary

In this PhD thesis, we present a comprehensive study on the impact of state aid subsidies on the economy. We examine this topic in three main chapters. The first chapter entitled "What we know so far about the process and impact of the Greek development law? A review of the literature" reviews existing studies on the performance of the longest-lasting state aid subsidies policy in Greece, called Development Law. It provides an analysis of its performance in terms of policy design, implementation, and impact as documented in fifty-two existing research studies. The second chapter, entitled "The Impact of EU State Aid on Firm Productivity: A Systematic Review of the literature," is a systematic review of thirty-five evaluations assessing the impact of EU state aid on firm productivity. The studies cover 369,643 firms participating in state aid programs that were active from 1996 to 2015 in twelve EU member states and employ propensity score matching techniques to conduct counterfactual impact analyses. Finally, the third chapter, entitled "A counterfactual impact evaluation of EU state aid in Greece," estimates the impact of development law on firm productivity based on a unique dataset created for the purposes of this thesis, using data extracted from the management information system of the Ministry of Economy of Greece and other sources. This chapter applies the propensity score matching method in a counterfactual impact analysis to estimate the causal effect of development law on firm productivity.

This thesis contributes, we believe, additional inputs (in the form of data and findings) to the discussion about evidence-based policies and the role of private investment incentives to the sustainable development of the EU. Evidence-based policies may be a major way to ensure that private investment incentives, such as state aid, are structured in a way that effectively supports sustainable economic development in the EU.

In what follows in this introductory chapter we present the motivation for this study and highlight the significance of evidence-based state aid policy. We provide a brief overview of state aid rules and the Greek state aid program known as the Development Law (DL henceforth), and the concepts of counterfactual impact evaluation and the propensity score matching. We also explain the reasoning for choosing productivity as a measure of state aid performance and outline the structure of the thesis.

Chapter 1. Introduction

Motivation

State aid subsidies, which refer to financial assistance provided by governments to firms, are considered to play a crucial role in promoting economic development (European Commission, 2016). These subsidies are funded by taxpayers' money; it is therefore important to understand how these subsidies are utilized and their impact on the economy.

To assess the impact of state aid subsidies and inform evidence-based policies, it is necessary to rely on robust empirical evidence. This thesis aims to contribute to this collective endeavour by examining a Greek state aid policy called the Development Law, which provides financial assistance for investments within the country. There are two main reasons for our choice. First, it is the longest-running state aid policy (since the 50s), and therefore, one can assume that it is important for promoting investments in Greece. Second, it adheres to the widely used guidelines set forth by the European Commission's General Block Exemption Regulation (GBER). As over 96% of new state aid programs in the EU follow GBER, it is important to examine how GBER works in practice and assist in the design of state aid policies that use it.

Definition and impact of state aid subsidies

State aid refers to any type of advantage provided selectively to firms engaged in economic activities. It is considered state aid if it meets four criteria: (1) it originates from the state or through state resources, (2) it provides a selective advantage to particular actors in the economy, specific industries, or companies located in specific regions, (3) it has the potential to distort competition, and (4) it is likely to impact trade between member states (European Commission, 2016).

As it will be discussed in Chapter 2, state aid subsidies can have both positive and negative impacts. On the positive side, subsidies can be utilized to support vital industries, promote job creation in areas with high unemployment rates, and provide targeted economic assistance to specific regions in need. Subsidies can also have

negative impacts. They can create an uneven playing field among firms. They can lead to the allocation of resources to firms or industries that would not be viable without government support, resulting in economic inefficiency and a waste of resources. Subsidies can also create dependency among recipients, who may become reliant on government support and less motivated to improve their performance or competitiveness.

The Greek development law and the EU Regulation

The DL is a state aid policy of Greece designed to support investments. It was established in the 1950s with the goal of attracting foreign capital into Greece. Over time, the DL has evolved and been updated, with the most recent version being DL 4887 of 2022 (Ministry of Economy, 2022b). It provides incentives for firms operating in various industries, including primary, secondary, and tertiary sectors. These incentives come in the form of financial aid. Under the DL, firms can apply for financial aid. The state then evaluates these applications and, upon positive assessment, issues decisions to provide aid upon completion of the investments. This means that the funds actually given to the firms are based on the actual expenses incurred during the implementation of the investment project.

In general, the DL follows the guidelines of the GBER set forth by the European Commission (European Commission, 2021d). This regulation facilitates the granting of aid that aims to reduce disparities between regions in the European Union by providing a framework for member states to develop state aid policies. The GBER establishes specific criteria for determining if state aid is compatible with the internal market; thereby reducing the need for prior approval of a state aid policy by the European Commission. It is worth noting that over 96% of new state aid programs in the EU have been found to be compliant with the GBER since 2015 (European Commission, 2021d). Given the widespread adoption of the GBER by member states, it is possible that the findings of the thesis could have supranational use. In other words, the insights gained from studying the implementation of DL in Greece could potentially inform the development of state aid policies with similar objectives in other EU member states.

A detailed analysis of the DL is provided in Chapter 2 (a review of the existing academic knowledge about the DL) and in Chapter 4 (an empirical evaluation of the impact of DL on productivity).

The need for evidence-based state aid policy making

The European Commission's state aid modernization communication report emphasizes the importance of evidence-based policy making in the context of state aid. In particular, the report notes that state aid control must be based on sound economic analysis, including assessment of market failures, public interest and proportionality of measures (European Commission, 2012).

Evidence-based policy making refers to the use of empirical evidence and scientific research to inform the design and implementation of policies. It is based on the principle that policy decisions should be guided by the best available evidence, rather than political ideology or personal opinions (Cairney, 2016).

As it will be discussed in Chapter 2, it seems that evidence-based policy making requires a strong commitment from all parties involved, including government agencies, researchers, and firms, to ensure that the best available evidence is being used to inform policy decisions. Evidence of the forty-year operation of DL is presented, highlighting that the need for evidence-based policy making is important for the design, implementation, and eventual impact of the policy.

A practical case for implementing evidence-based state aid policies in the EU and Greece

The EU has recently implemented measures to enhance the state aid budget. Recent examples are the temporary framework to support the economy during the COVID-19 outbreak and the temporary framework to support companies affected by the consequences of Russia's actions in Ukraine (European Commission, 2022h). These frameworks resulted in increased spending by EU 27 Member States on state aid, which amounted to €320.22bn in 2020 equivalent to 2.39% of EU 27's 2020 GDP (European Commission, 2022a). This is almost two-and-a-half times the expenditure in 2019 (extra

€185.13bn compared to €135.09bn in 2019). Greece, along with Malta and Poland, has the highest state aid expenditure among member states when considering it as a proportion of the respective national GDP, allocating approximately 4.2-4.8 percent of their GDP.

For the period between 2021 and 2027, the EU plans to allocate €1.8tr in financial support to member states, to support their economies (European Commission, 2021c). Greece is expected to receive the largest-ever amount of funding since joining the European Union. This funding is projected to reach a total of €72bn over this period (Ministry of Finance, 2021).

In view of the above, it is vital to create evidence-based state aid policies. As it will be evident in the following chapters, a good starting point in creating evidence-based state aid policies is to evaluate existing policies. By examining and analysing existing policies, governments can gain valuable insights and learn from both the achievements and shortcomings of these initiatives. These findings could then be incorporated into future policies. Moreover, new policies should undergo evaluation to ensure that state aid has been used effectively and efficiently. Effectively refers to achieving the desired policy goals, while efficiently refers to doing so with minimal cost. To identify what works and what does not can provide valuable input for policy making and the allocation of funds in different policies so that the interests of all stakeholders (including donors and receivers) are promoted.

Counterfactual impact evaluation

Counterfactual impact evaluation is a method of evaluating the effectiveness of a policy by comparing the outcomes of a treatment group (in our case those who applied and received state aid) to a control group (those who applied but did not receive state aid) to estimate the causal effect of the policy (Gertler et al., 2016; Khandker et al., 2009). It is argued that it provides a better understanding compared to traditional methods about the impact of a policy. The term "counterfactual" here refers to the hypothetical outcome of the treatment group in case the same (treated) firms had not received the state aid. Counterfactual impact evaluation is often implemented through randomized

controlled trials (RCT), where individuals or groups are randomly assigned to either the treatment or control group. However, especially in the social sciences, it can also be applied through other methods, such as propensity score matching, instrumental variables estimation, difference-in-difference analysis, or regression discontinuity design. In the following section, we outline the properties and features of propensity score matching as a non-randomized alternative to experimental designs in counterfactual impact evaluation.

Propensity score matching

Propensity score matching is a method employed in the context of counterfactual impact evaluation analysis to estimate the causal impact of a variable. The idea behind this method is to create a synthetic control group that is as similar as possible to the treated group, so that the observed difference in outcomes can be attributed to the treatment. The validity of propensity score matching depends on the assumption of conditional independence, which means that there are no omitted variables that are associated with both the treatment and the outcome. This assumption ensures that the observed differences in outcomes between the treatment and control groups are not due to some other factor that was not taken into account.

Productivity as an endpoint

Several endpoints (indicators) can be used to measure the impact of a state aid program. The choice of indicators should be based on the specific context and goals of the impact evaluation. For example, if the primary objective of the program is to stimulate job creation, then employment indicators may be more appropriate. If the objective is to encourage the adoption of new technologies, then innovation indicators may be more relevant.

As it will be discussed in Chapter 3, and despite its limitations, productivity seems to be a satisfactory endpoint and studies on productivity impact constitute a large and ongoing area of research. Measuring productivity seems to provide valuable information to both firms and governments. To firms, it helps identify areas for improvement in

terms of efficiency and competitiveness and inform strategic and operational decisions. To governments, it provides data into the country's economic performance and competitiveness and can help policymakers to evaluate the effectiveness of economic policies and make informed decisions on resource allocation.

Structure of the thesis

The thesis consists of five chapters, with Chapters 2, 3, and 4 representing three individual areas of study, each building upon the previous one to offer a comprehensive understanding of the impact of DL and state aid on firm productivity. Chapter 2 provides a comprehensive analysis of existing literature of the DL in Greece, with an aim to identify areas of improvement in its operation. Chapter 3 provides a systematic review of the impact of EU state aid on firm productivity, finding variables that will later be employed in our counterfactual impact evaluation. Chapter 4 uses counterfactual impact evaluation to examine the impact of DL on firm productivity, based on a unique purpose-built dataset with data from the Ministry of Economy and other sources. Our results are consistent with the findings from the systematic review of state aid programs in other EU member states, providing possible explanations for the previously identified problematic areas in the operation of DL. The concluding Chapter 5, summarizes and critically discusses the findings of the thesis, and offers recommendations for future research. Finally, the Appendix includes the permission from the Ministry of Economy to use the data for the research, as well as the Stata software commands used for the analysis and the resulting tables.

Chapter 2. What we know so far about the process and impact of the Greek development law? A review of the literature.

Summary

This literature review provides an overview of the current state of research on a Greek state aid policy known as development law. This policy has been a fundamental component of regional development in Greece for many years and existing research has used a variety of datasets to provide snapshots of its implementation. However, our literature review of fifty-two studies highlights several key drawbacks associated with the policy process, which may have contributed to the failure of many investments. We also find that the impact of development law on the Greek economy has not been fully explored because most studies have relied on observational methods to evaluate its operation, rather than using counterfactual impact evaluation to estimate the policy's causal impact.

Introduction

State aid investment incentives, such as tax breaks and grants, have become a common policy tool used by governments globally to attract investments in specific industries or regions. They can reduce the cost of capital for firms and thereby influence their investment decisions. The effectiveness of these incentives remains a topic of discussion among policymakers and economists. Subsidies can have an impact on the market, as they can create distortions in various markets and may lead to an uneven playing field for firms, affecting competition. Subsidies could be permissible if they can be justified on grounds of public interest, such as promoting regional development, supporting research and development, or protecting the environment, as long as they do not harm competition (European Commission, 2016).

Existing evidence on the impact of state aid on various aspects of the economy provides interesting insights. Recent European studies have shown both positive (Dvouletý & Blažková, 2019; Ratering, Amoako Agyemang, et al., 2020; Srhoj & Walde, 2020) and

negative impacts (Banai et al., 2020; Namiotko et al., 2019; Santos, 2019) of state aid on firm productivity, innovation, and growth. These studies suggest that the impact of state aid on firm productivity, innovation, and growth can vary based on factors such as the design and implementation of the policy.

This is the area that the literature review below tries to explore. It examines the impact of development law (DL henceforth) on the overall economy of Greece, with a focus on its design, implementation and impact (McConnell, 2010; Nagel, 2002; Pawson, 2006). The objective of this review is to provide a comprehensive understanding of current knowledge and to identify gaps in the literature requiring further exploration. The review begins by defining the DL and outlining its key aspects. It then presents the dataset chronologically, highlighting the main points of the scholars and the periods they refer to. The review then highlights the key insights of the DL in terms of policy design, implementation, and impact. It also highlights key factors that may affect the implementation of investments. Finally, the conclusion summarizes the evidence and proposes areas for further research.

Policy outline

The DL is a state aid policy used to support investments in Greece (Hassid, 2006; Petrakos & Psacharis, 2004). Its first formulation, DL 2176 in 1952, prohibited the granting of licenses for the establishment of industries in Attica and DL 2687 a year later provided incentives and guarantees to attract foreign capital to Greece. DL 1312 of 1972 and DL 1078 of 1977 aimed to stimulate regional development by dividing Greece into “incentive areas”. The DL architecture has evolved over time, with versions called DL 1262 in the 1980s, DL 1892 in 1990, DL 2601 in 1998, DL 3299 in 2004, DL 3908 in 2011, and DL 4399 in 2016. The most recent version of the DL is 4887 of 2022. Despite the DL undergoing multiple versions over time, some characteristics have remained constant. These characteristics are highlighted below:

The first common characteristic is the type of investments. The DL is applied to investments in the primary, secondary, tourism, and tertiary sectors. An investment budget typically includes the costs for building facilities, mechanical engineering

equipment of the production system, transportation-installation of equipment, special facilities, other equipment, transportation vehicles, know-how, landscaping the surrounding area, infrastructure projects, expenditure for studies and advisors, etc. In addition, the DL aims to support not only new entrepreneurs, but also existing firms in becoming more efficient and expanding into new markets. The investment proposal must be related to creating a new unit, expanding an existing unit, diversifying production in a unit, or making a fundamental change to the overall production process of an existing unit (European Commission, 2021a).

The second common characteristic is the source of financing. The state provides non-repayable aid. The maximum amount of the aid and the intensity of the aid are based on the size of the firm and the location of the investment, i.e. the smaller size of the firm in the poorest region receives higher aid. The types of aid include mainly grants, tax reliefs, and leasing subsidies. The remaining part of financing is from private contributions or from a bank loan, without any public support, which must amount to at least 25% of the total eligible investment budget, as part of the program's requirements.

The third common characteristic is the procedure. The investment proposal is submitted to the responsible authority for evaluation according to its investment budget. High budget investments are submitted to the Ministry of Economy and low budget investments to the regional units. High ranked proposals are reported to the Minister or to the regional Governor for approval. The firm receives the aid upon implementation of the investment (i.e. when the full proposed investment has been made). Upon completion of the investment a monitoring procedure is in place to verify that the investment indeed delivers the objectives stated in the terms of the approval decision for three years (for SMEs) or five years (for large enterprises) after the completion of the project.

Finally, the fourth common characteristic is that the DL complies with the conditions of the European Commission's General Block Exemption Regulation (GBER) for regional aid. GBER simplifies the process for member states in the European Union to provide state aid for regional development. The GBER establishes predefined criteria for the

assessment of aid compatibility with the internal market, thereby reducing the need for prior approval from the European Commission. Instead, member states simply notify the European Commission about the result of their assessment. It has been widely adopted, with over 96% of new state aid measures in the EU being compliant with the GBER since 2015 (European Commission, 2021d).

Data and findings

Our objective here is to perform a thorough analysis of the features of the DL, investigate the investment choices made by firms, and analyse their impact on the economy. We review the existing literature on the DL to identify any gaps, limitations, and future research opportunities. The results of this research will contribute to the wider body of knowledge on state aid measures in the European Union. Considering the recent implementation of supportive policies by governments in response to the COVID-19 pandemic and the energy market disruption resulting from Russia's invasion of Ukraine, we believe that this and similar studies are much needed to aid policy makers.

Data collection

We conducted a comprehensive search in six databases (Google Scholar, Scopus, Web of Science, ekdda.gr, ekt.gr, eap.gr) to identify relevant literature on six recent versions of the DL (4399/2016, 3908/2011, 3299/2004, 2601/1998, 1892/1990, 1262/1982). The search was conducted between March 15, 2022 and November 12, 2022. A three-step inclusion process was applied, including an initial screening of titles, abstract assessment, and full-text assessment. After the removal of duplicates, the final dataset included 52 studies covering state aid approvals from the period of 1982 to 2022. The period most represented was from 1982 to 2010, and the most discussed DL was 1892 (running from 1990-1998), which was included in 48% of the studies (25 studies).

Findings

Table 1 presents the studies in chronological order (by most recent publication date) and summarizes the main points of each study, type of analysis, and the DL version they referred to.

Table 1. Review of studies published on Development Laws of Greece up to November 2022.

Author	Type of analysis	Main points	4399/2016	3908/2011	3299/2004	2601/1998	1892/1990	1262/1982
Pseiridis & Kostopoulos (2023) ¹	Counterfactual (propensity score matching analysis)	DL has a minor negative impact on labour productivity on the firms that received financial support.		•				
Athanasiasiadi (2022)	Descriptive (based on regional data, type of firms and type of investments)	Micro enterprises in the social economy sector often fail to take advantage of state aid programs due to lack of awareness about available options.	•					
Paraskevaidou (2022)	Descriptive (based on regional and sectoral data)	Approximately 35% of all investment-supported projects are related to the tourism industry.		•	•	•	•	
Ikonomou (2022)	Descriptive (based on regional and sectoral data)	Needs better targeting with clear quantitative objectives. Lack of evaluations using econometric techniques.	•	•	•			
Argyrou (2021)	Descriptive (based on regional data)	The impact of DL on the Greek economy is uncertain due to lack of evaluation results.	•	•	•			
Kalogeresis (2020)	Descriptive (based on sectoral data)	The program for innovative new enterprises did not generate much interest, and it was not successful in attracting any applications.	•	•	•	•		
Evangelopoulou (2018)	Observations (analysis of the evaluation method of investment plans)	The evaluation process for investment plans is not adapted to the current needs of the market, which could result in a lack of recognition of productive investments.	•					
Stelianidis (2017)	Observations (analysis of the legal framework of DL)	The regulatory environment in Greece regarding state aid is overly complex and fragmented.	•					

¹ This study, which is a shortened version of Chapter 4, is not included in the subsequent analysis. However, it is included in this table just for reference.

Author	Type of analysis	Main points	4399/2016	3908/2011	3299/2004	2601/1998	1892/1990	1262/1982
Tsotsoli (2017)	Observations (analysis of the information system of DL)	The information system can supply important data to strengthen society's development actions.	•					
Kostopoulos & Pseiridis (2016)	Observations (analysis of the information system of DL)	The information system has not been treated as a complex entity. In addition to the development of technical solutions, the information system should introduce new culture, new characteristics of jobs, and different and stable power relations between organizational units.		•	•			
Kostopoulos & Pseiridis (2015)	Descriptive (based on sectoral, regional and type of subsidy data)	Cash grants are by far the most popular type of state aid.			•			
Markatou & Stournaras (2014)	Descriptive (based on sectoral, regional and type of subsidy data)	Lack of technology-intensive investments.		•	•			
Geraki et al. (2013)	Regression (investigates the allocation of public investment)	Some regions receive large amounts of subsidies on a consistent basis.		•				
Karafolas (2013)	Descriptive (based on sectoral data)	DL supports sizable investments in all sectors, agriculture, industry, and tourism.			•	•		
Delitheou (2012)	Observations (gives comments and opinions, to explore and understand the operation of DL)	Frequent changes in legislation. Need to modernize the administrative structures.		•	•	•		
Vlami et al. (2012)	Descriptive (based on regional and sectoral data)	The policy is not tailored to effectively address the specific demands and needs of the market and different regions.			•	•	•	•
Artikis et al. (2011)	Descriptive (based on sectoral data)	Financial incentives do not appear to play a significant role in the decision-making process for selecting a location for a plant in Greece.					•	

Author	Type of analysis	Main points	4399/2016	3908/2011	3299/2004	2601/1998	1892/1990	1262/1982
Psaltopoulos et al. (2011)	Descriptive (based on regional and sectoral data)	The effectiveness of state aid in promoting economic growth and development in certain regions is questionable.					•	•
Delitheou et al. (2010)	Descriptive (based on regional and sectoral data)	Despite the objective to support new firms as well, the DL mainly supports the expansion or the increase in capacity of an existing establishment.			•	•		
Vlami (2010)	Descriptive (based on regional and sectoral data)	The DL is focused on promoting the development and upgrading of high-end hotel properties, rather than the establishment of smaller or mid-range hotels.			•	•	•	•
Delitheou (2009)	Observations (gives comments and opinions, to explore and understand the operation of DL)	Policy making has a short time horizon.			•	•	•	•
Nikolaidis et al. (2009)	Descriptive (summarizes and describes the characteristics of the data collected from questionnaires)	The evaluation method and the evaluation criteria need re-evaluation.			•	•	•	•
Karavia (2009)	Descriptive (based on regional data)	Policy success is found to depend on the characteristics of the region. It requires astute diagnosis of problems, understanding of risks and opportunities, and utilization of the region's comparative advantages.			•	•	•	•
Stathakis et al. (2008)	Descriptive (based on sectoral data)	By implementing a system for evaluating potential investments, resources could have been allocated towards more productive and profitable ventures.				•	•	•
Karafolas (2007)	Descriptive (based on regional data)	A number of investors never finalized their investments.				•	•	

Author	Type of analysis	Main points	4399/2016	3908/2011	3299/2004	2601/1998	1892/1990	1262/1982
Polyzos & Minetos (2007)	Regression (based on variables describing economic, social, physical characteristics)	State aid is an important factor in determining the location of investments, but firms often choose to invest in metropolitan areas with less aid rather than in smaller regions with higher levels of aid.					•	
Margariti (2007)	Descriptive (based on regional and sectoral data)	Attracting investments depends on a stable macroeconomic environment, simplification of procedures, deregulation, transparency, synergies with other policies.			•	•	•	
Nikolaidis (2007)	Descriptive (manufacturing sector in East Macedonia and Thrace region)	Serious weaknesses in the evaluation process and in the implementation monitoring of the investment plans. Eligibility criteria are not capable of attracting sustainable investments.				•	•	•
Tahtalidis (2007)	Descriptive (based on regional and sectoral data)	Region characteristics, the accessibility of domestic and foreign markets, local infrastructure, and the educational level of the population play a role in the final investment choice.			•	•	•	•
Petrakos & Psycharis (2006)	Descriptive (based on regional data)	DL under analysis has introduced a reduction in bureaucracy and a simplification of administrative processes compared to previous one.			•			
Hassid (2006)	Descriptive (based on sectoral data)	DL promotes investments in traditional sectors of the Greek economy and not in sectors based on new technologies.					•	•
Nikolaidis & Christopoulou (2005)	Observations (qualitative analysis of the evaluation of investment proposals)	Need of a new evaluation system that would ensure integrity in the choice and the promotion of desirable investments.				•		
Dryllerakis (2005)	Observations (presents critical feedback on the structure of the law, highlighting areas that may require improvement)	DL is complex and difficult to navigate. Consequently, firms face challenges in understanding the eligibility criteria and requirements for accessing state aid.			•			

Author	Type of analysis	Main points	4399/2016	3908/2011	3299/2004	2601/1998	1892/1990	1262/1982
Filippaios & Kottaridi (2004)	Regression (logit model to assess investment patterns)	They find that location selection depends on market size and labour costs as well as infrastructure, human capital, and knowledge creation.					•	
Petrakos & Psycharis (2004)	Descriptive (based on regional and sectoral data)	The DL attracts firms in sectors where traditional production specialization is concentrated.				•	•	•
Bistroyianni-Karlou (2004)	Descriptive (based on regional data)	Over-regulation and over-proceduralization cause bureaucratic overload and delays in the evaluation process.				•	•	•
Papadoulis et al. (2003)	Descriptive (based on regional data)	The structure of incentives favours horizontal interventions without any spatial dimension at all.				•	•	•
Kokkinou (2003)	Descriptive (based on regional data)	State aid must enable firms to know the timing of future flows of aid provided. This is not the case in DL since there are delays in the evaluation process.				•		
Kampelis (2003)	Descriptive (based on regional data)	The DL encourages investments in traditional sectors of the country's economy.					•	
Daskalopoulou et al. (2000)	Descriptive (based on sectoral data)	The decision of firms to choose a location for their investments does not depend on the amount of assistance available.						•
Dimara et al. (2000)	Regression (utilizing a database of financial data of Greek food industries)	State aid has been beneficial for firm survival.					•	•
Ioannides & Petrakos (2000)	Descriptive (based on regional and sectoral data)	Policy will probably not succeed unless governmental administrative structures are reformed.					•	•
Skuras & Tzamarias (2000)	Descriptive (based on regional data)	Future policy design should be decentralized and highly adapted to local conditions.						•
Kouzelis (2000)	Descriptive (based on sectoral data)	The DL is complex, bureaucratic, and prone to delays.				•		

Author	Type of analysis	Main points	4399/2016	3908/2011	3299/2004	2601/1998	1892/1990	1262/1982
Skuras & Tzelepis (1999)	Descriptive (based on sectoral data)	State aid prolongs firm survival rates while it does not improve all of a firm's profitability indices.					•	•
Konsolas (1997)	Descriptive (based on regional and sectoral data)	There are no systematic studies evaluating the effectiveness of the policy. The DL is usually evaluated with descriptive statistics.						•
Psycharis & Papadaki (1996)	Descriptive (based on regional data)	The DL mainly attracts investments in traditional sectors.					•	
Labrianidis (1994)	Observations (presents critical feedback on the characteristics of the law)	The DL attracts large investments but fails to create the desired progress and growth.					•	
Labrianidis & Papamichos (1990)	Descriptive (based on sectoral data)	The DL can be a tool for promoting regional cohesion, but it is not always effective.						•
Thermoyianni-Artikis (1990)	Descriptive (based on sectoral data)	State aid is one of the many factors that firms consider when deciding where to invest, but they are not the most important criterion.						•
Kalogirou et al. (1989)	Descriptive (based on regional data)	The contribution to the industrialization of a region and to regional development in general is likely to be relatively small or insignificant.						•
Labrianidis (1989)	Observations (presents critical feedback on the characteristics of the law)	A management information system should be in place to monitor the implementation of the investments.						•

Author	Type of analysis	Main points	4399/2016	3908/2011	3299/2004	2601/1998	1892/1990	1262/1982
Andrikopoulou-Kafkala (1984)	Descriptive (based on regional data)	Designing a sound policy is crucial to addressing market failures, but it is not enough on its own. Adequate implementation and monitoring are also essential to ensure that the policy is effectively addressing the problem it was intended to solve.						•

Methods used in existing research

Almost four in five studies utilize quantitative methods to examine the relationship between state aid subsidies and independent variables. Thirty-eight studies (73%) utilize descriptive statistics to analyse DL based on regional and sectoral data. Four studies (8%) employ regression analysis. Ten studies (19%) use qualitative analysis to evaluate the characteristics of DL and draw conclusions about its operation. These are marked as “observations” in the table above.

Each method has its merits and provides valuable and complementary information on various aspects of the issues at hand. For example, linear regression is used when the research question involves predicting an outcome variable based on one or more predictor variables. It aims to estimate the strength and direction of the relationship between variables and make predictions based on that relationship. On the other hand, counterfactual impact evaluation is used when the research question involves estimating the impact of an intervention or program by comparing what happened with what would have happened in the absence of the intervention or program. Therefore, incorporating counterfactual impact evaluation in addition to regression analysis can enhance the accuracy and reliability of the analysis by providing a more comprehensive understanding of the causal effects of state aid subsidies through DL.

Overview of key insights

This section presents the key insights into the success or failure of the DL as drawn from the works included in this literature review. In what follows we group the insights into three areas which are all crucial to the success of public policy, like DL (i) policy design, (ii) implementation, and (iii) impact (McConnell, 2010; Nagel, 2002; Pawson, 2006).

Policy design

Policy design is the process of creating procedures to guide decision-making and action. It involves (a) problem identification; (b) goal setting and (c) strategy development. The aim of policy design is to ensure that a policy is effective, efficient, and equitable

(Howlett et al., 2009; Weimer & Vining, 2017). Below, we highlight key findings from DL research that are relevant to each stage of policy design:

(a) Problem identification. It is the process of defining and understanding the problem that the policy aims to address. Effective problem identification involves a clear definition of the problem, and the identification of its causes and consequences. The DL mainly aims to address the issue of regional development but this is intertwined with other objectives, such as increasing employment opportunities, enhancing the competitiveness of firms, but also contributing to environmental protection and energy conservation (Ministry of Economy, 2022b). Nevertheless, some researchers argue that the primary focus of the policy is on reducing investment costs, rather than promoting regional development (Giannitsis, 1993; Stathakis et al., 2008). Both suggest that the policy design should be re-evaluated to align its objectives more closely with regional needs and goals. Furthermore, they recommend that the policy should place a greater emphasis on factors such as product quality, skilled labour, productivity, economies of scale, and innovation to strengthen firm competitiveness.

(b) Goal setting. It is an essential aspect of policy design because it provides a direction for policymakers to prioritize their objectives. It is also important for those who read the policy because it helps them understand the purpose and intended outcomes of the policy. Additionally, clear goals provide a basis for evaluating the effectiveness of the policy. According to Dryllerakis (2005), the DL lacks clear jurisprudential principles and a strict organization of concepts, making its navigation (or comprehension) a challenge, as it is characterized by a high level of detail and complexity. He acknowledges that the DL contains a large amount of information that can be difficult to understand due to its repetitive nature and complex structure. It is composed of lengthy articles, which can further add to its complexity. These factors can make it difficult for individuals and firms to understand and comply with the DL and can hinder its effectiveness in achieving its intended goals. Stelianidis (2017) uses a table to show that investors, in order to determine their compliance with the eligibility criteria of DL, need to consult a number of other regulatory texts, which are often jointly determined by other Ministries besides the Ministry of Economy. According to Delitheou (2009), policy making in the DL often has a short-term focus, which can make it difficult to achieve long-term goals. Stathakis

et al. (2008) also note that there are continuous changes in the institutional framework, which can make it difficult to coordinate efforts between different public authorities. Labrianidis (1989) highlights the issue of continuous amendments to the DL, especially before the elections, which can make it hard for the firms to keep up with changes. Kouzelis (2000) agrees that the DL is complex, bureaucratic, and prone to delays, especially following governmental changes. He also notes that personnel changes after governmental changes can add to the difficulty of implementing the DL. Bistroyianni-Karlou (2004) emphasizes the importance of designing a consistent policy, which can inspire legislators, guide administrators, and create a sense of trust among investors. As Karavia (2009) states, when the measurement of inequalities in Greece is based on the per capita GDP of the regions, it leads to serious underestimations of the country's regional problem, due to the peculiarities of its spatial distribution and the GDP itself as an indicator.

(c) Strategy development. It involves identifying and selecting the most effective approach to achieve the policy goals. The design of administrative structures and public awareness are two factors that are closely related to strategy development in policy design.

Regarding the former, it involves determining how responsibilities will be assigned, what resources will be needed, and how the policy will be coordinated across different levels of government. Skuras & Tzamarias (2000) mention that policy design should be decentralised and adapted to local conditions. It should be combined with other instruments, such as infrastructure, consulting, and training. They also discuss the constraints of a top-bottom policy design. Thermoyianni-Artikis (1990) agrees that policy is administrated by the centre. Delitheou (2012) proposes updates to the legislation and modernization of the administrative structures. Ioannides & Petrakos (2000) suggest that policy making should take into account the needs and special circumstances of regions. They add that policy will probably not succeed unless governmental administrative structures of Greece are reformed, by the design of more efficient administrative units and by the amelioration of the human resources available to local and regional administration.

Regarding public awareness, if the information about the policy is communicated to the public in a clear manner, it is more likely that the public will understand the policy and support it. However, if information is presented in a confusing way, it can lead to misunderstandings, scepticism, and opposition. Hassid (2006) suggests that the social acceptance of a state aid policy is a catalyst for an increase in investments, by creating an environment that promotes entrepreneurship and innovation. Vlami et al. (2012) argues that the DL was based on social and political criteria and especially the tourism part of policy was based on institutional, economic, social, cultural, and environmental criteria. This may indicate that policymakers considered a broad range of criteria when developing the policy, in order to increase public awareness. Stelianidis (2017) states that public awareness is of critical importance, so that the public opinion presses the political system to the direction of regulatory reforms and at the same time the citizens become more supportive to investments.

Policy implementation

Policy implementation refers to the process of putting the policy into action and is the second critical step that determines whether the DL will achieve its intended goals. However, implementation is a complex process that can be affected by various factors, including (a) political factors; (b) administrative challenges; (c) implementation difficulties, and (d) resistance to change, see e.g. Hill & Hupe, 2002; Sabatier & Mazmanian, 1980. We review each factor in turn, reporting the relevant insights from the literature reviewed:

(a) Political factors. Political factors refer to the conditions within the political environment that can affect policy implementation, including the priorities and interests of political leaders, and the influence of interest groups. Kalogirou et al. (1989) claim that if the DL favours foreign capital with strong political influence then it may be less likely to be successful. It has been argued that clientelist interests between politicians and firms also affect policy implementation (Labrianidis & Papamichos, 1990; Roumeliotis, 2014). Additionally, the involvement and the lack of coordination of too many decision-makers in the process, such as policy-makers, legislators, members of representative bodies, politicians, members of authorities, may also complicate and/or

hinder the policy implementation process (Petrakos & Psycharis, 2006; Stathakis et al., 2008). Additionally, not only political but socio-economic factors seem to also be important parameters of the effectiveness of the DL (Bistroyianni-Karlou, 2004).

(b) Administrative challenges. These are issues related to the organization of the implementation process. For instance, if the structure of the organization needs modernization, it may be difficult to implement the policy as intended (Delitheou, 2009). Policy will probably not succeed unless governmental administrative structures are reformed, by the design of more efficient administrative units and by the improvement of the human resources available to local and regional administration (Ioannides & Petrakos, 2000). To ensure successful implementation, the state should increase its efforts to monitor the progress on state aid policy (Kokkinou, 2003). A highly centralized administrative system (Konsolas, 1997) and a lack of synergies with other policies (Margariti, 2007) have also been found to be barriers to effective implementation. Giannitsis (1993) also identifies all the above issues stating that policy design and administration should be aligned.

(c) Implementation difficulties. They refer to challenges that arise during the implementation process itself that can hinder the success of policy implementation. They can be categorised in two areas: (1) evaluation of investment proposals; (2) monitoring of investments after the approval of the proposal.

Regarding proposal evaluation issues, Labrianidis & Papamichos (1990) found that the period between submission, approval, and granting the subsidy is long, resulting in increased costs for firms. Kalogirou et al. (1989) reported delays that can be caused by requests for approval without having a complete business plan. Nikolaidis et al. (2009) concur, stating that firms often submit applications that do not fulfil all the necessary documentation to support the investment. Furthermore, approval delays from banks can also contribute to delays in the evaluation process (Roumeliotis 2014). Over-regulation and over-proceduralization can cause bureaucratic overload and delays in the proposal evaluation process (Bistroyianni-Karlou, 2004). When stakeholders lack the necessary knowledge and skills to implement effective policies, several evaluation problems may arise. According to a study by Nikolaidis et al. (2009), there is a significant gap in the provision of information and guidance by relevant authorities to firms seeking

subsidies. The lack of a specific strategy for helpdesk support from the authorities further exacerbates this problem for SMEs, as they have limited (and sometimes unequal) access to consulting services. Additionally, Hassid (2006) highlights that the evaluation of investment projects is often biased towards traditional sectors, as evaluators are more experienced and familiar with assessing such projects. Furthermore, Roumeliotis (2014) points out that a shortage of qualified administrative staff leads to delays in the evaluation process. Labrianidis & Papamichos (1990) suggest that evaluation delays may be caused by policy makers' lack of expertise in creating an incentive policy that uses a set of clearly defined objective criteria. Nikolaidis et al. (2009) further suggest that the absence of objective eligibility criteria results in investments that are not sustainable in the long-term. Without clear and consistent proposal evaluation standards, investment selection may be driven by short-term gains rather than long-term viability.

Regarding monitoring issues, Papadoulis (2003) argues that the lack of monitoring during the implementation of subsidized investments makes it difficult to draw information about the capabilities of the recipient firms to carry out their approved investment plans and possibly prevent failures. Argyrou (2021) highlights that the absence of monitoring and evaluation processes raises questions about the impact of the DL on the Greek economy. Labrianidis (1989) emphasizes the need for an evaluation system to monitor the impact of the DL. Furthermore, as noted by Konsolas (1997) a management information system can be a basis for a more data-driven decision-making process as such a system would allow for easy access to accurate data, leading to better-informed decisions. Andrikopoulou-Kafkala (1984) argues that designing a sound policy is essential to remedy market failure, but inadequate implementation monitoring can cause policy failure. This is because if the state is not aware of the status of the implementation of investments, it cannot make realistic estimates for annual budget planning. Consequently, the state may end up with an obligation that it cannot fulfil, i.e. it might end up paying more firms per year than originally planned. Additionally, firms that are expecting payments may be negatively affected as they are unable to effectively plan their activities based on uncertain payment schedules (Kokkinou, 2003).

(d) Resistance to change. Resistance to change can significantly affect policy implementation, as it refers to the reluctance or outright opposition of stakeholders to adopt and support the policy. As highlighted by Evaggelopoulou (2018), inability of the state to adapt to current conditions can be a major barrier to the successful implementation of policies, as they may not be well-suited to addressing the problems at hand and recognizing productive investments. Kostopoulos & Pseiridis (2016) report that the introduction of a new management information system in 2011 spurred a new culture within state officials. This is because information management systems fundamentally altered the way that information is collected, stored, shared, and used, leading to a more transparent culture. However, the success of the system was highly dependent on the level of acceptance and buy-in from the state officials.

Policy impact

The impact of a policy refers to the intended and unintended consequences of the policy on firms and the economy. As described in the policy outline section (see p.18 above), the DL is not a state aid policy that targets specific investments, sectors, or regions. Instead, it aims to support overall economic development, through providing financial assistance to firms and promoting investments in various sectors, regions, and industries. Assessing the impact of the DL is important to understand its effectiveness and identify areas for improvement. This can help policymakers and state officials to make informed decisions about the policy. In what follows we outline the literature grouped in four issues: (a) the type of investments that the DL attracts; (b) the sectors that usually apply for aid; (c) the regions that benefit the most; and (d) the sustainability (viability) of investments (McConnell, 2010; Nagel, 2002).

(a) Type of investments. The DL, according to Ioannides & Petrakos (2000), is intended to create new investment opportunities, primarily in the form of new production facilities, as noted by Markatou & Stournaras (2014) and Tahtalidis (2007). However, Stathakis et al. (2008) report that the DL also provides subsidies for expansion of large production lines, even when they are operating at only half of their capacity. Labrianidis (1994) notes that the DL promotes large investments, and Karafolas (2013) explains that it supports large investments across all sectors, but mainly in agriculture, industry, and

tourism. Skuras & Tzamarias (2000) also point out that the DL favours large-scale industrial projects. Athanasiadi (2022) suggests that micro-enterprises may not use the state aid provided by the DL because they may not be aware of the available opportunities under the DL.

(b) Sectors. Giannitsis (1993) argues that traditional sectors have absorbed the majority of investments due to their established position in the market. Markatou & Stournaras (2014) report that there are very few investment projects in technology-intensive industries. This is similar to the findings of Papadoulis et al. (2003), who note that sectors with traditional production methods attract more investments, and that the DL tends to attract labour-intensive rather than technology-intensive investments. Hassid (2006) also argues that enterprises in traditional sectors have benefited the most from the DL. Kalogeresis (2020) notes that the DL's emphasis on innovation has not been attractive to firms. The importance of subsidizing high-intensive technology sectors stems from Stathakis et al. (2008) who found that manufacturing firms that invest in R&D gain more in terms of competitiveness than those that only invest in plant buildings and basic process equipment.

(c) Regions. Vlami (2010) argued that already established tourist areas got more funding. Vlami et al. (2012) discusses the efficiency of policy by geographic area, and argues that subsidies reinforced existing tourism foci rather than creating new ones. Tahtalidis (2007) argues that despite the high intensity incentives offered to disadvantaged areas, there has been no observed increase in capital mobilization in these areas. Instead, already developed areas were found to be the primary recipients of subsidies. He suggests that factors such as the region's characteristics, accessibility to domestic and foreign markets, local infrastructure, and the educational level of the population play a role in determining where investments are made. These results align with the findings of other researchers (such as Artikis et al., 2011; Daskalopoulou, et al., 2000; Filippaios & Kottaridi, 2004; Giannitsis, 1993; Kostopoulos & Pseiridis, 2015; Labrianidis & Papamichos, 1990; Margariti, 2007; Papadoulis et al., 2003; Petrakos & Psycharis, 2006) who also observe that larger aid amounts in some regions do not necessarily lead to a higher number of investments in these areas. Ioannides & Petrakos (2000) discuss that policy making should consider the needs and special circumstances of regions. Geraki et

al. (2013) also discuss the effective allocation of public resources and conclude that certain regions consistently receive a large amount of state aid. Labrianidis (1989) notes that consumer product industries tend to be located in dense urban areas. For example, the agglomeration in Attica can be attributed to its already established population of firms, which benefit from shared inputs, infrastructure, and knowledge networks that support their operations. Polyzos & Minetos (2007) suggest that initially incentivizing large cities to achieve agglomeration economies may not be conducive to regional cohesion, but it could be a way to spur higher rates of growth in the whole economy.

(d) Sustainability of investments. It seems that in some cases the DL supports investments that are never completed. This phenomenon has been well documented in numerous studies (Kalogirou et al., 1989; Karafolas, 2013; Karavia, 2009; Labrianidis, 1989; Papadoulis et al., 2003) but is also confirmed with data by the Ministry of Economy (2016b). Investments that have been granted state aid for implementation have either failed to start or started but were discontinued. This phenomenon has severe implications, both (1) in terms of incurring substantial administrative expenses for the public sector and (2) in jeopardizing the stability of the firms involved. More specifically, administrative expenses include the steps to recover the funds that were advanced to the firm which include the creation of new specialized units to manage the recovery of the funds, training of new employees, audits, site visits, etc. Further, firms may have already committed significant resources to the funded project, such as time, money, and human capital. Abandoning an investment plan amounts to the loss of the resources used. Moreover, if the firm is unable to repay any funds advanced by the public sector to support the project, it may face financial difficulties, which could lead to bankruptcy or insolvency. As a result, it is imperative for decision makers to be vigilant of the potential risks associated with investment plans, enhance the likelihood of success, and ensure that public funds are being optimally utilized.

Charting an evidence-based path

Based on our analysis of the literature reviewed in this chapter, we propose that attention should be directed towards three key areas: (a) incomplete (discontinued) investments, (b) the regional distribution of investments, and (c) the types of

investments being attracted by DL. Firstly, the existence of discontinued investments may lead certain sectors or regions experiencing more significant growth than others, potentially worsening social and economic inequalities. Secondly, the regional distribution of investments may exacerbate existing inequalities in regional economic growth. Finally, the types of investments being attracted are also essential to be considered, as certain types of investments may be more beneficial to the economy than others. In the following paragraphs, we provide detailed elaboration on these identified areas of focus:

(a) Incomplete (discontinued) investments. As discussed in the implementation difficulties section above, some investments that have been approved for funding never start, some start but are discontinued. We believe that one of the main reasons for this phenomenon is poor budgeting on behalf of the state. The Public Investment Program (PIP) is a state budget tool that finances development policies and projects aimed at increasing both private and public capital in the economy. It is divided into two categories: the National PIP, which includes projects financed solely by national resources, and the co-financed PIP, which involves projects co-financed by both the European Union and national resources. The DL falls under the National PIP category and is funded solely by national resources, with an allocated yearly budget of €0.4bn (Ministry of Economy, 2022b). It appears that although a high number of investment plans are considered as successful during the proposal evaluation phase, the capacity of the state to provide the corresponding financial aid is insufficient: in many cases the state is not able to make the payment for all successful investment proposals or delays payments. The inability of the state to fulfil its financial obligations supports the notion that effective state budgeting is crucial to produce the expected results of the DL.

(b) Regional distribution of investments. The calculation of aid intensity by the European Commission which is based solely on the GDP per capita of a region perhaps is a contributing factor to regional inequalities. This is something that we discussed in the goal setting section (see p. 29 above). This method fails to accurately reflect the living standards and unemployment rate in the region, which are important indicators of a region's need for aid and investment. By ignoring the unemployment criterion, the European Commission's calculations may not accurately cater for the actual needs of

firms looking to invest in these regions. This can lead to a mismatch between the allocation of aid and the actual needs of the regions, potentially perpetuating regional inequalities. To address this issue, a more comprehensive approach, considering a wider range of indicators such as living standards and unemployment rates, would provide a more accurate picture of the needs of a region and ensure that aid is effectively targeted to the regions where it is most needed.

(c) Types of investments. We believe that the type of investment proposals that are submitted depends on the method used for the evaluation of the investment proposals. As discussed in the implementation difficulties section (on page 32 above), existing research shows that the evaluation process for investment plans under the DL is slow. In addition, the evaluation duration has varying timelines for different regions. Based on the website of the Ministry of Economy for the last call for small enterprises of the DL 4399/2016, the Ministry of Economy takes an average of one year to provide evaluation results, while the Ionian island region takes an average of two years (Ministry of Economy, 2016a). This means that two similar investments that are submitted to different evaluation authorities may have a one-year difference in their starting dates. These delays may not be suitable for high-tech firms that require significant investments in R&D and advanced technology, as they may result in missing out on investment opportunities.

Conclusion

The literature review has identified several crucial drawbacks in the DL that need to be addressed by policymakers to improve its effectiveness. Our analysis is split into three areas: policy design, implementation, and impact. The findings are interconnected and demonstrate the need for a comprehensive approach to address the challenges facing state aid subsidies and their impact on the economy.

With regards to policy design, existing literature has identified several problems, such as the lack of specific, measurable, and achievable goals for the policy, the complexity of the DL, and the need for increased public awareness. These issues can create difficulties in policy implementation and policy impact (effectiveness), as they make it

harder for policymakers and administrators to effectively implement and evaluate the policy.

In terms of policy implementation, the literature suggests that the administration is centralized and that major issues are delays in the evaluation process, lack of evaluation competence, inefficiency of monitoring, and inability of the state to adapt to current conditions. These implementation challenges can hinder the policy's ability to achieve its goals, as they make it more difficult for the policy to target sustainable firms and to evaluate the results of the subsidies.

Finally, in terms of policy impact, the literature has highlighted that traditional sectors have so far absorbed the majority of investments; technology-intensive industries do not opt to apply for subsidies; and that there has been no observed increase in capital mobilization in disadvantaged areas despite the high intensity incentives being offered. These findings indicate that the policy has not been successful in achieving its intended outcomes, particularly in terms of supporting the growth of technology-intensive industries and increasing capital mobilization in disadvantaged areas. This is something that we discussed in the goal setting section.

In conclusion, the analysis of available research on the DL provides a comprehensive overview of the patterns and trends associated with state aid subsidies in Greece. As we have explained above (see p.36) we believe that the most significant issue among all identified issues is the high number of incomplete investments because the intended benefits of the policy are not fully realized. This can be detrimental to the economy, which may miss out on potential opportunities for growth and development.

We also believe that, despite the large body of existing literature, the impact of the DL on the economy remains uncertain as the evaluation of the DL does not rely on a statistically robust assessment of its impact on the Greek economy. To gain a clearer understanding of the effects of the DL on the economy, researchers should apply more sophisticated techniques like counterfactual impact evaluation techniques in their assessments. This approach involves comparing the outcomes of a group that received state aid to a similar group that did not receive it, enabling the estimation of the causal effect of the policy. Through the use of this method, a more thorough understanding of the impact of state aid subsidies on the economy can be gained, ultimately informing

any necessary adjustments or improvements to the design and implementation of such policies. The following chapter conducts a systematic review of thirty-five counterfactual impact evaluations that examine the influence of EU state aid on the productivity of firms. Chapter 4 focuses specifically on conducting a counterfactual impact evaluation of DL.

Chapter 3. The impact of EU state aid on firm productivity: a systematic review of the literature

Summary

Significant state resources are directed to firms, so we expect that state aid programs impact positively on firms. This paper systematically reviews thirty-five quantitative evaluations assessing the impact of EU state aid on firm productivity. The combined sample consists of 369,643 firms and represents state aid programs of twelve EU member states that were active from 1996 to 2015. All studies include propensity score matching methods. Only seventeen studies find a positive impact of state aid. These mixed findings prevent us from concluding that EU state aid automatically has a positive impact on firm productivity.

Introduction

One of the objectives of state aid is to change the behaviour of firms so they carry out economic activities that they would not perform otherwise (United Nations, 2004). Nowadays, due to Covid-19 and energy crises, the main objective of state aid is the development of temporary frameworks to protect firms from pausing their operations (European Commission, 2022d). Both types of state aid objectives aim to prevent economic failures and improve situations that market itself cannot deliver (Bellak & Leibrecht, 2016). An important characteristic of temporary frameworks is that they are designed very urgently and are considered less strict. Indeed, Executive Vice-President Margrethe Vestager, in charge of competition policy, stated: “...the Commission will enable Member States to use the flexibility foreseen under State aid rules to tackle this unprecedented situation, while protecting the level playing field in the Single Market.” (European Commission, 2022d).

In a period of high uncertainty and limited knowledge of temporary frameworks the question is if there exists state aid knowledge that can be leveraged. The European Commission’s state aid repository includes more than 43,068 registered state aid cases (European Commission, 2022f). As of August 15, 2022, 1,350 cases represent positive decisions to support the economy in the context of the coronavirus outbreak with an

estimated budget of €3.2tn. This is a tremendous EU response if we consider that for 2019 the Member States have spent €134.6bn for state aid (European Commission, 2020).

Despite the proliferation of state aid cases only 51 decisions for ex-post impact evaluations can be found in the repository, thus providing limited knowledge on the impact of state aid. Our aim is to examine if state aid has a positive impact on those who receive it. A method to estimate what would have happened if there was no aid is counterfactual impact evaluation (CIE) (Gertler et al., 2016; Khandker et al., 2009). CIE is a method of comparison which compares the expected outcome (e.g. the productivity) of firms which benefited from state aid (the “treated group”) with that of a group similar in all respects to the treatment group (the “comparison group”), the only difference being that the comparison group has not been exposed to state aid (Joint Research Centre, 2022). This method is specifically designed to estimate the causal impact of an intervention, such as state aid. By comparing the outcomes of a group that received state aid to a similar group that did not receive state aid, the CIE approach aims to control for other factors that could have influenced the outcomes, such as differences in the characteristics of the two groups. This arguably allows for a more accurate estimation of the impact of state aid on the firms. Therefore, we picked studies that are using this approach (CIE). Further, due to the broad range of CIE methodologies, this paper has a narrow focus to the propensity score matching method (PSM) as it seems that is getting more popular in terms of research output (Joint Research Centre, 2012)².

The chapter is organized as follows: Section 2 describes the conceptual framework. Section 3 presents the research question and methodology, and section 4 reviews the literature. Section 5 discusses the variables used to measure firm productivity in the propensity score matching method, and section 6 the potential sources of bias. We conclude the paper with policy implications and suggestions for future research.

² An analysis of PSM in the context of CIE can be found in Chapter 4.

Conceptual framework

This section begins by exploring the rationale behind state aid and then proceeds to illustrate how a typical state aid program in Greece works. Furthermore, the significance of evaluating state aid programs is emphasized, particularly through the use of counterfactual impact evaluation methods, and discusses the measurement of state aid impact.

Rationale behind state aid

State aid is a term used to describe any financial aid that simultaneously meets four specific criteria: the aid comes from state resources; it improves the financial condition of the beneficiary firms; it favours a selected sector³ of the economy; and it attracts investments from other member states (European Commission, 2016). If even one of these criteria is not met (e.g. financial aid of a government to all firms of the economy and not to a specific sector) then the financial aid cannot be considered as state aid. Given that all four criteria are met, state aid control by the European Commission prevents any firm from gaining an unfair advantage over firms from other EU member states. For this purpose, the European Commission guidelines, structured around thematic areas⁴, define the conditions that should be met to avoid competition distortion in each thematic area (European Commission, 2022e).

These conditions are:

1. the aid contributes to an objective of common interest; i.e. support the development of renewable energy sources to reduce carbon emissions and combat climate change, which is a common interest for the society as a whole;

³ Four-digit according to NACE classification, e.g. 55.10. (Hotels and similar accommodation)

⁴ These thematic areas are: Important Projects of Common European Interests (IPCEI); Regional aid; Research and Development and Innovation (R&D&I); Aid to disadvantaged and disabled workers; Training aid; Risk finance; Risk capital; Rescue and restructuring aid; Agriculture, food and fisheries; Electronic Communications; Energy and environment; Financial services; Information Communication Technologies; Media; Motor vehicles; Pharmaceuticals & Health Services; Postal services; Professional services; Sports; Transport (European Commission, 2022g).

2. it is necessary; i.e. it supports a struggling industry during an economic crisis to prevent widespread job losses and maintain economic stability;
3. it provides incentives to firms to undertake new activities; i.e. it encourages firms to take risks and pursue new opportunities that they might not have otherwise pursued;
4. it avoids negative effects on competition; i.e. it provides fair and non-discriminatory support to eligible firms based on an objective grading system;
5. it is limited to the minimum necessary amount; i.e. it prevents excessive financial burdens on public resources and encourages efficiency in the use of aid funds;
6. it must be a suitable policy instrument; i.e. it utilizes tax relief rather than grants; and
7. it is administered transparently; i.e. it ensures that information regarding the aid awarded is accessible to everyone (European Commission, 2021a).

How state aid programs work

The implicit hypothesis in any discussion about aid programs in general is that policy makers have identified a market failure; they have set goals and objectives and ideally have shared the idea with the community to receive feedback. Then, a policy to amend the market failure is formulated.

A typical state aid program in Greece is formulated in five parts: (1) the general part; (2) eligibility criteria; (3) type of aid; (4) evaluation criteria; and (5) implementation issues⁵.

The first part includes the policy objectives of the program, the budget of the program, the program duration including the start and end dates of the program, the authorities responsible for granting the aid, and the compatibility of the program with EU state aid rules.

The second part includes the eligibility criteria, i.e. eligible regions, firms that may be eligible for the aid (beneficiaries), the type of investment projects (usually new unit or

⁵ An example of a state aid program is the Greek development law. For further elaboration of the Greek development law see the documentation (Ministry of Economy, 2022a) which provides detailed information.

expansion of existing unit), and the types of investment costs that can be covered by the program (eligible costs). For example, investment projects eligible for regional investment aid under the General Block Exemption Regulation (European Commission, 2021d)⁶, should mainly include the setup of a new establishment or the capacity extension of an existing establishment. In addition, the eligibility of applicant firms is important and is closely related with policy objectives. Small and medium-sized enterprises (SMEs) make up 99% of total firms in the EU (European Commission, 2022c), so nearly all state aid programs are aimed at SMEs. SMEs are firms that are defined by their number of employees and financial criteria. Specifically, SMEs are firms that have fewer than 250 employees, and either an annual turnover of €50m or less, or a balance sheet total of €43m or less (European Commission, 2015).

The third part (type of aid) includes the available financing tools, the financial contribution of beneficiary firms, the maximum percentage of state aid on the total investment budget (which is called state aid intensity), and maximum state aid amount per firm. Financing tools can take numerous forms i.e. grants, tax advantages, guarantees, loans, repayable advances, risk capital, equity intervention, debt write-off, etc. They cover part of, or sometimes all, an investment's eligible costs depending on the respective state aid rule. Beneficiary firms may be needed to cover the rest of the financing.

The fourth part includes the evaluation criteria of each investment proposal. Usually there are on/off criteria and criteria based on a point system that is used to rank the successful applications. Eligibility criteria may include the competence of the firm's human capital, the owner's experience, the environmental impact of the project, the project's innovative characteristics, etc.

The last part (implementation issues) includes all information that is relevant to the management of each investment proposal i.e. the submission process, the evaluation

⁶ By using this regulation, the European Commission has the authority to classify types of state aid as compliant with the provisions of the Treaty on the Functioning of the European Union, provided they meet specific criteria. As a result, these types of aid are not subject to the prerequisite of prior notification and approval from the European Commission.

process, the approval process, the obligations of successful applicants, and the payment process.

The evaluation of state aid programs (do they work?)

The evaluation of state aid programs can provide an indication of whether and to what extent the objectives of an aid policy have been fulfilled. It can serve as the basis for formulating future state aid policies. We can think of policy evaluation in roughly the same way as we think about an evaluation of a new medical treatment. Without proper evaluation, we lack essential insights into the effectiveness, safety, and overall outcomes of the medical treatment. The same applies when public resources are spent on programs without evaluation. The counterfactual impact evaluation method enables the assessment of cause and effect between state aid programs and outcomes. It provides an estimate of what would have happened in the absence of the aid program (Khandker et al. (2009) provide a review). The main methods used in counterfactual impact evaluation are Propensity Score Matching (PSM), double-difference methods, instrumental variable methods, and regression discontinuity design. In the context of evaluating the impact of state aid subsidies on firm productivity, PSM would be a suitable method because it matches individuals in the treatment group to individuals in the control group based on a set of observable characteristics, or "propensity scores", that are related to the probability of receiving the treatment, to reduce selection bias and estimate treatment effects (Rosenbaum & Rubin, 1983).

Other methods like double-difference, instrumental variables, and regression discontinuity design may have equal merit in this context. For example, in the double-difference method one must compare the change in the outcome variable for the treatment group before and after the intervention to the change in the outcome variable for the control group over the same period. On the other hand, instrumental variables method requires the identification of valid instruments, which are variables that are highly correlated with the treatment variable but are not related to the outcome variable. Finally, regression discontinuity design methods require the assumption of a clear cutoff point for the treatment assignment based on a continuous

variable, where firms that are just above the cutoff are eligible for the program, while those just below are not.

PSM is a useful starting point in estimating treatment effects in observational studies as it can help reduce selection bias by matching individuals based on observable characteristics. However, the other methods such as double-difference, instrumental variables, and regression discontinuity design can also be useful in certain contexts. For example, double-difference may be appropriate when there is a clear comparison available; instrumental variables may be suitable when there is a valid instrument that can be identified; and regression discontinuity design may be applicable when there is a clear threshold for treatment assignment based on a continuous variable. Ultimately, the choice of method will depend on the research question, the available data, and the underlying causal mechanisms.

Measurement of state aid impact

The evaluation questions should guide the selection of specific result indicators that effectively capture quantifiable information regarding the outcomes achieved through the State aid policy. For example, the state aid evaluation methodology document of the European Commission (European Commission, 2014) offers a non-exhaustive list of result indicators that encompass the direct impact of state aid policies. The Greek development law 4399/2016 is currently (as of June 2023) under evaluation from the European Commission (European Commission, 2018) which uses many of these indicators⁷.

One of these indicators is productivity. State aid can assist firms in investing in resources that can enhance their output or reduce their costs. The primary goal of measuring productivity is to identify how efficiently a firm is utilizing these resources. Measuring productivity is essential for firms as it helps them understand how much output they can produce with given resources (OECD, 2001). This knowledge enables them to

⁷ The full list of indicators used by the EC for the evaluation are: change in capital, employment, turnover, fixed assets, intangible assets, share of exports, gross value added, investment expenditure, productivity, Return on Asset (ROA), Return on Equity (ROE), technological upgrade, upgrade of the enterprises along the value chain towards the production of more complex products.

identify areas where they can improve their production process. Governments also find measuring productivity crucial as it helps in formulating policies and assessing the performance of subsidized sectors. There are two fundamental types of productivity measurement: single-factor productivity and multifactor productivity. Single-factor productivity measures output in relation to a single resource, such as labour or capital, while multifactor productivity measures output in relation to a combination of resources, including labour, capital, energy, and materials (OECD, 2019).

Research question and method

As explained above, an important question to us is whether state aid programs deliver the results that the market fails to deliver. If they do deliver, what is the size of the impact (if any) of EU state aid programs on firm productivity? Both are cause-and-effect questions that aim to track changes in firm productivity that are directly attributable to state aid programs. To answer these questions, we conducted a systematic review using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Page et al., 2021). The PRISMA guidelines provide a framework for authors to report the methods, results, and conclusions of systematic reviews.

Based on the above, the search inclusion criteria targeted articles that evaluate the impact of state aid on firm productivity in EU member states. We applied searches in Google scholar, Scopus, and Web of Science. We conducted the searches between 12 May 2022 and 10 June 2022. We followed the steps below:

1. **Develop the search code:** We conducted an advanced search on Google scholar using: Find articles with all the words: "state aid", productivity, and "propensity score matching" which are the three basic keywords defining our research objective. However, due to the limited number of keywords allowed by Google Scholar, we couldn't include all EU member states or alternative terms for state aid that would better meet our inclusion criteria. Subsequently, we conducted a search on Scopus using additional keywords such as different types of state aid, the names of EU member states. The search code used in Scopus was:

(("state aid" OR "state intervention" OR tax OR grant OR debt OR equity OR " risk capital" OR guarantee OR loan OR subsidies OR eu OR europe OR austria OR

belgium OR bulgaria OR croatia OR cyprus OR "czech republic" OR denmark OR estonia OR finland OR france OR germany OR greece OR hungary OR ireland OR italy OR latvia OR lithuania OR luxemburg OR malta OR netherlands OR poland OR portugal OR romania OR slovakia OR slovenia OR spain OR sweden) AND ("propensity score matching" OR psm) AND productivity)

The Google search returned 406 documents and the Scopus search returned 124 documents.

2. **Screen titles and abstracts:** We assessed whether the articles aligned with our research focus i.e. they addressed the relationship between state aid, productivity, and the utilization of propensity score matching. We specifically focused on documents about EU member states. In this process we excluded (a) duplicate articles found within each search (b) studies that examined state aid policies in non-EU countries, (c) articles lacking all three of our keywords, and (d) having content unrelated to our research focus. After screening the titles and the abstracts, we identified as potentially relevant 48 of 406 articles from Google Scholar and 15 of 124 articles from Scopus. It should be noted that all 15 articles of Scopus were also retrieved with the Google Scholar search.
3. **Read the full text of the articles:** Then, we obtained access to the full text of the 48 selected articles. We studied the complete articles to gain a comprehensive understanding of their methods and findings. We identified 28 studies that utilized propensity score matching as the main method to evaluate the impact of EU state aid policies on firm productivity. In order to explore additional research works by the scholars of the 28 studies and also identify any other potentially relevant studies that were not included in the initial search, we reviewed the reference lists of these articles. We utilized the Web of Science and Scopus databases for this purpose. This process resulted in 214 search results. We reviewed the abstracts and titles of these 214 articles to determine whether they met the inclusion criteria for our review. We found 15 additional articles and obtained access to their full text.
4. **Final selection of articles:** After evaluating the 28 studies of the initial search and the additional 15 studies from the review of their reference lists, we had 43 documents in total that met our inclusion criteria. During this examination, we excluded 8 articles due to their methodology approach. These studies did not primarily utilize

propensity score matching as the main methodology but rather treated it as a complementary approach. Therefore, we worked on a final set of 35 articles.

Review of studies

Based on the inclusion criteria mentioned above, we identified thirty-five European studies that measure the impact of EC state aid on firm labour productivity using one of the methods of CIE, called propensity score matching. The studies come from the following countries: Croatia (Srhoj et al., 2020; Srhoj, Lapinski, et al., 2019; Srhoj, Škrinjari, et al., 2019; Srhoj, Škrinjarić, & Radas, 2021; Srhoj, Škrinjarić, Radas, et al., 2021; Srhoj & Walde, 2020), Czech Republic (Dvouletý & Blažková, 2018, 2019; Medonos et al., 2012; Mezera et al., 2013; Ratering et al., 2013; Ratering, Amoako Agyemang, et al., 2020; Špička, 2018a, 2018b), Denmark (Rotger et al., 2012), Finland (Karhunen & Huovari, 2015; Koski & Pajarinen, 2015), France (Sissoko, 2011), Germany (Caliendo et al., 2016; Kölling, 2015; Michalek et al., 2013), Hungary (Banai et al., 2017, 2020; Muraközy & Telegdy, 2020), Italy (Bernini & Pellegrini, 2011; Bia & Mattei, 2012; Biagi et al., 2015; Bondonio et al., 2016; Gabriele et al., 2006; Pellegrini & Centra, 2006), Latvia (Benkovskis et al., 2019), Lithuania (Namiotko et al., 2019), Portugal (Santos, 2019; Santos et al., 2019), Spain (Duch et al., 2009).

Classification of studies according to their characteristics

The main findings are listed in Table 2 below (from p. 51).

The first study of these 35 state aid evaluation studies was published in 2006 and the last one in 2021. The studies examine the years from 1996 to 2015. The period 2014-2021 includes 24 studies (68%). The average duration of aid studied is five years. The period covered by most studies is 2007-2011. On average, they evaluate the impact of state aid programs five years after their end (the last day for applications). The total budget of the evaluated programs for the period 1996-2015 is €54bn. As a measure of comparison, the expenditure of member states for 2019 was €134.6bn excluding aid to agriculture, fisheries, and railways (European Commission, 2022g). More than 369,643 firms are included in the evaluation studies of our sample.

Table 2. Characteristics of studies

Author & year	Country	National/regional target	Policy target	Size of enterprises targeted	Granting authority	Type of incentives	Budget	Period of analysis	Sample (firms)	Program effects
Gabriele et.al (2006)	Italy	Local (Trento)	Entrepreneurship support	All	Local government	Grants	n/a	1998-2003	n/a	Positive (temporary) and statistically significant effects of program on labour productivity that are reabsorbed after one year.
Pellegrini & Centra (2006)	Italy	Local (Mezzogiorno)	Regional development	All	n/a	Grants	€16bn	1996-2005	Treated: 665 Untreated: 1,493	Negative and statistically significant effects of program on labour productivity. A possible explanation is that the reduced investment cost caused by the subsidy drives the subsidized firm to invest in projects with lower productivity. Another explanation is that firms can decide to increase the number of new employees if this option can improve the probability of receiving the subsidy.
Duch et al. (2009)	Spain	Local (Catalonia)	R&D		Local government	Grants	€8.6m	2000-2002	Treated: 421 Untreated: 414	Positive and statistically significant effects (using Kernel and Radius estimators) of program on labour productivity.

Author & year	Country	National/regional target	Policy target	Size of enterprises targeted	Granting authority	Type of incentives	Budget	Period of analysis	Sample (firms)	Program effects
Bernini & Pellegrini (2011)	Italy	Local (Southern Italian regions)	Sectoral development (Manufacturing)	All	Ministry (for Industry)	Grants	€23bn	1996-2007	Treated: 665 Untreated: 1,228	Negative and statistically significant effects of program on labour productivity. Explanations given by the authors are that the reduction in the investment cost caused by the subsidies drive the subsidized firm to invest in projects with a lower than average productivity. Furthermore, in the selection procedure of the measure the higher the employment on investment ratio, the higher the ranking of the project. As a result, firms may decide to increase the number of new employees since this option positively improves the probability of being subsidized.
Sissoko (2011)	France	National	R&D	All	n/a	Grants	n/a	1998-2005	Treated: 87 Untreated: 87	Positive and statistically significant effects of program on labour productivity. Speed of technology adoption plays an important role. Some remarks are that (1) initial productivity levels play an important role on the timing of the effects of productivity, (2) delays may appear when firms spend time to explain to their research patterns how to innovate and (3) amount of R&D subsidies are not enough for large firms to allow them to innovate fast.

Author & year	Country	National/regional target	Policy target	Size of enterprises targeted	Granting authority	Type of incentives	Budget	Period of analysis	Sample (firms)	Program effects
Bia & Mattei (2012)	Italy	Local (Piedmont)	Entrepreneurship support	All	n/a	Grants, soft loans, tax benefits	€230m	2001-2003	Treated: 4,802 Untreated: Not found	Positive and statistically significant effects of program on labour productivity. Authors believe that some firms may prefer investments that allow them to bring up labour-saving innovations whereas some other firms may primarily aim at scaling up operations, by also increasing their labour force.
Medonos et al. (2012)	Czech Republic	National	Sectoral development (Agricultural)	All	Fund (State Intervention Fund for Agriculture)	Grants	€121m	2008-2010	Treated: 291 Untreated: 553	Positive and statistically significant effects of program on labour productivity. Authors believe that investment in machinery is an indication that firms show emphasis on labour productivity.
Rotger et al. (2012)	Denmark	Local (North Jutland)	Entrepreneurship support (Start-ups)	SME	Regional institutions in collaboration with business support authorities in the municipalities	Soft business support (consultancy advice)	€134k	2002-2005	Treated: 467 Untreated: 609	Positive and statistically significant effects of program on labour productivity. No effect in the first year but after three years the effect is significant.
Mezera et al. (2013)	Czech Republic	National	Regional development	All	Ministry (of agriculture)	Investment support (no details found)	n/a	2007-2010	Treated: 110 Untreated: 110	Positive effects of program on labour productivity.

Author & year	Country	National/regional target	Policy target	Size of enterprises targeted	Granting authority	Type of incentives	Budget	Period of analysis	Sample (firms)	Program effects
Michalek et al. (2013)	Germany	Local (Schleswig-Holstein region)	Regional development	All	n/a	Grants	€29m	2001-2007	Treated: 101 Untreated: 706	No effect of program on labour productivity.
Ratinger et al. (2013)	Czech Republic	National	Sectoral development (Agricultural)	All	Ministry of Industry and Trade	Grants	€329m	2007-2013	Treated: 447 Untreated: 827	Positive and statistically significant effects of program on labour productivity.
Biagi et al. (2015)	Italy	National	Regional development	All	n/a	Grants	€2.6bn	2000-2006	Total: 6,200 (no details found)	Negative, albeit not statistically significant effects of program on labour productivity. The effect is quite stable across the different types of incentives and the size and sector of the assisted firms.
Karhunen & Huovari (2015)	Finland	National	R&D (SME)	SME	Agency of the Ministry of Employment and the Economy	Grants, loans	€611m	2002-2007	Treated: 1,215 Untreated: 1,874	No significant positive effect on labour productivity over the five-year period after a subsidy is granted.
Kölling (2015)	Germany	National	Regional development	All	Banks and funding institutions.	Grants	€842m	1996-2009	Total subsidised: 18,175 (no details found)	Positive and statistically significant effects of program on labour productivity five years after funding. As the author states this result is puzzling since economic funding is granted after the funded investments have been realized and not at the first stage of project implementation.

Author & year	Country	National/regional target	Policy target	Size of enterprises targeted	Granting authority	Type of incentives	Budget	Period of analysis	Sample (firms)	Program effects
Koski & Pajarinen (2015)	Finland	National	R&D (SME)	All	Agency of the Ministry of Employment and the Economy	Grants, loans	€611m	2003-2010	Total: 10,000 (no details found)	No statistically significant effect (short term and long term) of program on labour productivity.
Bondonio et al. (2016)	Italy	Multi National	R&D	All	n/a	Grants	n/a	2007-2011	Total: 13,169 (no details found)	No statistically significant effect of program on labour productivity
Caliendo et al. (2016)	Germany	National	Entrepreneurship support (Start-ups)	All	n/a	Grants	€1.6bn	2007-2011	Treated: 589 Untreated: 699	Positive effects and statistically significant effects of program on labour productivity, 20 and 40 months after start up.
Banai et al. (2017)	Hungary	National	Entrepreneurship support	SME	Central agency, financial intermediaries.	Grants, loans, guarantees	€30m	2007–2013	Treated: 9.636 Untreated: 192.571	No effect of program on labour productivity. Authors concluded that investments implemented from non-refundable EU subsidies can be regarded as expansion investments rather than efficiency improving investments.
Dvouletý & Blažková (2018)	Czech Republic	Local (Czech NUTS III regions, except the Capital of Prague)	Sectoral development (Manufacturing)	SME	Ministry (of Industry and Trade)	Grants	€97m	2007-2013	Treated: 143 Untreated: 634	Positive albeit not statistically significant effects of program on labour productivity, two years after the end of the intervention.

Author & year	Country	National/regional target	Policy target	Size of enterprises targeted	Granting authority	Type of incentives	Budget	Period of analysis	Sample (firms)	Program effects
Špička (2018a)	Czech Republic	National	Sectoral development (Manufacturing)	All	Ministry (of Industry and Trade)	Grants	€300m	2007-2015	Treated: 206 Untreated: 206	No positive effect of program on labour productivity. It was expected that modernization and innovation should improve labour productivity, but rural policy motivates firms to keep high employment rates in the rural areas under investigation.
Špička (2018b)	Czech Republic	National	Sectoral development (Manufacturing)	SME	Ministry (of Agriculture)	Grants	€11m	2007-2013	Treated: 391 Untreated: 486	No significant, positive effects on the intensity of the use of fixed assets and labour productivity, which has been a key impact indicator for program evaluations.
Benkovskis et al. (2019)	Latvia	National	Entrepreneurship Support	All	Ministry (of Finance)	Grants	€3.9bn	2007–2013	Treated: 380 Untreated: 1,490	Positive and statistically significant effects of program on labour productivity, visible only in the third period after launching a project. Positive effect on productivity is more likely to happen for companies that are bigger and less productive prior to participation in EU supported measures.
Dvouletý & Blažková (2019)	Czech Republic	National	Sectoral development (Manufacturing)	SME	Ministry (of Agriculture)	Grants	n/a	2007-2013	Treated: 157 Untreated: 1,224	Positive and statistically significant effects (using Kernel and nearest neighbour estimators) of program on labour productivity, two years after the end of the intervention.

Author & year	Country	National/regional target	Policy target	Size of enterprises targeted	Granting authority	Type of incentives	Budget	Period of analysis	Sample (firms)	Program effects
Srhoj, Škrinjari, et al. (2019)	Croatia	National	Entrepreneurship support (Women startups)	All	Ministry (of Entrepreneurship and Crafts)	Grants	€2.1m	2008–2013	Treated: 484 Untreated: 6,380	No statistically significant effect of program on labour productivity. Grants were targeted at business development, and they brought skills and knowledge, which introduced changes in firm behaviour. The absence of any significant effect in our study can be explained by the difficulty that survival presents for a young firm in recession: namely, just surviving and maintaining the same level of performance takes so much effort that none of the firm's capacity is left for performance improvement.
Namiotko et al. (2019)	Lithuania	National	Sectoral development (Agricultural)	All	n/a	Grants	€2.1m	2007–2012	Total: 284 (no details found)	No statistically significant effect of investment support on labour productivity in Lithuanian family farms.
Santos (2019)	Portugal	National	R&D	SME	n/a	Loan	€2bn	2008–2012	Treated: 243 Untreated: 320	No statistically significant effect of program on labour productivity. Subsidized firms also perform less well than matched non-subsidized ones, and they are less effective in achieving the planned goals concerning labour productivity and value creation.

Author & year	Country	National/regional target	Policy target	Size of enterprises targeted	Granting authority	Type of incentives	Budget	Period of analysis	Sample (firms)	Program effects
Santos et al. (2019)	Portugal	National	R&D	SME	n/a	Loan	€2bn	2007-2013	Treated: 2,680 Untreated: 2,659	No statistically significant effect of program on labour productivity. Treated firms in comparison with the control group (those with non-approved applications) have investment projects with a lower contribution to growth and lower economic efficiency (return on investment in terms of productivity).
Srhoj, Lapinski, et al. (2019)	Croatia	National	Entrepreneurship support (SME)	SME	Ministry	Grants	€2.3m	2008-2015	Treated: 610 Untreated: 16,386	No statistically significant effect of investment support on labour productivity.
Banai et al. (2020)	Hungary	National	Entrepreneurship support (SME)	SME	Central agency, financial intermediaries.	Grants, loans, guarantees	€2.2m	2007–2013	Total subsidised: 22,106 (no details found)	No statistically significant effect of investment support on labour productivity. This insignificant impact suggests that the investments implemented from non-refundable EU subsidies can be regarded as capacity-expanding rather than efficiency-improving (measured by labour productivity). This is reconcilable with the fact that one of the main objectives of the program was to foster employment. Besides, as typically the more productive firms receive support, the faster growth rate of such companies may still result in an improvement of aggregate productivity.
Ratinger, Amoako Agyemang, et al. (2020)	Czech Republic	National	R&D	All	Ministry (of Industry and Trade)	Grants	€480m	2013-2015	Total subsidised: 375 (no details found)	Positive and statistically significant effects of program on labour productivity.

Author & year	Country	National/regional target	Policy target	Size of enterprises targeted	Granting authority	Type of incentives	Budget	Period of analysis	Sample (firms)	Program effects
Muraközy & Telegdy (2020)	Hungary	National	R&D	SME	n/a	Grants	€1.8m	2004-2014	Treated: 2,936 Untreated: 869	Positive and statistically significant effects of program on labour productivity.
Srhoj & Walde (2020)	Croatia	National	Entrepreneurship support (SME)	All	n/a	Grants	€23m	2009-2012	Treated: 361 Untreated: 2,911	Positive and statistically significant effects of program on labour productivity.
Srhoj et al. (2020)	Croatia	National	Entrepreneurship Support (SME)	SME	Ministry (of Entrepreneurship and Crafts)	Grants	€2.3m	2008-2012	Treated: 610 Untreated: 16,386	No statistically significant effect of program on labour productivity.
Srhoj, Škrinjarić, Radas, et al. (2021)	Croatia	National	Entrepreneurship support (Women)	All	Ministry (of Entrepreneurship and Crafts)	Grants	€2.1m	2008-2011	Treated: 484 Untreated: 6,380	Positive and statistically significant effects of program on labour productivity. This result is observed three years after the treatment.
Srhoj, Škrinjarić & Radas (2021)	Croatia	National	Entrepreneurship support (Startups)	SME	Ministry	Grants	€2.1m	2008–2013	Treated: 222 Untreated: 12,429	No statistically significant effect of program on labour productivity.

Note: Compiled by author.

One would expect that the majority, if not all, of the studies would show a positive result. However, out of the thirty-five studies examined, only seventeen of them (48%) reported a positive impact of state aid on firm productivity. To further investigate this issue, we searched the papers for findings about whether specific policy characteristics affect policy impact. For example:

1. **Policy objectives** – Whether the specific policy objectives of state aid programs affected the relationship found between state aid and firm productivity.
2. **Program duration** – Whether the length of time that state aid programs are in operation affected the relationship found between state aid and firm productivity.
3. **Firm size eligibility** – Whether the eligibility criteria for state aid programs based on firm size affected the relationship found between state aid and firm productivity.
4. **Local/national target** – Whether the geographical target of state aid programs (local or national level) affected the relationship found between state aid and firm productivity.
5. **Type of granting authorities** – Whether the type of authority responsible for granting state aid affected the relationship found between state aid and firm productivity.
6. **Financing tools** – Whether the specific financing tools used to deliver state aid affected the relationship found between state aid and firm productivity.

To explore the above questions, we utilized the chi-square test of independence, which is one useful statistics tool for testing hypotheses. In our case, we aim to determine whether there is an association between policy characteristics (such as objectives, duration, firm size, regional target, type of granting authority, and type of financing tool) and policy impact on firm productivity (positive or negative). The null and alternative hypothesis is:

H₀: There is no association between policy characteristics and policy impact.

H₁: There is an association between policy characteristics and policy impact.

The null hypothesis (H_0) states that there is no association between policy characteristics and policy impact, implying that the different policy characteristics have no influence on whether the impact is positive or negative. The alternative hypothesis (H_1) posits that there is indeed an association between policy characteristics and policy impact,

suggesting that certain policy characteristics may have a significant effect on whether the impact is positive or negative. By conducting the chi-square test of independence, we can evaluate the evidence against the null hypothesis and determine if there is sufficient support to accept the alternative hypothesis. The chi-square test was performed using Stata software, and the detailed commands and tables can be found in the appendix (Stata code 1).

The findings are presented in the below table. It provides insights into the relationship between state aid policy characteristics and their impact on firm productivity. It presents an analysis of various policy characteristics, including policy objectives, program duration, firm size eligibility, local/national target, type of granting authorities, and financing tools. The "Category within a policy characteristic" column helps to organize and differentiate the various aspects of each policy characteristic.

The "No of papers" column indicates the number of papers that focused on each policy characteristic. The column "Papers finding positive result on productivity" provides the percentage of papers within each category that reported a positive result on productivity. The last column of the table presents the results of Pearson's chi-squared test for each policy characteristic which provides insights into the significance of the relationship between the policy characteristic and productivity.

Table 3. Papers reporting positive results, by policy characteristics.

Policy characteristics that were studied	Category within a policy characteristic	No of papers	Papers finding positive result on productivity	Pearson's χ^2
All papers		35	17 (48%)	
Policy objectives (total papers = 35)				$\chi^2 (3) = 0.8602$, Pr = 0.835
	General business activities	13 (37%)	7 (54%)	
	R&D	9 (26%)	5 (56%)	
	Sectoral development	8 (23%)	3 (38%)	
	Regional development	5 (14%)	2 (40%)	
Program duration (total papers = 35)				$\chi^2(1) = 10.9804$, Pr = 0.001
	Up to 3 years	8 (23%)	8 (100%)	
	From 4 to 13 years	27 (77%)	9 (33%)	
Firm size eligibility (total papers = 35)				$\chi^2 (1) = 2.6239$, Pr = 0.105
	All firm sizes	22 (63%)	13 (59%)	
	SMEs	13 (37%)	4 (31%)	
Local/national target (total papers = 35)				$\chi^2 (1) = 0.0085$, Pr = 0.927
	National	27 (77%)	13 (48%)	
	Local	9 (23%)	4 (50%)	
Type of granting authorities (total papers = 35)				$\chi^2 (1) = 0.3050$, Pr = 0.581
	Ministry	14 (40%)	6 (43%)	
	Local	21 (60%)	11 (52%)	
Financing tools (total papers = 35)				$\chi^2 (1) = 0.0037$, Pr = 0.952
	Grants	31 (89%)	15 (48%)	
	No grants	4 (11%)	2 (50%)	

Source: Own calculations.

The only case that the chi-square test suggests a statistically significant association is program duration. Papers examining shorter programs (up to three years) are more likely to report positive impacts compared to those examining longer programs (four to thirteen years). Apart from program duration, there is no statistical evidence to support a relationship between other policy characteristics (policy objectives, eligibility based on firm size, geographical targeting of programs, type of granting authority, type of

financing) and policy impact. It is important to acknowledge these limitations when interpreting the findings.

Variables used in the reviewed articles

The analysis of the 35 studies reveals that human capital, physical capital, firm age, FDI, exports, and innovation are the most commonly used independent variables. Twenty-five (71%) include human capital, twenty-two (63%) include physical capital, fourteen (40%) include firm age and FDI, twelve (34%) include exports, and ten (29%) include innovation. These variables are in line with existing knowledge on productivity. In what follows, we provide an overview of the theoretical grounds for the choice of these variables as well as a discussion of measurement issues in empirical work, including the 35 articles we studied. Below table shows the variables and measurement method used in each study.

Human capital

A commonly used definition of human capital is provided by OECD as “the knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being” (Keeley, 2007). Following Solow’s model, seminal studies (G. S. Becker, 1970; Denison, 1962; Mincer, 1958) started to include the human factor in their theoretical models on explaining productivity growth. More recent theoretical studies (Jones & Manuelli, 1990; Lucas, 1988; Romer, 1990) further developed these models, see Kwon (2009) for an overview.

The impact of human capital on productivity seems to be sensitive to the measures used. Four approaches of human capital measurement can be identified in the literature: (1) the cost-based approach (Eisner & Ruggles, 1991). This approach measures the cost required for a human to develop his or her skills. This approach has been used by several studies of our systematic review (Benkovskis et al., 2019; Biagi et al., 2015; Dvouletý & Blažková, 2018, 2019; Kölling, 2015; Michalek et al., 2013; Srhoj et al., 2020; Srhoj, Škrinjari, et al., 2019). A limitation of this approach is that it does not provide qualitative information about the effect of human capital on productivity; (2) the income-based approach (Jorgenson & Fraumeni, 1993). This approach measures the earning power of

human capital based on the expected returns of the investment in education (Srhoj, Lapinski, et al., 2019); (3) the education-based approach (Barro, 2001). Education is measured using proxies like literacy rates; average years of schooling in the population, and test scores, see Le et al. (2005) for an overview. This approach has been criticized for emphasizing quantity rather than quality of the human capital (Caliendo et al., 2016; Koski & Pajarinen, 2015; Rotger et al., 2012); (4) the experience-based approach. It provides a more qualitative approach since it emphasizes the specialization of the human capital (Muraközy & Telegdy, 2020; Rotger et al., 2012; Santos et al., 2019; Srhoj, Škrinjarić, Radas, et al., 2021). For a critical review see Marginson (2019).

Physical capital

Physical capital is one of the main factors included in the first theoretical models of productivity. The definition of physical capital includes different types of assets like buildings, machinery, warehouse supplies, and technology that a company owns (Barney, 1991). Physical capital is rather the most difficult to measure as it combines different types of assets and cannot be measured in terms of physical units, as the number of buildings cannot be compared with the number of machines. So, capital measurement has two aspects. The first aspect includes the measurement of the market value of capital (Banai et al., 2017; Gabriele et al., 2006; Medonos et al., 2012; Mezera et al., 2013; Michalek et al., 2013; Namiotko et al., 2019; Pellegrini & Centra, 2006; Santos, 2019). The second aspect includes the productive and eco-friendly capability of an asset (use of clean technologies)⁸ (Kirkwood & Longley, 1995). A detailed review can be found in Schreyer et al. (2009). With the exception of Pseiridis & kostopoulos (2023) which use the eco-friendly capability of assets no other articles use the second measure of physical capital.

⁸ OECD definition of clean technology: All stages of the life cycle of a product or process may adversely affect the environment by using up limited resources of materials and energy or by creating waste. Any substitution or change that reduces consumption of materials and energy and production of waste – including, for example, recycling of materials and energy – may be regarded as more environmentally friendly or “clean” (OECD, 1998).

Age of firm

Age is the period of time a firm exists. There seem to exist two viewpoints about the relationship between firm age and productivity (Coad et al., 2013; Kaoru et al., 2020; Rossi, 2016). The first suggests that as firms age, they gain experience, accumulate knowledge, and develop networks and collaborations, gain a deeper industry understanding, and define their processes all of which can positively impact productivity (see among others Jovanovic (1982), Ericson & Pakes (1995)). The second view point suggests that as firms grow older, they might become complacent, less adaptable, less innovative, resistant to change, and burdened by bureaucratic structures, all of which may lead to a decline in productivity (see Barron et al. (1994), Coad et al. (2013) and Esteve-Pérez et al. (2018) for an overview).

The measurement of firm age is not straightforward either. Generally, there are two perspectives about age measurement. The first is the number of years that the firm is a legal entity and the second is the number of years of productive operation. For example in a merger between two firms the new legal firm is recent while the production is older (see de Kok et al. (2006) and Duch et al. (2009) for a discussion).

In the studies of our systematic review age is used in five studies and all of them use the concept of years in operation, not age of the legal entity (Benkovskis et al., 2019; Bia & Mattei, 2012; Koski & Pajarinen, 2015; Rotger et al., 2012; Sissoko, 2011).

Foreign Direct Investment (FDI)

A firm is engaged in foreign direct investment (FDI) when it possesses ownership over assets of firms of another nationality (Dunning, 1980). Dunning treats inward investment as an additional input in the production process since it enhances the funding of a project and brings know-how to the firm; i.e. experienced management and technological skills, see for an overview Boddewyn (1983) and for a recent review see Tokes (2019). OECD measures inward FDI as the equity held by foreign investors (Golub, 2003). Few studies of our systematic review use this variable and all of them measure it as the equity held by foreign investors (Banai et al., 2017; Benkovskis et al., 2019; Duch et al., 2009; Karhunen & Huovari, 2015; Rotger et al., 2012; Santos et al., 2019).

Exports

Foreign markets provide a larger audience for domestic firms. In the classical studies of Bhagwati (1978) and Krueger (1978) exports are an important factor explaining productivity growth. They suggest that exports are higher (1) among the most efficient sectors of the economy, (2) when economies of scale exist, (3) when production costs are lower, and (4) with high externalities on other sectors or activities within the domestic economy. Exports can be measured in various ways; an overview of the relevant indicators is provided in Carneiro et al. (2016). In the studies of our systematic review, five studies use sales and all of them use sales as a percentage of total products of firm (Banai et al., 2017; Benkovskis et al., 2019; Santos et al., 2019; Srhoj, Škrinjari, et al., 2019).

Innovation

Probably the most comprehensive document on innovation is the OSLO manual, developed jointly by Eurostat and the OECD. Innovation is defined as “the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations” (OECD & Eurostat, 2018). To measure innovation, the Oslo manual provides four categories of innovation: (1) product innovations, (2) process innovations, (3) organizational innovations, and (4) marketing innovations. The annual European Innovation Scoreboard (European Commission, 2020) uses innovation indicators to assess the innovation performance of member states. Some of them are introduction of an innovation in the market or within the organization, R&D expenditures, innovation in-house, collaboration between innovating firms, and patent applications. In the systematic review we have R&D expenditures (Duch et al., 2009; Pellegrini & Centra, 2006; Sissoko, 2011; Srhoj et al., 2020; Srhoj, Škrinjari, et al., 2019) and patent applications (Bondonio et al., 2016; Karhunen & Huovari, 2015; Santos et al., 2019).

The table below summarizes the studies of our systematic review per variable.

Table 4. Variables used for the investigation of the relationship with productivity of funded firms.

Variable	Measured as	Studies in systematic review using the variable as a determinant of productivity
Human capital	cost-based	Benkovskis et al., 2019; Biagi et al., 2015; Dvouletý & Blažková, 2018, 2019; Kölling, 2015; Michalek et al., 2013; Srhoj et al., 2020; Srhoj, Škrinjari, et al., 2019
	income-based	Srhoj, Lapinski, et al., 2019)
	education-based	Caliendo et al., 2016; Koski & Pajarinen, 2015; Rotger et al., 2012
	experience-based	(Muraközy & Telegdy, 2020; Rotger et al., 2012; Santos et al., 2019; Srhoj, Škrinjarić, Radas, et al., 2021)
Physical capital	market value of capital	Banai et al., 2017; Gabriele et al., 2006; Mezera et al., 2013; Michalek et al., 2013; Namiotko et al., 2019; Pellegrini & Centra, 2006; Santos et al., 2019
Age of firm	number of years of productive operation	Benkovskis et al., 2019; Bia & Mattei, 2012; Koski & Pajarinen, 2015; Rotger et al., 2012; Sissoko, 2011
Foreign Direct Investment	equity held by foreign investors	Banai et al., 2017; Benkovskis et al., 2019; Duch et al., 2009; Karhunen & Huovari, 2015; Rotger et al., 2012; Santos et al., 2019
Exports	percentage of total sales of firm	Banai et al., 2017; Benkovskis et al., 2019; Santos et al., 2019; Srhoj, Škrinjari, et al., 2019
Innovation	R&D expenditures	Duch et al., 2009; Pellegrini & Centra, 2006; Sissoko, 2011; Srhoj et al., 2020; Srhoj, Škrinjari, et al., 2019
	patent applications	Bondonio et al., 2016; Karhunen & Huovari, 2015; Santos et al., 2019

Source: Own calculations.

Having discussed the variables used in the 35 studies we now turn to the discussion of potential sources of bias that may affect the results of individual studies and also the findings of our systematic review. We also discuss our efforts in Chapter 4 to address these issues. It is important to acknowledge and address these biases to ensure the validity and reliability of our analysis.

Potential sources of bias

Potential sources of bias refer to factors that can distort research findings and compromise the validity and reliability of study results (Higgins & Cochrane

Collaboration, 2020). Bias can compromise the validity of a study, leading to inaccurate or misleading results. Bias can also introduce systematic errors into study results, making them less reliable and less likely to be replicated in future research. To identify and address potential biases in our systematic review we followed the Cochrane handbook for systematic reviews of Interventions (Higgins & Cochrane Collaboration, 2020). It provides detailed guidance on conducting systematic reviews, covering all aspects of the review process, including risk of bias assessment. It is widely used in the field of health sciences but it is also recommended for social sciences (Davis et al., 2014). According to the handbook, sources of bias could be: (i) arising from the process; (ii) due to deviations from intended interventions; (iii) due to missing data; (iv) in measurement of the data; and (v) in selection of the reported result.

Below, we provide an analysis of each topic, highlighting how the studies included in our systematic review addressed these issues. We also discuss how we handled the same topics in our counterfactual impact evaluation in Chapter 4.

Bias arising from the process

Propensity score matching analysis is a statistical technique that attempts to mimic the randomization process of a randomized controlled trial (RCT) in an observational study. In an RCT, random assignment of participants in one of the study groups ensures that the treatment and control groups have similar characteristics. This allows for a causal interpretation of the treatment effect.

When it is impossible to randomly assign participants, the similarity of groups can be achieved in the context of propensity score matching through the assumption of conditional independence. This assumption requires that each variable used in the analysis affects both participation in the intervention and the intervention outcome (Austin, 2007; Austin et al., 2007; Caliendo & Kopeinig, 2008; Guo & Fraser, 2009; Rubin, 1979; Stuart & Rubin, 2008). In this way the effect of variables affecting the outcome is eliminated in both groups and as a result any difference in the outcome of the groups can be attributed only to the treatment.

In the systematic review of the studies in this chapter, we were unable to find a discussion of whether each variable used affects both participation in the state aid program and the outcome (productivity).

In our propensity score analysis in Chapter 4 (see the variable selection section, p.89 below), we addressed this potential bias by using variables that influence both firm participation in the intervention and productivity. For the variables affecting participation in the intervention (i.e. the application was approved for funding) we examined the eligibility criteria for DL. Among those we kept the ones for which a theoretical and/or empirical link with productivity exists, and we excluded variables influencing participation in DL that were projected financial indicators (such as expected internal rate of return of the investment, expected profitability ratio, etc.).

Bias arising from propensity score matching analysis, where variables affecting both participation in the state aid program and the outcome (productivity) are not adequately considered, may lead to estimated treatment effects that will not accurately capture the true causal effect. For example, if a variable X, which affects participation in the state aid program and productivity, is not included in the analysis, the estimate of the program's effect will be confounded with the effects of X. This confounding makes it difficult to understand the true impact of the program.

Bias due to deviations from the intended interventions

Another assumption of propensity score matching is that the outcome of the treatment under study should be independent from other treatments, thus fulfilling the Stable Unit Treatment Value Assumption (Abadie & Imbens, 2016; Rosenbaum & Rubin, 1983). In our case this means that additional state aid interventions given to the same firm either for the same project or for other projects may create this type of bias. Additionally, a firm that applied for funding with no success and is included in the control group might have applied and succeeded later in the same or another state aid program.

In our systematic review we did not find information on how this particular bias has been addressed.

In our propensity score analysis in Chapter 4 (refer to the data section, p.86 below), this concern was tackled by excluding from our sample firms with double funding throughout the period of study⁹.

Bias from unintended interventions, like additional state aid given to firms, could possibly overestimate observed differences, wrongly attributing them solely to the studied state aid program.

Bias due to missing data

Having defined the variables that simultaneously affect productivity and participation- the propensity score matching method calculates the probability that a firm receives financial support and then matches treated firms to non-treated ones based on the similarity of their probability scores (Khandker et al., 2009). However, missing measurements of variables can affect the estimation of the impact of the intervention. The main difficulty here is that while data for treated firms are likely to be available (since the investments are under monitoring and firms should continuously provide data) this is not the case for untreated firms. It should be noted that the group of untreated firms theoretically comprises both firms with unsuccessful applications and those who did not apply at all.

Several studies (Banai et al., 2017; Bernini & Pellegrini, 2011; Bia & Mattei, 2012; Dvouletý & Blažková, 2018; Michalek et al., 2013; Sissoko, 2011) have tackled this issue by collecting data from multiple public sources, including ministry databases, research and development databases, and commercial databases that provide financial and business information. For example, government databases maintained by ministries offer data concerning the policies being studied; research and development databases, such as the Eureka database, provide details on research and development; commercial databases like Amadeus supply financial and business data.

⁹ Another source of bias may arise when the authorities that are responsible for maintaining the database of funded firms do not regularly update it.

In our propensity score analysis conducted in Chapter 4 we, too, tried to overcome this issue by utilizing multiple data sources. However, the problem with missing data has not been fully eliminated (see p.86 below).

The direction of bias due to missing data can vary depending on the specific characteristics of the missing firms. If some firms with high productivity are missing from the dataset, this can lead to underestimation of the impact. Conversely, if low productivity firms are missing from the dataset, these can lead to overestimation of the impact.

Bias in the measurement of the data

While the use of multiple data sources can help fill in the gaps of missing data, they can also introduce variations in the measurements. Each source may have its own unique methods, techniques, instruments, and data processing approaches, which can lead to discrepancies in the measurements of the same variable.

As part of our systematic review, we thoroughly examined the available studies but found no specific references highlighting potential disparities or suggesting necessary actions to address them.

In Chapter 4, we utilized financial statements of treated and untreated firms. Since the financial statements should follow the same accounting standards, it is reasonable to assume that the risk arising from this type of bias is minimized; thereby the need to take steps to mitigate it is eliminated.

Failure to eliminate bias in the measurement of the data could result in either overestimation or underestimation of the effect, depending on the nature of the discrepancies present. For example, suppose that operational firm age positively affects productivity. If a data source measures age as the number of years that the firm has been a legal entity and legal age is larger than operational age then the impact of age on productivity may be underestimated compared to a measurement from another data source that considers the number of years of productive operation.

Bias in the selection of the reported result

Bias in the selection of the reported result to be reported refers to the selective reporting of study findings that favours a particular outcome or interpretation. The result could be biased based on its direction, magnitude, and/or statistical significance. Directional bias is the reporting of findings that support a particular viewpoint while ignoring contradictory results. Magnitude bias occurs when researchers selectively report larger effect sizes while disregarding smaller ones. Statistical significance bias is the selective reporting of statistically significant findings while disregarding non-significant ones (Page & Higgins, 2016).

The above can lead to publication bias, if studies that do not find statistically significant results or results of the expected direction and magnitude, are less likely to be submitted or accepted for publication (Page & Higgins, 2016). However, it is important to recognize that not finding a relationship between two variables is still an important finding and should be reported. It is crucial for researchers to report all their findings, regardless of whether they support their initial hypotheses or not, to avoid biased interpretations of the results and to advance scientific knowledge more accurately.

In our systematic review, 18 out of 35 studies did not yield statistically significant results on the relationship between state aid and productivity. Although we see that studies with non-significant results are well represented there is no way to know whether these are the only ones.

Missing studies due to non-significant results could affect access to valuable information. For example, in Chapter 4 of our review, we conducted a propensity score analysis and based our variable selection on the systematic review. Therefore, any variables that were not included in the review due to non-significant results could have potentially impacted our analysis.

In our case the requirement of the propensity score matching method that variables used affect both participation and outcome limit the degree that this bias is present.

The existence of this kind of bias may lead to the belief that the relationship between state aid and productivity is a statistically significant one. Further, the existence of

unpublished studies might affect the selection of variables used and the result of the counterfactual evaluation study in unknown ways.

Policy implications, suggestions, and conclusions

Counterfactual impact evaluations help us observe what would have happened without state aid programs. From our systematic review on propensity score matching method studies, we find no clear evidence that the impact of state aid on firm productivity is always positive. This is an indication that state aid may not always be necessary; it may also be a sign of failure to properly design and implement a state aid policy (as discussed in Chapter 2).

Based on the analysis of this chapter we understand that there are implications for all stakeholders: (i) the government, (ii) the European Commission, (iii) firms, and (iv) taxpayers. Each of these stakeholders plays a critical role in shaping the outcomes and effectiveness of state aid programs. Therefore, understanding the specific implications for each group is essential for informed decision-making and successful policy implementation.

Government: The government should carefully evaluate the effectiveness of previous state aid programs before implementing a new one. They should also monitor the impact of the programs and be willing to make changes or discontinue them if they are not achieving the desired results. Additionally, the government needs to consider alternative ways to support firms, such as providing access to credit.

The European Commission: They should also consider the effectiveness of state aid programs and evaluate whether they are achieving their intended goals. The EU should encourage member states to use evidence-based policymaking and to carefully predict the impact of state aid programs before providing them.

Firms: The findings suggest that firms should not rely solely on state aid programs to improve their productivity. Instead, firms should invest in their own resources, such as research and development, innovation, and employee training.

Taxpayers: They should be aware that state aid programs may not always be effective and that their money may be better spent elsewhere. Taxpayers should demand

transparency and accountability from the government in evaluating the impact of state aid programs and allocating public resources.

An important element of all the above suggestions is the ability to evaluate and the availability of existing evaluations to stakeholders. To improve the evaluation of state aid programs and gain a better understanding of state aid impact on firm productivity, several practical steps can be suggested.

(1) **Establish a common reporting protocol for evaluation studies.** This protocol should include guidelines for data collection, analysis, and reporting, as well as standards for the quality and transparency of evaluation studies. A common reporting protocol can help to ensure that evaluation studies are conducted in a consistent and rigorous manner, and that the results are comparable across different studies.

(2) **Use a variety of evaluation methods.** While propensity score matching is a commonly used method to evaluate state aid programs, it is not the only, nor the best method. Other methods such as difference-in-differences, regression discontinuity, and instrumental variable analysis can also be used to evaluate the impact of state aid programs. Each method provides useful information, despite its limitations.

(3) Another suggestion is to **improve data collection and access of evaluators (i.e. state officials and researchers) to them.** Administrative data, such as state aid records and business registrations, can provide a rich source of information for evaluating state aid programs. Public organizations should be encouraged to share their data with evaluators to facilitate the evaluation of state aid programs.

(4) It is important to **exchange evaluation findings between policymakers, practitioners, researchers, and other stakeholders.** This can help improve the design and implementation of state aid programs and ensure that public resources are being used as effectively as possible.

(5) Lastly, **evaluations of state aid programs should also consider their long-term impacts.** This can help identify whether the short-term gains or failures from state aid programs are still valid in the long term. For example, a state aid program that provides financial support to an economic sector may temporarily save jobs and prevent firm closures. However, in the long run, this support may discourage the sector from

adapting to changing market conditions or investing in innovation, leading to its eventual demise. Therefore, a long-term evaluation of the program's impact can help to identify whether it has created a sustainable and resilient economic development or just prolonged an inevitable decline.

As a conclusion and realizing that many times state aid programs are planned in an urgent manner, we suggest that (1) policy makers acknowledge that the impact of state aid is not always positive; (2) policy making be based on evidence.

Chapter 4. A counterfactual impact evaluation of EU state aid in Greece¹⁰

Summary

EU state aid adopted from Member States is increasing at a fast pace due to the Covid-19 pandemic and energy crisis. Given its impact on the European economy, securing a maximum value added is a challenge for both policy makers and public administration. State aid impact depends not only on available resources but also on spending decisions that must be in line with state aid rules. It is believed that new policies would benefit if they were based on assessed evidence of existing policies during periods with similar characteristics. Our contribution analyses the characteristics of Greek development law based on a unique dataset extracted from the management information system of the Ministry of Economy. We hypothesize that there will be a change in firm productivity in the first years since program closure. Using counterfactual impact evaluation and propensity score matching, we find that there is a minor negative impact of development law on productivity. This might be an indication that firms receiving state aid do not perform as expected and perhaps better planning during policy modelling is needed.

Introduction

“One of the great mistakes is to judge policies and programs by their intentions rather than their results.” (Friedman, 1975). Indeed, governments are increasingly using policies to support firms, all the more so due to the covid-19 outbreak (European Council, 2021) and the energy market disruption caused by Russia's invasion of Ukraine (European Commission, 2022b). As state resources are limited and these programs are ultimately financed by taxpayers, it is expected that they have an overall beneficial impact. Thus, the challenge is to design programs for meeting well-defined objectives.

¹⁰ A short version of this chapter has been published in January 2023 with the title “A Counterfactual Impact Evaluation of EU State Aid in Greece” in the Journal WSEAS Transactions on Business and Economics 20:352-372, doi: [10.37394/23207.2023.20.33](https://doi.org/10.37394/23207.2023.20.33).

Designing a program to improve a current market status is quite like designing a medical treatment for a patient. You need to know what works, what does not, whether the observed results are attributable to the intervention, and whether the results are worth the expense.

More than 200 million EU people (48% of the EU-28 population) are eligible for regional state aid during the period 2022-2027 (European Commission, 2021a). The European Commission already uses a method called Counterfactual Impact Evaluation (CIE) to diagnose inefficiencies on existing policies and support policy makers on a range of decisions i.e. to scale up existing policies, to adjust budget allocations, or even to stop policies that do not seem to work. It expects to receive over 2,000 evaluations by 2023 (Brandtner & Vidoni, 2018). The need for ex post evaluation of the effective implementation of adopted state aid cases is also highlighted during competition policy discussions in the European Parliament (European Parliament, 2022). CIE answers a particular type of question, i.e. what is the causal effect of an intervention on an outcome of interest? To estimate the causal effect, CIE is based on an analysis of what happened to participants compared to a scenario of what would have happened to them in the absence of the intervention. The methodological challenge is to build a group of non-participants with similar characteristics with the group of participants, i.e. the counterfactual group. The difference between the observed outcome and the outcome of the counterfactual is seen as the causal impact.

In February 2011, the government of Greece issued the national development law 3908 (DL henceforth). Development laws are in general the longest-standing state aid national policy for investment incentives in Greece. DL was open for applications until 2014 and eligibility criteria were based on General Block Exemption Regulation 800/2008 (European Commission, 2006). The program appeared potentially promising before implementation, since it was targeted to improve a large number of areas such as entrepreneurship, technological development, competitiveness, regional cohesion, green economy, efficient utilization of existing infrastructures, and deployment of the country's human resources (Ministry of Economy, 2011a). This argument is even stronger if we consider that between 1998 and 2014 development laws funded investment plans of a total budget of more than €32bn with a government contribution

of €6.2bn (Ministry of Economy, 2016a). This amount is one third of the investment gap¹¹ in Greece (Hellenic Fiscal Council, 2018). Therefore, an investment incentives tool that might contribute to closing the investment gap can be considered as an important tool to support Greek firms. But, despite the alleged potential benefits of development laws, there is already some evidence that they fail to generate the expected impacts. An assessment of the Ministry of Economy (2016b) revealed that out of 11,735 approvals for aid during the period 2004-2014, only 5,364 firms have eventually managed to carry out the planned investments.

Throughout the years, CIE is used to assess policies similar to DL; results have been contradictory. There is evidence that competition for incentives can offer more projects to poor areas (Fisher & Peters, 1998); can be effective for the economy (Black & Hoyt, 1989); reduces initial cost of investment and lowers the risk of a new investment (UNCTAD, 1997); provides externalities to local market (Fagerberg et al., 2004); increases value added (Mezera et al., 2013); and helps firms to survive (Dvouletý et al., 2020). On the other side, Blomström et al. (2000) find that it is very difficult to make projections about the benefit of investments; Charlton (2003) suggests a targeted allocation of EU funds to more important areas like education or infrastructure; Michalek (2012) reports that the same investments would have been performed without aid; and Santos (2019) finds that subsidized firms have a lower contribution to growth. For an overview of the research on positive and negative effects of investment incentives, see Cedidlova (2013).

Our intention is to contribute to this discussion, by assessing the impact of DL on the performance of firms which received state aid. As a measure of performance, we use productivity, i.e. how well resources are used to produce output. In an input-constrained environment producing the same output with less resources is important in terms of natural resources and available working units (OECD, 2020). To do this we need to compare two groups of firms (funded and non-funded). Comparing groups with dissimilar characteristics (other than funding) would be problematic, therefore we use

¹¹ This is defined as missing investments in Greece to reach European average competitiveness level.

propensity score matching to find a reliable counterfactual for our CIE. Propensity score matching calculates the probability of receiving financial support on the basis of a set of observable characteristics and matches treated firms to non-treated ones with similar probability scores. We use data extracted from the management information system (MIS) of the Ministry of Economy and compare the productivity levels of treated and non-treated manufacturing firms two years after the ending of DL.

We evaluate DL mainly for two reasons. The first reason is data availability, i.e. the existence of a MIS. As reported on the explanatory memorandum of DL (Ministry of Economy, 2011b) the MIS was designed to collect and organize applicant firm data and support granting authorities to make correct decisions. Although the creation of this MIS was an uncharted field for the granting authorities, it contributed to the rationalization of the existing procedures, facilitating information exchange between granting authorities and the firms. This common information flow was expected to create a positive climate of trust, thus improving transparency on the selection criteria of the firms. The second reason is the duration of the measure. The DL was active (i.e. open for submissions) for less than four years. This can be considered a short duration if we consider that previous laws (development law 1262 of 1982, development law 1892 of 1990) were active for at least eight years. This short duration means that it is more likely that all firms of DL implement their planned investments under the same economic, political, socio-cultural, and technological conditions.

There are four areas of discussion that we usually encounter in a state aid policy evaluation, i.e. number of applicants, number of approvals, implementations actually made, and impact of the program. The first area is the most communicated one, since policy makers pursue to publish the number of applicants and the total budget of the investments. For example, a three-month open call for investments in tourism managed to attract 562 applications with an estimated budget of €1.6bn (Ministry of Economy, 2022c). The second area is about the approval decisions. Many applications are usually rejected due to budget limitations. In our example the available state aid budget is 150 m€ per year (Ministry of Economy, 2022a). The third area includes the finalized investment plans that received the financial aid. There is evidence that many firms never finalize their investments (Ministry of Economy, 2016b). The fourth area is the analysis

of policy impact. Much of the research emphasis to date has been on monitoring the collected data in terms of capital formation, creation of new firms, and creation of new jobs at both the regional and sectoral perspective (Kostopoulos & Pseiridis, n.d.-a). But state aid policy might appear potentially attractive yet fail to generate the expected results. In our example, can we tell if a new aided investment operates better than non-funded ones in terms of productivity? Counterfactual impact evaluation could answer this question since it estimates the change that would have occurred without the state aid policy. The European Commission and member states already use this method to evaluate state aid policies (Kostopoulos & Pseiridis, n.d.-b). To our knowledge, there are no evaluations of this kind in Greece yet, although there is one study under preparation (European Commission, 2018). Our aim is to bring some evidence in the area of counterfactual impact evaluation and contribute to the creation of an evidence-based state aid policy in Greece, especially nowadays that the available state aid budget for the period 2021-2027 has been more than doubled compared to last period due to the Recovery and Resilience Fund.

The rest of the paper is organized as follows: Section 2 describes the policy framework. Section 3 reviews the literature. Section 4 discusses the theoretical hypotheses of our research. Section 5 introduces propensity score matching analysis and section 6 presents the data. Section 7 provides the methodology steps and the corresponding assumptions and the findings. Section 8 discusses the policy implications of the findings and provides recommendations to policy makers. We conclude with a summary and suggestions for future research.

The policy under examination

DL is a state aid measure that provides financial support to firms wishing to implement new investments in Greece. This type of public support may confer advantages to firms over competitors. Therefore, state aid measures must follow specific rules to ensure that distortion of competition is avoided at both the national and European levels. In our case, DL is a national law that follows European Commission (EC henceforth) regulations applicable for all state members. It complies with the conditions of General Block Exemption Regulation for regional aid (GBER henceforth). It is a simplified

regulation that declares certain categories of aid compatible with the internal market. The main advantage of GBER is that the member state assesses the measure based on predefined criteria and then it simply notifies the results to the EC. It is so popular that since 2015, more than 96% of new state aid measures in the European Union comply with GBER (European Commission, 2021d).

Based on the state aid case registry (European Commission, 2021b) more than 1,405 measures with similar characteristics to the DL have been created in the European Union since 2011. Therefore, the evaluation of DL provides insights potentially useful to other EU countries as well.

DL offers financial grants and tax reliefs to private firms for the implementation of investment projects. The investments must be related to the building of new establishments or to the upgrading of existing establishments (Ministry of Economy, 2011a). Eligible costs include both tangible and intangible assets i.e. buildings, mechanical engineering equipment for the production line, transportation and installation of equipment, special facilities, transportation vehicles, know-how, landscaping the surrounding area, infrastructure projects, and expenditures for consulting studies (Ministry of Economy, 2011c). Creation of new jobs is also related to the above investments.

Maximum aid intensities are applicable to the above eligible costs taking into consideration the location of the investment. The aid intensity (i.e. the percent of the investment budget that is provided as aid) is not higher than 40% of the total eligible cost in NUTS 2 regions whose GDP per capita is below 55% of the EU average and is not higher than 15% in NUTS 2 regions whose GDP per capita is below 65% of the EU average. The maximum aid intensities are increased by 10% for medium-sized enterprises and by 20% for small enterprises. The beneficiary has to cover the remaining part of the investment providing a financial contribution of at least 25% of the eligible costs of the project (European Commission, 2006). Upon each call for proposals, any Greek private legal entity can submit an application for aid, including all necessary documents and data (Ministry of Economy, 2011e). To be successful and receive financial support, applicants must fulfil a set of eligibility criteria and must pass a

minimum threshold of a point system based on a set of criteria (Ministry of Economy, 2011d). The former represents on/off criteria based on the typical requirements and the objectives of DL. The latter represents the criteria used to score the applications and rank the eligible applications. The firm can only initiate its intended project activities after the application for the aid. This indicates that the new investment is due to the incentives provided through DL (incentive effect). If otherwise, the project is rejected (Ministry of Economy, 2011a).

The minimum budget of an investment plan can be €100k and the maximum amount of aid per firm can be €15m (Ministry of Economy, 2011a). The responsible body for monitoring high budget investments i.e. more than €3m is the Ministry of Economy. Regional authorities are responsible for the monitoring of investments with lower budgets. The appraisal of the investments is performed from the members of the National Register of Evaluators (Ministry of Economy, 2011f). The approval decision contains all terms and conditions that the beneficiary should fulfil during the implementation of the project. The relevant summary of the Ministerial decision is published in the Official Gazette and the state aid enters into force (Ministry of Economy, 2011g).

Literature review

We have identified thirty-seven European studies that measure the impact of EC state aid on firms' labour productivity using propensity score matching, one of the methods of CIE. The studies come from thirteen countries: Croatia (Srhoj et al., 2020; Srhoj, Lapinski, et al., 2019; Srhoj, Škrinjari, et al., 2019; Srhoj, Škrinjarić, & Radas, 2021; Srhoj, Škrinjarić, Radas, et al., 2021; Srhoj & Walde, 2020), Czech Republic (Dvouletý & Blažková, 2018, 2019; Medonos et al., 2012; Mezera et al., 2013; Ratering, Amoako Agyemang, et al., 2020; Ratering, Čadil, et al., 2020; Spicka et al., 2017; Špička, 2018a, 2018b), Denmark (Rotger et al., 2012), Finland (Karhunen & Huovari, 2015; Koski & Pajarinen, 2015), France (Sissoko, 2011), Germany (Caliendo et al., 2016; Kölling, 2015; Michalek et al., 2013), Hungary (Banai et al., 2017, 2020; Muraközy & Telegdy, 2020), Italy (Bernini & Pellegrini, 2011; Bia & Mattei, 2012; Biagi et al., 2015; Bondonio et al., 2016; Gabriele et al., 2006; Pellegrini & Centra, 2006), Latvia (Benkovskis et al., 2019),

Lithuania (Namiotko et al., 2019), Portugal (Santos, 2019; Santos et al., 2019), Spain (Duch et al., 2009), and Sweden (Nilsson, 2017).

Twenty (54%) studies showed negative or no results. The remaining seventeen (46%) showed positive results. As the results of this literature about the impact of the incentives are mixed, we examined results based on regional characteristics of the programs. Of the 37 studies, twenty-eight (76%) studies were performed at the national level. In sixteen (57%) of them the impact of the incentives was negative. Nine cases (24%) were performed at the regional level; the cases of positive impact were higher (56%) than those with the negative impact. Even national incentives policies seem to provide contradictory results as some policies provide positive results and some others negative results. For example, in the Czech Republic, 5 (56%) studies showed positive results. In Italy and Croatia four (67%) studies showed negative results. Motivated by the above contradictions we run a parallel study to examine the characteristics affecting the outcome of the above policy interventions (Kostopoulos & Pseiridis, 2021). In this study we found a lack of consistent reporting of the propensity score matching method and we propose guidelines to allow comparison across studies and to facilitate interpretation across academia and policy makers.

Theoretical hypotheses

As in the above studies, in this paper we examine the impact of an incentive policy on the labour productivity of firms. We examine the impact of DL on manufacturing firms that applied for state aid to implement new investments. Their applications include business plans for the establishments of new production units or for the upgrade of their existing production units.

DL offers non-repayable financial support to firms that manage to pass the selection criteria. This could mean that successful applicants face a relief on their financial obligations over non-successful applicants. Therefore, DL minimizes implementation risk and firms can dedicate their efforts to improve performance.

On the other hand, successful applicants may start implementing business plans that perhaps they are not yet ready to successfully implement and hence their submitted

business plans are not carried out to the end. As mentioned in the introduction, nearly half of the approved projects have not managed to successfully implement their investments.

Therefore, an interesting question to ask would be: what happens, in terms of performance, to those firms which receive state aid. Therefore, we work with three hypotheses. The first hypothesis is that DL has a negative impact on successful firms; the second hypothesis is that DL has a positive impact; and the third hypothesis is that there is no impact.

Method

Policy interventions are typically aimed at remedying an existing situation. They can be seen as analogous to treatments given in medicine. In this light, DL is the treatment, which is implemented on the expectation of improving the status of firms that will receive state aid. The aim of our analysis is to measure the effect of DL on labour productivity that is our outcome of interest. Of course, changes in the outcome may be only partly due to the intervention, and sometimes not at all. Thus, a fundamental problem is how to establish attribution, i.e. how to determine that the outcome is the effect of the intervention and not of other factors.

Since we cannot observe the same firm at a certain point of time, being in both statuses, the challenge is to define a group consisting of firms that have not received state aid but have similar characteristics with the firms that are treated (we call this the non-treated group). This group consists of firms that applied for aid but did not get funding (while the treatment group consists of firms that did get funding). This can be done using counterfactual impact evaluation. Counterfactual model analysis was first started by Neyman-Rubin (Rubin, 1974). Khandker et al. (2009) provide a review.

The causal impact of DL can thus be seen as the difference between the outcome of treated firms and the outcome without the treatment (Rosenbaum & Rubin, 1983; Rubin, 1974). The impact of the intervention using the outcomes of two groups can be calculated only if the two groups have similar characteristics. Random assignment is considered to be a reliable form of research design since all eligible firms have the same

probability of receiving the treatment (Guo & Fraser, 2009). If all firms have the same probability of getting treated, then it is considered that the output will represent the eligible population and that the impact is due to the intervention. In our case, we cannot randomly assign firms in the two groups (treated and non-treated) since DL uses an evaluation procedure that selects the firms that will be funded.

A positive evaluation leads to treatment (financial support) while a negative evaluation leads to non-treatment. Therefore, the two groups cannot be built randomly. Instead the groups can be built based on the selection criteria of the evaluation procedure of DL (Ministry of Economy, 2011d). Rosenbaum & Rubin (1983) first showed that a method called propensity score matching can mimic random assignment under the condition that the study is performed based on a set of observable firm characteristics. Therefore, the groups can be defined based on a series of selection criteria. Propensity is defined as a firm's probability of being treated. That means that two firms with the same characteristics have the same probability of receiving the aid. If a firm from the control group has the same propensity score with a firm of the treated group, then it is considered as the most comparable counterpart and the allocation can be considered as random. A review of the propensity score matching method can be found in a series of most cited studies (Stuart, 2010; Ho et al., 2007; Joffe & Rosenbaum, 1999; Rosenbaum & Rubin, 1985, 1984, 1983; Rubin, 1981). Gertler et al. (2016) and Khandker et al. (2009) provide an overview.

The propensity score is used to convert the multidimensional vector of observable characteristics to a single composite variable. In our case, if we assume that the age of the firm is a selection criterion in DL, and theory and empirical findings also suggest that it affects productivity, a simple method would be to compare all firms with similar age in both treated and non-treated firms. But, as mentioned earlier, there is a series of criteria that affect the selection of a firm while economic theory and empirical literature report a series of productivity determinants. Therefore, it seems more plausible to create a multidimensional vector of variables that affect selection of firms and the outcome of the treatment. Propensity scores convert this dimensionality issue into a single score, and then based on this score firms from the two groups can be matched. In other words, two firms with the same propensity scores have about the same

observed characteristics except the exposure to treatment. Therefore, the effect of the treatment (DL) can be measured by comparing the output (i.e. labour productivity) of a matched pair of firms.

Data

Our dataset consists of 1,910 firms that applied for state aid under DL. All applications were submitted between September 2011 and March 2014. Following the assessment of the applications by the granting authorities, 1,261 investment applications were successful (deemed eligible to receive aid) and 649 applications were rejected. Table 5 shows the number of approved investments and their main characteristics. We highlight that state aid to industry is €1.24bn in total of €1.95bn for all sectors, which shows that the main part (63%) of the financial support of the DL is channelled to industry.

Table 5. DL investments.

Type	Number of investments	Total budget of investments (€bn)	State aid (€bn)	New Average Working Units
Applications (all sectors)	1,910	7.95	2.75	9,774
Approved (all sectors)	1,261	5.68	1.95	6,140
Applications (industry)	1,114	5.08	1.73	3,791
Approved (industry)	742	3.64	1.24	2,375

Source: Own calculations, data retrieved from Greek Ministry of Economy.

The call was open for economic activities in the primary, secondary, and tourism sectors (Ministry of Economy, 2011a). Our scope is limited to firms which submitted business plans to operate only in the secondary sector because (a) we want to compare firms with similar characteristics and (b) the secondary sector offers the largest sample. Therefore, we consider applications with economic activities belonging to the statistical classification NACE 10-39 (Table 6); thus, our sample includes 1,114 firms.

We made some exclusions, as follows. As discussed, our aim is to find firms with similar characteristics. Thus, we exclude 495 cases of wind and hydropower generation plants (NACE 35) and our sample now consists of 619 industrial firms. We exclude these firms because they seem to have different characteristics from other industrial firms. For

example, wind power plants find abundant sources of raw material, and they have very few permanent employees.

Then, we exclude firms with two applications and firms that relate to other applicant firms. We find this information on the declaration forms signed by the firms. The reason for this exclusion is that the outcome of one project should be independent from the assignment of treatment on other projects, thus fulfilling Stable Unit Treatment Value Assumption (Abadie & Imbens, 2016; Rosenbaum & Rubin, 1983). Thus, we keep 544 firms that were already operating at the time of the application. We exclude firms that do not operate at the time of the application because they may never operate upon failing to receive state aid. Thus, these firms could not be included in the control group.

Table 6. NACE codes used in the analysis.

NACE	Description
10,11,12	Manufacture of food products, beverages, and tobacco products
13, 14, 15	Manufacture of textiles, wearing apparel, leather, and related products
16	Manufacture of wood and of products of wood and cork, except furniture
17	Manufacture of paper and paper products
18	Printing and reproduction of recorded media
19	Manufacture of coke and refined petroleum products
20	Manufacture of chemicals and chemical products
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
22	Manufacture of rubber and plastic products
23	Manufacture of other non-metallic mineral products
24	Manufacture of basic metals
25	Manufacture of fabricated metal products, except machinery and equipment
26	Manufacture of computer, electronic and optical products
27	Manufacture of electrical equipment
28	Manufacture of machinery and equipment
29	Manufacture of motor vehicles, trailers, and semi-trailers
31-32	Manufacture of furniture; other manufacturing
33	Repair and installation of machinery and equipment
36	Water collection, treatment, and supply
37, 38, 39	Sewerage, waste collection, treatment, and disposal activities; materials recovery, remediation activities and other waste management services

Source: Own elaboration, data retrieved from Greek Ministry of Economy.

We then exclude cases with missing values, which occur mainly among limited liability companies. These are mostly very small enterprises with low sales figures and low

average working units. Therefore, we have a working dataset of 135 industrial enterprises. All of them include a business plan for the establishment of new production units. Among them, the firms whose investment plans were rejected are 66. One of the characteristics of DL was that rules and selection criteria are published in advance and a firm entering in the MIS knows (a) if it is eligible and (b) the assessment points it receives. Therefore, it is most likely that firms knowing that they cannot achieve a high ranking do not proceed with an application for state aid. This is an important characteristic of the management information system that reduces the work needed from the agencies to evaluate the applications. Regarding our research, while this characteristic reduces the effort to build a large control group, it provides a control group which is more similar to the “treatment” group, because firms included in our control group are those applying for aid but failed to provide the documentation to justify their application. This is a condition of DL: applications that are not accompanied by all supporting documentation in original form are rejected (Ministry of Economy, 2011g).

We now need to evaluate whether our sample is large enough for our statistical analysis. The discussion on the proper sample size is based on two criteria. The total sample size and the size of the control group compared to the size of the treatment group. Many studies (Bai, 2015; Dehejia & Wahba, 2002; Rosenbaum & Rubin, 1983; Rubin, 1974) report that the size of the control group is a crucial parameter for the quality of the results. Intuitively, a high control-to-treatment ratio provides a better probability to find two reliable matched groups. However, as Rubin (1979) reported in his study, the improvements in bias reduction from control-to-treatment ratio 2:1 to 9:1 were modest. Thus, we found no clear guidelines in the extant literature about the sampling characteristics. In our case, only one applicant out of five is not approved. This fact does not provide us the opportunity to use a high control-to-treatment ratio.

Data was drawn from the MIS of the Ministry of Economy under official permission. To complete our dataset with financial data, we also used publicly available sources (General Electronic Commercial Registry, 2021; National Printing House of Greece, 2021; National Transparency Portal, 2021). Table 7 lists the source we used to collect data.

Table 7. Sources of data for observable variables and indicators.

Source	Observable Variable (Indicator used in the study)
Ministry of Economy	Status of firm (treated and non-treated firms)
	Human Capital (experience of shareholders, experience of management team, specialization of management team, education)
	FDI (financial contribution of foreign investors)
	Innovation (use of innovative techniques)
	Physical capital (eco-friendly production process)
	Firm age (years of operation)
	Exports (exporting revenues)
	Average Working units of firms, used for the calculation of labour productivity
General Electronic Commercial Registry	Balance sheet information used for the calculation of labour productivity
National Printing House of Greece	
National Transparency Portal	
Websites	

Source: Own elaboration.

Propensity score matching: use and results

The steps of the propensity score matching method were outlined by a number of studies (Beal & Kupzyk, 2014; Garrido et al., 2014; Caliendo & Kopeinig, 2008; Harris & Horst, 2016; Guo & Fraser, 2009). Our study includes five steps: (1) variable selection, (2) calculation of propensity scores, (3) matching estimation, (4) diagnosis of matching quality, and (5) calculation of average treatment on treated effect¹².

Variable selection

A basic assumption of propensity score matching is conditional independence (Rosenbaum & Rubin, 1983). This means that all variables that affect both participation and outcome of the intervention are included in the analysis (Austin, 2007; Austin et al., 2007; Caliendo & Kopeinig, 2008; Guo & Fraser, 2009; Rubin, 1979; Stuart & Rubin,

¹² For our estimation we use the Stata commands *pscore* (Becker & Ichino, 2002) and *psmatch2* (Leuven & Sianesi, 2018) respectively. Becker and Ichino have developed a command (*pscore*) for propensity score matching estimators i.e. nearest-neighbour, kernel, and radius. Leuven and Sianesi (2018) have developed the command *psmatch2* that includes routines for covariate imbalance testing (*pstest*) and common support graphing (*psgraph*).

2008). This holds true in our case, since each variable we selected represents a selection criterion of DL (conceptual relevance) and is also a determinant of productivity (theoretical relevance) (Angrist & Pischke, 2009). Variables affected by the treatment are not to be included in propensity score matching (Garrido et al., 2014). Under this assumption, assignment to the intervention can be considered as random and each firm has the same probability of being treated.

Based on our literature review of 35 studies that analyse the impact of state aid on firm productivity using propensity score matching we use the eleven variables listed below (Kostopoulos & Pseiridis, n.d.-b). The variables *Shareholders*, *Management*, *Specialization*, *Age*, *Education*, *Innovation*, *Eco-friendly*, *Exports*, and *FDI* show firm characteristics in the pre-treatment phase (i.e. year 2011), the *Treated* variable shows if a firm has been selected for treatment during the period 2011-2014, and *Labour productivity* shows the status of the firm two years after the end of the intervention (i.e. 2016). We assign 0 and 1 values to the variables after elaboration of data extracted from MIS, as follows.

1. ***Treated***: takes the value of 1 if a firm has received funding and 0 otherwise.
2. ***Labour productivity***: We use a firm's total revenue as an output metric (Gal, 2013) and average working units (AWUs), which essentially is a headcount, as a labour metric. For the calculation of AWU, we consider that an employee, who worked full time within an enterprise during an entire year, counts as one unit. Part-time staff, seasonal workers, and those who did not work the full year are treated as fractions of one unit (European Commission, 2015).
3. The ***Shareholders*** variable refers to whether most shareholders of the firm participated in any business entity with net positive earnings for more than three years, during the last five years. In that case, the variable takes the value of 1 and 0 otherwise.
4. The ***Management*** variable rates the most experienced executive (among Chairman, Board of Directors, and Managing Director). If one of these executives has management experience of at least two years during the last five years, then the variable takes the value of 1. If less, it takes the value of 0.

5. The ***Specialization*** variable takes the value of 1 if one of the executives has postgraduate studies or business experience in a field related to the main activity of the investment. If none of the executives have any experience the value is 0.
6. The ***Age*** variable takes the value of 1 if the firm operates for at least three fiscal years with positive net profits. Otherwise, the value is 0.
7. The ***Education*** variable shows the educational characteristics of the firm. It is coded by the MIS as 1 if the percentage of graduate employees per total employees is more than 25%. Otherwise, the value is 0.
8. The ***Innovation*** variable takes the value of 1 if the firm has introduced in its production innovative techniques such as research and development (R&D), product design, quality assurance, certification systems and patents. Otherwise, the value is 0.
9. The ***Eco-friendly*** variable takes the value of 1 if the firm includes in the production process technologies that reduce environmental impact i.e. renewable energy, recycling. Otherwise, the value is 0.
10. The ***Exports*** variable takes the value of 1 for firms with exporting revenues at 30% of the total revenues. Otherwise, the value is 0.
11. The ***FDI*** variable takes the value of 1 when at least 25% of the financial contribution for the project to be financed comes from investors located in another country. Otherwise, the value is 0.

We evaluate the impact of DL two years after the end of the submission deadline. According to Bondonio (2009) this period is considered appropriate to assess the impact of a program. Bergstrom (2000) agrees by stating that very short time evaluation will misrepresent the impact of a program while evaluating in a longer time would hinder the isolation of the effects of the program. On the same vein, Antonioli et al. (2014) and Autio & Rannikko (2016) define as a reliable threshold a 2-year period after the program submission deadline.

Table 8 summarizes the variables and their description and shows the characteristics of the sample. Most firms of our sample have an experienced management team, are already in the market for more than three years, have a small percentage of graduate

employees, have exporting activities, do not use eco-friendly technologies, and use funds from domestic sources.

Table 8. Observed characteristics of firms.

Variable	Short description	% of sample with value 1 (except vars with *)
*Treated	Categorical variable, indicates successful application for funding.	
*Labour Productivity	Outcome variable, calculated as annual revenue (€k) /average working units.	Average (all firms) = 372
Shareholders	Control variable, participating in a business entity with net earnings of at least three years.	44%
Management	Control variable, management experience of at least two years.	97%
Specialization	Control variable, management specialization in the area.	44%
Age	Control variable, firms with more than three years of operation.	81%
Education	Control variable, percentage of graduates per total employees is more than 25%.	25%
Innovation	Control variable, use of innovative techniques.	54%
Eco-friendly	Control variable, type of production process.	33%
Exports	Control variable, exporting revenue per total revenue is more than 30%.	80%
FDI	Control variable, financial contribution from foreign resources at least 25% of total contribution.	5%

Note: 135 observations (69 treated, 66 non-treated). Source: Own elaboration.

Calculation of propensity scores

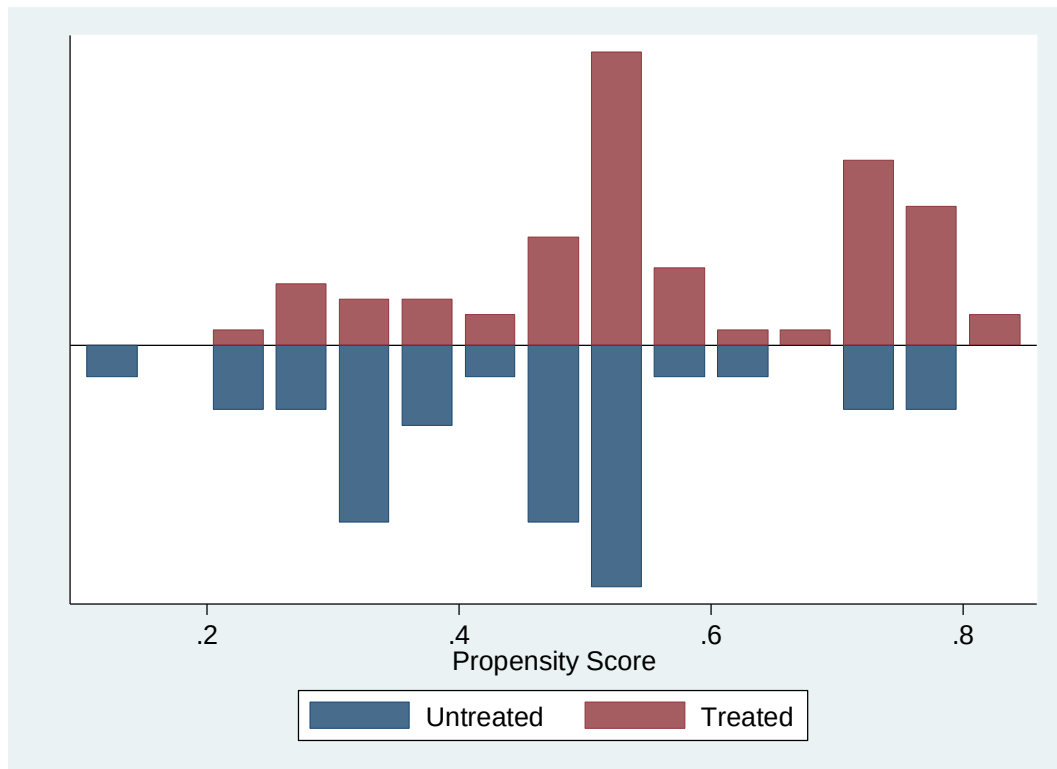
We estimate the propensity scores, using probit regression (Austin, 2007; Stuart, 2010). We use the pre-treatment variables as predictors of a firm being assigned the treatment. All firms are assigned a propensity score showing the predicted probability of receiving treatment (Appendix: Stata code 2). For a review of propensity score calculation refer to Khandker et al. (2009).

Matching estimation

We assess the comparability of treated and non-treated firms. To do this we estimate the “common support area”, another fundamental characteristic of propensity score matching. It is the area where the mean propensity scores of treated and non-treated are similar. Within this area, a firm can be potentially observed with treatment and without treatment. Firms that have low or high propensity scores and have no

counterpart from the other group are excluded. In our case, propensity scores below 0.2 come from only non-treated firms while scores upwards of 0.8 come only from treated ones. Therefore, the common support is between 0.2 and 0.8 (see Figure 1) and all firms with propensity scores falling outside this range are discarded from our analysis. The common support area of our study includes 131 firms.

Figure 1. Balance between control and treatment groups.



Source: Own calculations.

Following the identification of the above range, we classify firms into blocks based on their propensity score. This classification ensures that the mean propensity score is not different for treated and controls in each block (Appendix: Stata code 3). The number of blocks calculated with this procedure is 5, as shown in Table 9.

Table 9. Blocks of propensity score.

Propensity score	Treated		Total no. of firms
	0	1	
0.2	22	11	33
0.4	30	33	63
0.6	10	23	33
0.8	0	2	2
Total	62	69	131

Source: Own elaboration.

Then, we perform a second classification based on the comparison of the observable characteristics of the firms, to check for the possibility of close matching. Close matching would offer a perfect balance between treated and non-treated firms, making treatment assignment looking random, providing evidence for the validity of the conditional independence assumption.

Exact matching of treated and non-treated firms cannot be achieved most of the time. The closest scenario to exact matching is to find the nearest firm from the control group in terms of the propensity score. To do this, we first use a stratification estimator. Rosenbaum & Rubin (1983) showed that estimates based on stratification represent estimates of real average treatment effects. Stratification ensures that estimates can have accuracy in the sub-samples and comparison between sub-samples can be performed with equal statistical power.

Then, to test whether the estimated results are sensitive to different model specifications we perform our analysis using another estimator called Radius estimator. In this case each treated firm is matched with a non-treated firm whose propensity score lies within a predefined calliper. The propensity range allows more than one non-treated firm to be selected for matching. The method reduces poor matching since non-treated firms outside of the range are excluded.

Finally, we use a Kernel estimator. In this case, the propensity scores of non-treated firms receive a weight in proportion to its distance from the matched treated firm. Each treated firm is assigned a weight of one. The non-treated firms with the closest propensity score receive the highest weight. All non-treated firms that lie within the

specified bandwidth, i.e. the common support area, are included in the calculation. Thus, a group of non-treated firms with weighted propensity scores is used to create a match with a treated firm.

Diagnosis of matching quality

We check whether the above matching estimators improve the balance of a covariate's distribution within the blocks of propensity score (Austin, 2009, 2011). Rosenbaum & Rubin (1983) suggested checking the standardized differences and distributions before and after matching (Appendix: Stata code 4).

The standardised % bias is the percentage difference of the sample means in the treated and non-treated groups as a percentage of the square root of the average of the sample variances in the treated and non-treated groups (Rosenbaum & Rubin, 1985). Values close to zero represent minimum bias. This method is used in many studies (Caliendo et al., 2005; Flury & Riedwyl, 1986; Ho et al., 2007; Lechner, 1999; Sianesi, 2004). It is preferred compared to t-test for checking the balance of covariates. The scope is to diagnose the properties of treated and non-treated groups and not to provide inferences about the total population (for detailed analysis refer to Austin (2009) and Stuart (2010)). The degree to which the standardized difference is improved after matching, provides indication of the balancing performance. The strictest acceptable level is reported from Caliendo & Kopeinig (2008) who state that if the absolute standardized bias is reduced to less than 5% the matching method is effective. Harder et al. (2010) and Stuart (2010) stated that a standardized bias not exceeding 25% is acceptable. Rosenbaum and Rubin (1985) suggested that standardized differences should be less than 20%.

Plots including all covariates in y axis and standardized bias in x axis are included in Figure 2 up to Figure 4. For each covariate the standardized bias is presented before and after matching. We observe that before matching the variables *FDI*, *Specialization*, *Shareholders*, and *Innovation* were above the threshold of 20% standardized bias, thus presenting evidence of imbalance. After incorporating matching methods, we observe reductions in imbalance and firms from treatment and control groups have identical means on all covariates.

In addition, Figure 5 up to Figure 7 provide a visual representation of the distribution of the differences for the covariates that are included in the analysis. After matching, all standardized differences in covariate means are substantially reduced. Since standardised bias is quite small, this is an indicator that reliable estimates can be produced.

Figure 2. Standardized percentage bias across covariates before and after matching (Stratification).

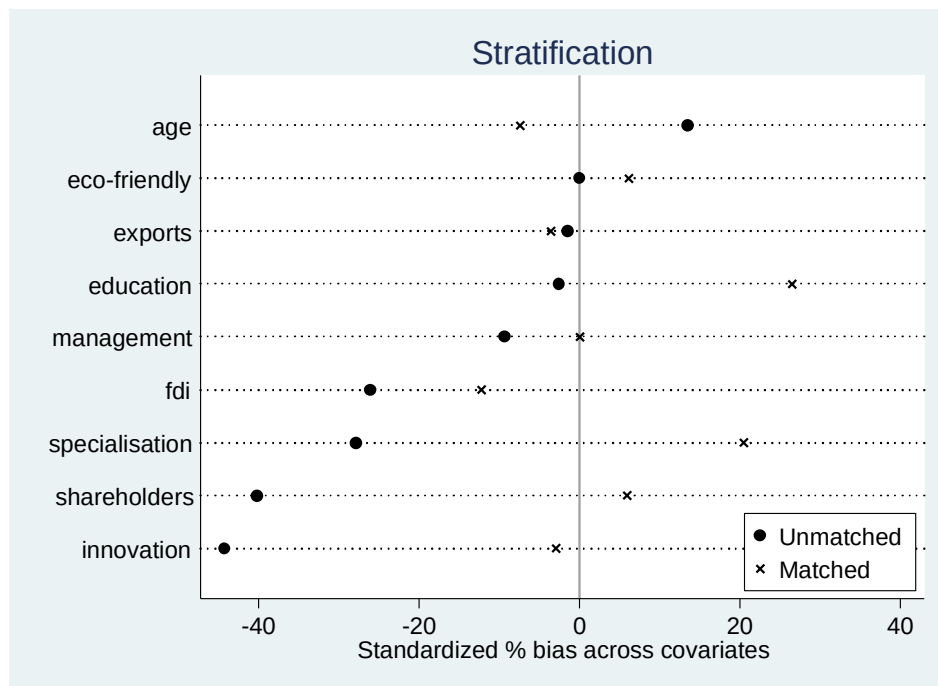


Figure 3. Standardized percentage bias across covariates before and after matching (Radius).

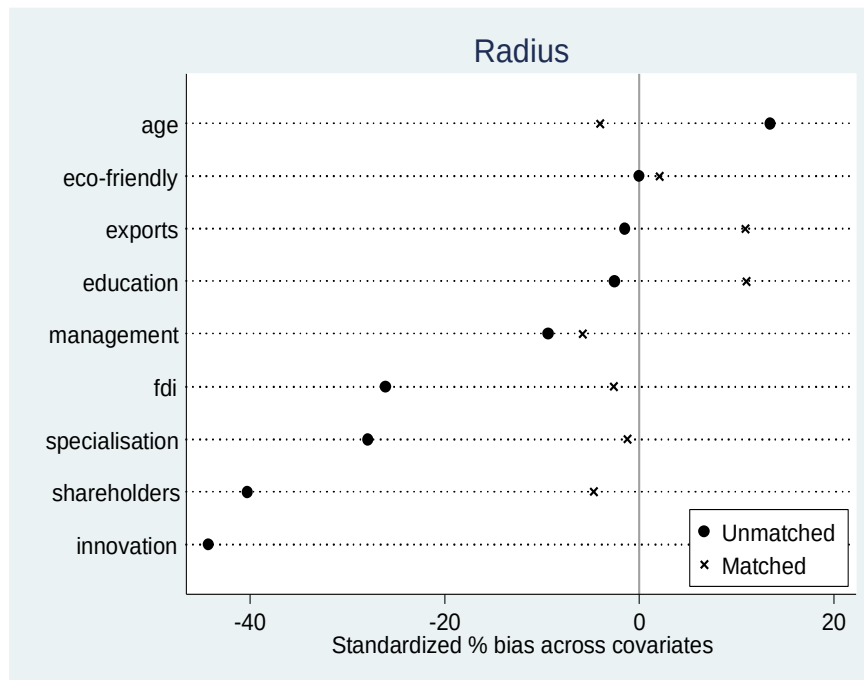


Figure 4. Standardized percentage bias across covariates before and after matching (Kernel).

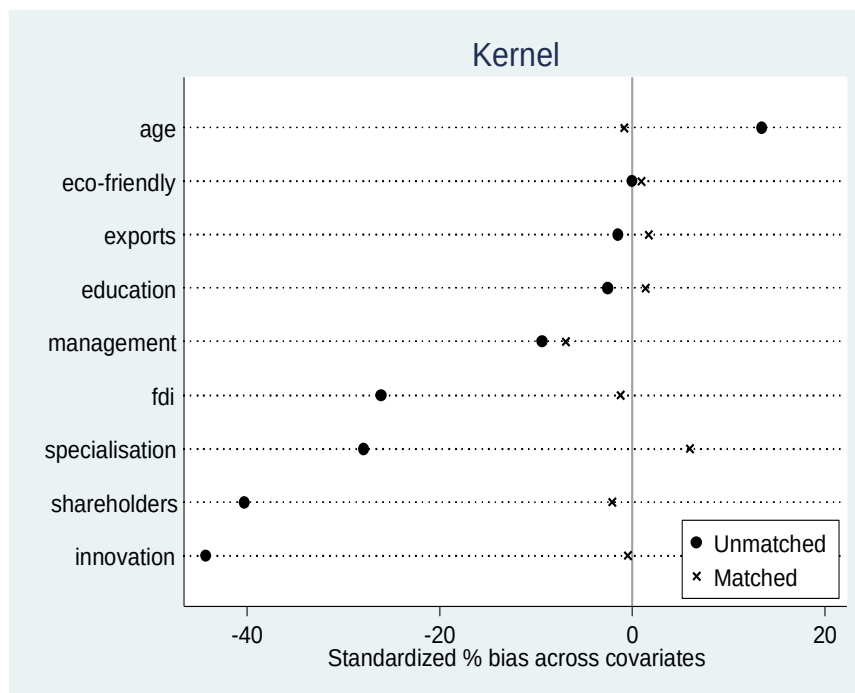


Figure 5. Histogram of standardized percentage bias across covariates before and after matching (Stratification).

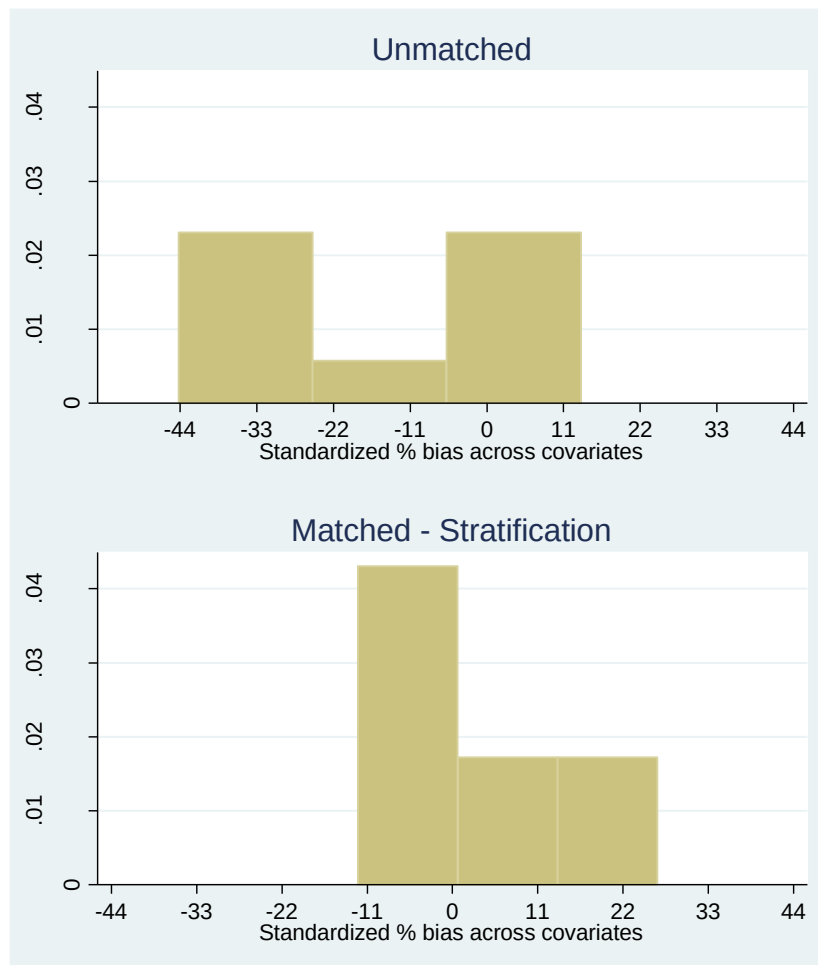


Figure 6. Histogram of standardized percentage bias across covariates before and after matching (Radius).

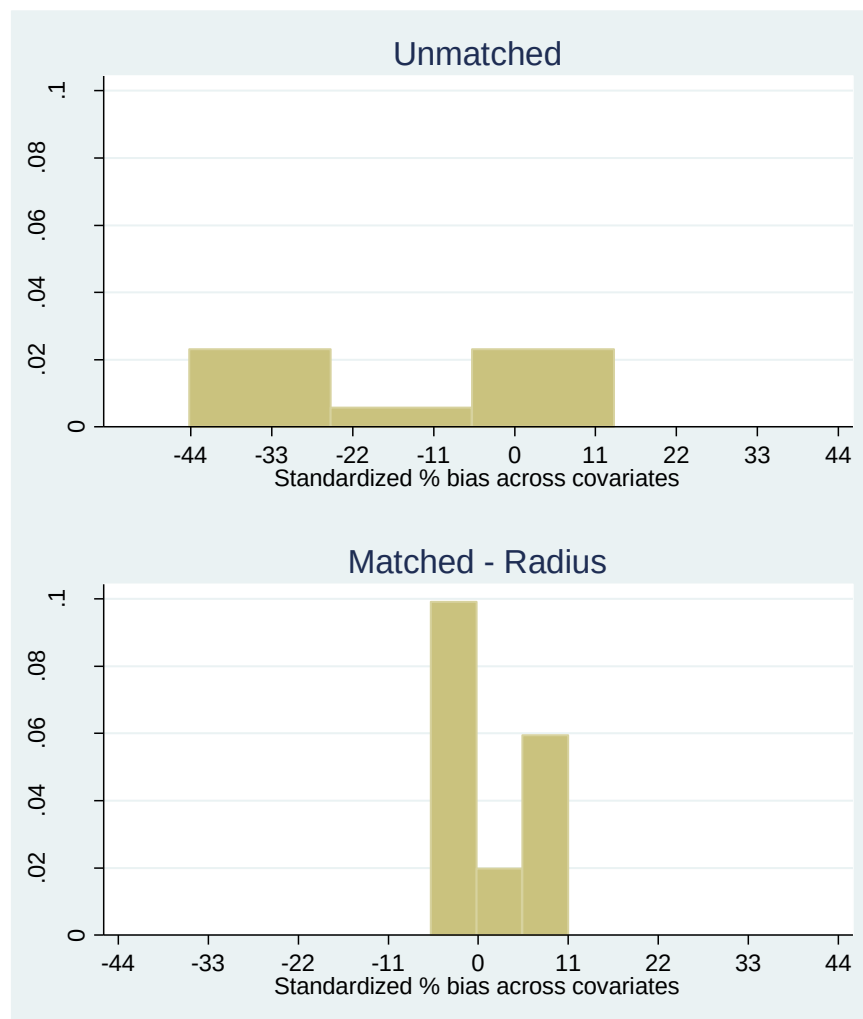
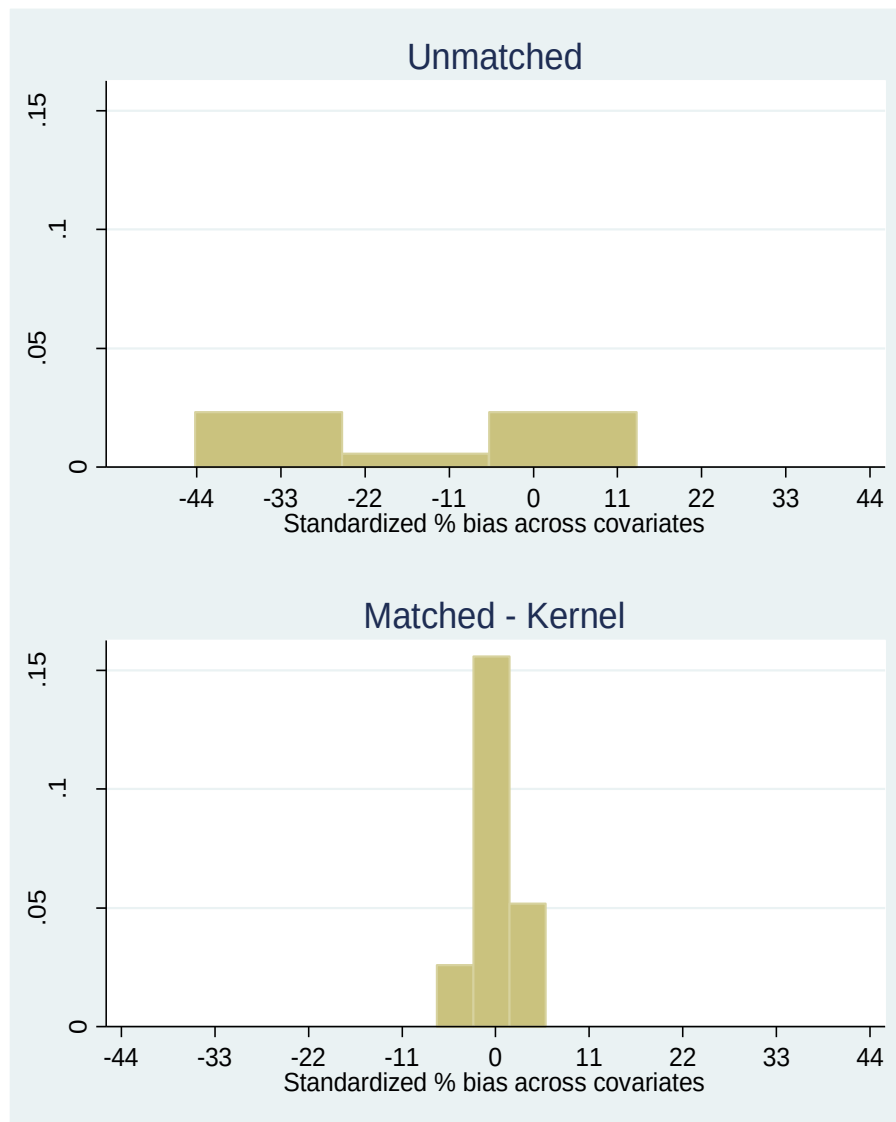


Figure 7. Histogram of standardized percentage bias across covariates before and after matching (Kernel).



Calculation of average treatment on treated effect

The average treatment on treated (ATT) effect (S. Becker & Ichino, 2002; Rubin, 1974) is the causal effect of the treatment (DL) on an outcome of interest (firm productivity). Thus, we need to calculate the outcome of a firm with the treatment (financial aid) and the outcome of the same firm with no treatment (Appendix: Stata code 5). The difference would be the treatment effect of the intervention. Since we cannot observe the same firm being in both statuses at a certain point of time, the challenge is to find

firms with similar characteristics. Based on theory, characteristics that affect both the participation in the program and the outcome of the intervention are included in the analysis (see variables selection section). So, each firm is characterized based on a set of observable characteristics. The propensity score is used to convert this multidimensional vector of observable characteristics to a single composite variable. All firms are assigned a propensity score showing the predicted probability of receiving treatment. As explained above, we have restricted our analysis within the common support area where the mean propensity scores of treated and non-treated are similar. Using matching techniques (see matching estimation section), we find the most comparable counterparts for the analysis (see diagnosis of matching quality section). The average difference in outcome (here: productivity) between the treated and their respective control(s) is the average treatment on treated.

Since we compare the characteristics of one firm with another firm, we cannot have a matching in absolute terms. Depending on the characteristics of each technique aiming to find the closest counterpart the average treatment on treated effect varies. As we see in Table 10, all three matching estimators (see matching estimation section) show that treated firms experience a negative impact from €73 to €8,270 on annual sales per average working unit. Thus, in our case all firms of our sample applied for state aid, and some receive treatment while others do not. The negative figures suggest that two years after the end of the interventions, firms operating in the industrial sector which received state aid do not receive a benefit in terms of labour productivity. If we consider that treated firms have an average of €368,971 annual sales per average working unit, the magnitude of the negative impact is not high. In addition, the state aid cost per new job position is €317,589 (based on data of Table 5, the financial support of the state to 1,261 firms was €1.95bn and resulted in 6,140 new job positions). Compared with similar estimations from other scholars this cost is high. Indicatively, (Thomas, 2011) reports that state aid in the automotive industry of the US is 200,000 dollars per new job, and Bondonio et al. (2016) report €230,000 per new job in Italy. This can be seen as an indication that DL does not provide good value for money, since a high level of financial support to firms does not seem to offer high levels of productivity.

Table 10. Average treatment on treated.

Method	Treated	Control	ATT (€)	Std. Error	t
Stratification	69	44	−3,022	93,099	0.255
Radius matching	69	62	−73	98,958	−0.001
Kernel matching	69	62	−8,270	85,265	−0.097

Source: Own calculations.

Discussion

We may highlight two observations about the effect of DL on treated firms. The first observation is related to the human capital of firms. As planned investments materialize, the technological status of the firm changes; thus, it might take time for employees to become familiar with it. This lag between technological development and personnel readiness could result in a low utilization of firm capital, leading to lower productivity levels. This could be supported by the fact that 75% of the firms of our sample have employees with relatively low education. The same reasoning could also be applicable to the new employees that join the firm as a result of the investment. If their skills are not suited to the requirements of the production facility, the quantity of the employees does not accurately depict the real workforce of the firm. The managerial team also plays an important role in communicating with, and supporting, employees to familiarize with new goals. In our case, nearly all firms (97%) have an experienced management team but less than half (44%) have a specialized management team.

The second observation is related to firm output. All firms of our sample are already operating at the time of their application and most of them (81%) are in operation for more than three years. This means that they have an established portfolio of goods and services. The lower capital costs, due to state aid support, might encourage firms to undertake a new investment. The fact that state aid programs are not continuously available strengthens our explanation as they may seem as windfalls to be used whenever they appear, instead of submitting the application whenever this is suitable to the strategic plan of firms. The state aid programs come at specific and unknown points in time when the state believes that there is a market failure that can be solved by providing non-refundable subsidies to firms. At the time that a call for applications is open, a firm might be not in a position to proceed with a new investment (e.g. because

it might have not reached its full capacity utilization), but in order to apply for ‘free money’ the firm brings forward (sometimes hastily) an investment which would be better left to be executed at a later stage. Besides the potential capacity of the firms, the type of the new investment might have an implication on firm output. If the new investment provides the same goods and services, then state aid functions similarly to a reduction in the existing production costs. Lower production costs should result in better prices, thus attracting customers from other competitors. On the other hand, if the new investment provides goods and services that are not already in the existing portfolio, then state aid works as a tool to overcome entry barriers to a new market. In our case, the business plans of the firms include the establishment of new production units and not the expansion of existing ones. This could be one explanation of the poor performance since the firms have to develop a new marketing strategy, new communication channels, new logistics processes, etc., for the new portfolio; and these activities put a burden on existing managerial and other human resources and might take time to materialize.

Based on the above observations, we can make two recommendations to policy makers. The first recommendation is related to the design of the policy. DL objectives should be (a) realistic and measurable and (b) designed in a manner that long term benefits are enhanced.

Concerning the design of realistic and measurable objectives, DL is arguably an expensive law in terms of budget spending, thus the expectations from policy makers seem rather optimistic. As we note in the introduction, DL has a wide range of objectives but its impact on the economy remains unknown since there are no measurable criteria to quantify the progress. A useful change would be the creation of a list of objectives like the ones (i.e. basic, specific, additional benefits) used from Gabor & Sauvant (2019) to describe the “Authorized Sustainable Investor”, combined with the list of sustainability characteristics of investments (economic, social, environmental) used from Sauvant & Mann (2017).

The second recommendation is about the focus on long term results. Policy makers know that the results of the policy will come at a later phase and at that time they will

(most probably) not be still in the same position, thus it seems that they use DL to achieve short term political rewards. Short term rewards may come by designing a policy which attracts a high number of new investments. To attract a high number of investments the selection criteria cover a wider area of firms that are not necessarily able to achieve the objectives of the intervention. This is totally understandable if we hypothetically consider a scenario with a DL bearing very strict and targeted selection criteria. This intervention could only attract a small portion of firms since only few could fulfil the strict criteria. This result could harm the political reputation of the policy makers, since it is difficult to communicate to the public that the strict criteria would ensure a successful implementation of the investments and the achievement of the intended development goals, thus providing benefits for the economy. To prevent ineffective design, policy makers should use evidence from experience. Policy makers together with data experts can develop a data-driven policy making procedure based on feedback loops from the implementing authorities.

Our second recommendation is about the implementation of the policy. The informational advantage of implementing authorities should be the interconnection link with policy design. A strong public organization must be in place to support implementation problems. DL includes high budget investments that usually take time to implement. During this period, it is not unusual for firms to face challenges that were not foreseen during the preparation of the application. These implementation issues are not communicated to the implementing authorities since firms have no obligation to do it. The official communication process is mainly performed after the implementation of the project. If we combine this information gap with our findings on rather poor performance, this could be a reason why part of the approved investments is never completed; problems have never been identified so they never had the opportunity to be fixed. Thus, a performance monitoring process should be in place to ascertain whether firms are still operating and developing the approved business plans. A monitoring process could include: (1) an updated monitoring process to meet the needs of implementing authorities; and (2) an improved information system to provide reliable data from the monitoring process to policy makers.

Conclusion and future directions

In this study we have conducted an impact assessment for a Greek state aid policy. Our results show that DL has a minor negative impact on labour productivity of the firms that received financial support, a finding consistent with other recent national studies (Banai et al., 2017, 2020; Bondonio et al., 2016; Karhunen & Huovari, 2015; Koski & Pajarinen, 2015; Namiotko et al., 2019; Ratinger, Amoako Agyemang, et al., 2020; Santos, 2019; Santos et al., 2019; Špička, 2018a, 2018b; Srhoj et al., 2020; Srhoj, Lapinski, et al., 2019; Srhoj, Škrinjari, et al., 2019; Srhoj, Škrinjarić, & Radas, 2021). Our findings, based on a dataset from the Ministry of Economy covering the period 2011-2014, contribute to the state aid effectiveness discussion providing empirical evidence that such policies might not offer advantages to firms receiving the aid. We came to this conclusion using propensity score matching analysis on a sample of manufacturing firms which we observed for the first few years after program closure.

Although we have identified a negative impact of development law 3908/2011 on labour productivity of the treated (funded) firms, we are unable to assess/evaluate the effectiveness of the policy based solely on our findings. We believe that our study should be used together with other state aid studies, giving emphasis not only on the results but to all actions and assumptions made which are connected to these results. Then, policy makers could more easily convert the research knowledge into an evidence-based state aid policy based on the customized needs of each policy program.

Chapter 5. Findings, implications, and conclusions

Synopsis

In this thesis, we conducted three distinct studies to examine the assumption that state aid subsidies have a positive effect on the receiving firms. The primary objective was to shed light on the impact of state aid on firm productivity and provide insights for evidence-based policy making. The first study (Chapter 2) aimed to synthesize existing research on the Greek development law (DL) and identify key findings and trends. The second study (Chapter 3) employed a systematic review method to examine existing studies that have used propensity score matching to evaluate EU state aid policies. The third study (Chapter 4) is an original counterfactual impact evaluation of the DL. This involved comparing the outcomes of firms that received state aid subsidies under the DL with a counterfactual scenario where they did not receive such support.

Findings

The key findings per study are:

1. The literature review examined all existing fifty-two relevant academic articles and studies on the Greek DL over the past four decades. The literature we identified was about the six recent versions of the Greek DL (excluding the one currently in operation). We found that almost four in five studies use quantitative methods to examine the relationship between state aid subsidies and independent variables. Thirty-eight (73%) of all studies use descriptive statistics; four (8%) employ regression analysis; ten (19%) use qualitative analysis¹³. We then attempted to evaluate the characteristics of DL and draw conclusions about its operation. The analysis of the findings of the studies is divided into three areas: policy design, implementation, and impact, all of which are interconnected and demonstrate the need for a comprehensive approach to address

¹³ Our work is currently the only one using counterfactual impact evaluation methods. It should be noted that the absence of counterfactual impact evaluation studies led us to conduct the first such evaluation in the context of this thesis.

the challenges facing state aid subsidies. (i) In terms of policy design, existing literature points out issues such as the lack of specific and measurable goals, the complexity of the DL, and the need for increased public awareness. These factors can hinder effective implementation and evaluation of the policy. (ii) Regarding policy implementation, the literature suggests that centralized administration, delays in the evaluation process, lack of evaluation competence, inefficiency in monitoring, and the state's inability to adapt to current conditions seem to pose significant challenges. These implementation issues make it difficult for the DL to effectively target sustainable firms and evaluate the outcomes of the subsidies. (iii) The analysis of policy impact reveals that traditional sectors have absorbed the majority of investments; technology-intensive industries do not actively seek subsidies; and there is no observable increase in capital mobilization in disadvantaged areas despite high-intensity incentives. In our opinion, the most critical finding is that the DL supports investments that are never completed. These findings may be an indication that the DL has not successfully achieved its intended outcomes, particularly in supporting the growth of technology-intensive industries and increasing capital mobilization in disadvantaged areas.

2. In our systematic review we examined studies from twelve European Union member states which assess the impact of state aid policies on firm productivity. We focused on studies using propensity score matching analysis as this method of analysis is gaining popularity in program impact evaluations at the EU and global level. We found thirty-five studies, with a combined sample of 369,643 firms, representing EU state aid programs that were active from 1996 to 2015. The findings of the studies revealed a mixed picture, with only half of the studies demonstrating a positive effect of state aid on firm productivity. Through the analysis of these studies, we explored the impact of specific policy characteristics on firm productivity, including policy objectives, program duration, firm size eligibility, local/national targeting, type of granting authorities, and financing tools. We found that shorter program durations were more likely to yield positive impacts, while the other factors did not show significant associations with impact.

3. Third, having identified a gap in evaluating the impact of the DL, a counterfactual impact evaluation was conducted using propensity score matching to assess the impact

of the DL on firm productivity. We created a purpose-built unique dataset combining data from the Ministry of Economy, General Electronic Commercial Registry, National Printing House of Greece, websites, and the National Transparency Portal. The working dataset consists of 1,910 firms that applied for state aid under the DL. However, the results of the counterfactual impact evaluation did not show a clear positive effect of the DL on firm productivity, but rather the opposite. This finding suggests that either the DL may not have achieved its intended goals or that the mechanisms through which state aid influences firm productivity are more intricate than initially anticipated. It highlights the need for further investigation and a more nuanced understanding of the causal effects of state aid subsidies.

To summarize, the results of all three chapters indicate that state aid may not always have a positive impact. The literature review of Chapter 2 revealed several shortcomings in the policy design, implementation, and overall impact of the Greek DL. Furthermore, the systematic review of studies from various European Union member states in Chapter 3 provided insights into the mixed effects of state aid policies on firm productivity. Finally, the counterfactual impact evaluation conducted for the Greek DL in Chapter 4 yielded inconclusive evidence regarding its positive impact on firm productivity.

A synthesis of the findings through an illustrative example

To illustrate the practical context of our research, we attempt to draw a hypothetical example involving a firm applying for state aid within the DL and examine how this process may impact the productivity of firms and its ability to successfully carry out a proposed investment.

First, the firm develops a business plan and applies for state aid. The evaluation process typically takes around twelve months. The financing of the project is divided between state aid, which covers 50% of the total cost, and a bank loan, which covers the remaining 50%.

Once the firm receives a positive decision on the application for state aid, it can proceed with the project implementation which includes among others the order of new equipment and construction works. The firm needs the necessary liquidity to order the

required equipment for the investment. At this point, it makes an agreement with a bank to receive 50% of the investment budget. Additionally, the firm can also request the remaining 50% (state aid part) in advance from the bank, using the approval decision from the state as a guarantee.

Once the funds are secured, the firm begins ordering the required equipment. However, as we have identified through our research, delays in project implementation can occur at various stages. These delays may include delivery delays, construction delays, licensing delays, and other unforeseen challenges. Each delay has the potential to impact the overall timeline and cost of the project, the latter primarily due to the interest accrued on the bank agreements.

Furthermore, once the construction is completed, the firm asks for the auditing process conducted by the authorities to confirm that the project has been completed. Further delays in the auditing process can increase the cost of project. As soon as the auditing is completed, then the firm is supposed to receive the state aid funds. However, if there is no allocated state budget at that time, payment delays can occur, hindering the firm's ability to use the approved state aid funds in a timely manner.

The resulting delays in project implementation can significantly impact project costs, particularly when there is a bank loan with interest payments due since the start of the implementation period. Additionally, if the application for state aid was primarily driven by opportunistic motives to obtain free money, rather than for expanding a fully utilized production capacity, adding a new production line may not result in increased production (and potential increase in sales). This means that the firm experiences higher costs with the same level of sales, indicating lower productivity compared to a counterfactual scenario without state aid. These factors could ultimately jeopardize the completion of the project if immediate actions are not taken. For instance, without a comprehensive monitoring procedure, it becomes challenging for the authorities to track and address problems faced by firms. In addition, the absence of such a monitoring procedure hampers proper state budget allocation at the appropriate time, leading to further challenges.

If we consider that half of the firms that receive state aid approval fail to complete their investments, it can be safely assumed that the above scenario holds true for many cases. These findings have significant policy and practical implications, highlighting the need for proactive measures to address the challenges faced by firms in effectively utilizing state aid and successfully completing their investment projects.

Policy and practical implications

When you spend public money, the expectation of positive results is inherent. However, “unfavourable” findings in research may be valuable. They challenge collectively held assumptions, and guide researchers towards new directions, ultimately contributing to scientific progress and hopefully to the optimal use of public resources. By highlighting what does not work, such unfavourable findings trigger adjustments in methods, exploration of alternative approaches, and a deeper understanding of state aid. Our intention in presenting the results of these three studies in this concluding section is not to isolate and emphasize specific suggestions or recommendations mentioned within each work: it is important to avoid drawing premature conclusions or assuming immediate feasibility without considering the specific circumstances. Instead, we encourage readers to examine each study in its entirety to develop a fuller understanding of state aid. By doing this, readers can gain a picture of the complexities surrounding state aid subsidies and their impact on firm productivity. Each study contributes unique insights and highlights different aspects of state aid, providing a holistic, broader perspective.

One important insight derived from this thesis is to consider state aid as a treatment, analogous to medicine. Just as we need proper evaluation to understand the effectiveness, safety, and overall outcomes of a medical treatment, the same principle applies to the allocation of public resources through state aid. Without rigorous evaluation, we lack essential insights into the impact and effectiveness of state aid subsidies. The significance of this message is heightened by two important factors. Firstly, Greece is a high-spending European Union member state when it comes to state aid. Understanding the impact of state aid in such contexts is crucial for informed decision-making and optimal resource allocation. Secondly, the DL adheres to the

guidelines of the General Block Exemption Regulation (GBER) established by the European Commission. Remarkably, more than 96% of new state aid programs in the European Union have been found to be compliant with the GBER since 2015. Given this widespread compliance, the findings of this thesis have the potential to hold relevance and applicability beyond national borders.

Conclusions and future research

By recognizing the need for evidence-based assessments of state aid programs (such as counterfactual impact evaluations) stakeholders may increase the probability that public resources are utilized effectively and efficiently. Evidence-based assessments of state aid policies allows for a more comprehensive understanding of their impact on targeted objectives (e.g. firm productivity) and facilitates informed decision-making at both national and supranational levels. Ultimately, an evidence-based approach may be instrumental in optimizing the allocation of resources and promoting wider goals such as sustainable economic development.

We hope that this thesis has contributed to the wider issue of whether state aid is both necessary and effective. Of course, we have only scratched the surface; more research is needed to know what works and what does not. Then, better policies could be created.

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Appendices

A1. Glossary

State aid glossary in conceptual order

State aid	Any measure taken by a state that provides an advantage to one or more firms that could distort competition and trade in the European Union.
State resources	Any resources under the control of the state, including direct grants, tax credits, soft loans.
Firm	Any entity engaged in economic activity, regardless of its legal form and the way in which it is financed.
Advantage	Any form of support or assistance granted by a state that improves the financial situation of a firm in a way that would not have been possible under normal market conditions.
Distortion of competition	Any practice that affects the conditions of competition in a market and leads to an artificial advantage for certain firms over others.
State aid guidelines	Guidelines of European Commission that provide detailed guidance on how to interpret and apply European Union state aid rules.
General Block Exemption Regulation (GBER)	Regulation issued by the European Commission that allows EU member states to provide state aid to firms without having to seek prior approval from the European Commission.
State aid program	A general measure adopted by a government or public authority that provides aid to a particular sector or category of firms. State aid programs are designed to support specific policy objectives, such as entrepreneurship, technological development, competitiveness, regional cohesion, green economy, etc.
Aid decision	Aid that is granted to an individual firm for a specific purpose, which is covered by an existing aid state aid program.
Recovery	The process to recover aid that has been granted to a firm.
Investment	An investment mainly includes the setup of a new establishment or the capacity extension of an existing establishment.
Eligible costs	The expenses that are considered necessary and relevant to the investment being supported by a state aid program. Eligible costs can include the cost of constructing or renovating buildings, purchasing machinery, etc.
Aid intensity	The percentage of eligible costs that can be covered by state aid under a particular state aid program. Aid intensity is determined based on the type of investment, location of the investment, and the size of the enterprise.
Aid amount	The total amount of state aid that can be provided to a particular investment. The aid amount is calculated based on the eligible costs of the project, the aid intensity permitted under the state aid program, and any other conditions or limitations that may apply.
Location of investment	The geographic area in which the investment is located. The location of investment can be a key factor in determining the level of state aid that can be provided, as some regions or industries may be considered a priority for investment and development.
Direct grants	These are direct payments made by the government to a specific company or organization to support their business activities.

Tax credits	These are tax incentives provided by the government to companies that invest in research and development, or that carry out activities in certain designated areas or industries.
Soft loans	These are low-interest loans provided by the government to companies that have difficulty obtaining financing from private lenders, such as banks.
Small and Medium-sized Enterprise (SME)	A business that meets certain criteria in terms of size, turnover, and number of employees, as defined by the European Commission.
Micro enterprise	The smallest type of SME, with fewer than 10 employees and an annual turnover or balance sheet total not exceeding €2 million.
Small enterprise	An SME with fewer than 50 employees and an annual turnover or balance sheet total not exceeding €10 million.
Medium enterprise	An SME with fewer than 250 employees and an annual turnover not exceeding €50 million or an annual balance sheet total not exceeding €43 million.
Turnover	The amount of revenue a company generates from its business activities during a given period of time.
Balance sheet total	The total value of a company's assets, liabilities, and equity at a specific point in time.
Employment	The number of people employed by a firm, including full-time and part-time employees.

Methodology glossary in conceptual order

Counterfactual	A hypothetical scenario that represents what would have happened in the absence of the state aid program being evaluated.
Treatment group	The group of firms that receive the state aid being evaluated in a counterfactual impact evaluation.
Control group	The group of firms that do not receive the state aid being evaluated in a counterfactual impact evaluation, but are otherwise similar to the treatment group.
Propensity score	A score that represents the likelihood of a firm receiving the state aid being evaluated in a propensity score matching analysis, based on observable characteristics.
Common support	The range of values of the propensity score that are shared by both the treatment and control groups in a propensity score matching analysis.
Matching algorithm	The method used to match firms in the treatment and control groups in a propensity score matching analysis, based on their propensity scores.
Caliper	The maximum distance allowed between the propensity scores of matched firms in a propensity score matching analysis.
Weighting	A technique used in propensity score matching to adjust the weight given to each firm in the treatment and control groups, based on their propensity score.
Average Treatment Effect on the Treated (ATT)	The average difference in outcomes between the treatment group and the control group.

A2. Permission from the Ministry of Economy to use the data for the research

The original document, including the signatures, is available upon request.

ΣΥΜΒΑΣΗ ΓΙΑ ΤΗΝ ΠΡΟΣΒΑΣΗ ΣΕ ΕΜΠΙΣΤΕΥΤΙΚΑ ΔΕΔΟΜΕΝΑ ΓΙΑ ΕΡΕΥΝΗΤΙΚΟΥΣ ΣΚΟΠΟΥΣ

Η Διεύθυνση Ιδιωτικών ΕΠενδύσεων του Υπουργείου Ανάπτυξης & Ανταγωνιστικότητας (Έδρα: Νίκης 5-7, 101 80 ΑΘΗΝΑ), εφεξής καλούμενη χάριν συντομίας «φορέας», εκπροσωπούμενη εδώ από τον κ. Σωτήρη Αθανασίου και του ΓΙΑΝΝΗ ΚΕΣΤΟΠΟΥΛΟΥ υποψήφιου διδάκτορα ΠΑΝΤΕΙΩΝ ΠΑΛΕΟΠΟΛΕΩΝ ΣΧΟΛΗΣ ΕΠΙΣΤΗΜΩΝ ΟΙΚΟΝΟΜΙΑΣ & ΑΓΓΛΟΛΟΓΙΑΣ ΔΙΟΙΚΗΣΗΣ (ΤΟΠΑ), κάτοχο Α.Φ.Μ. 078083415 ΔΟΥ 'ΧΑΛΑΡΡΟΥ', καλούμενο εφεξής, χάριν συντομίας, «ερευνητής» συμφωνούν και συναποδέχονται τα εξής:

ΣΚΟΠΟΣ ΚΑΙ ΠΕΔΙΟ ΕΦΑΡΜΟΓΗΣ ΤΗΣ ΣΥΜΒΑΣΗΣ

1. Η παρούσα σύμβαση αφορά στην παραχώρηση στον ερευνητή του δικαιώματος πρόσβασης σε δεδομένα, εφεξής «στοιχεία», για την διενέργεια της επιστημονικής του έρευνας, σύμφωνα με τους όρους που καθορίζονται παρακάτω:

α. Σκοπός της παρούσας σύμβασης είναι η δωρεάν διάθεση, εκ μέρους του φορέα προς τον ερευνητή, αρχείων με στοιχεία για ΤΟΝ ΑΝΑΠΤΥΞΙΑΚΟ ΝΟΜΟ.

Ο ΤΙΤΛΟΣ ΤΗΣ ΔΙΔΑΚΤΟΡΙΚΗΣ ΔΙΑΤΡΙΒΗΣ ΕΙΝΑΙ:

"SUSTAINABLE DEVELOPMENT: EU POLICIES AND THE
ROLE OF PRIVATE INVESTMENT INCENTIVES".

Γ. Στα στοιχεία πρόσβαση θα έχει μόνο ο ερευνητής και η συνεννάτης.

ΠΡΟΣΒΑΣΗ ΚΑΙ ΧΡΗΣΗ ΤΩΝ ΣΤΟΙΧΕΙΩΝ

2. Το υλικό και τα στοιχεία παρέχονται στον ερευνητή από τον φορέα, έχοντας παραχθεί με τις βέλτιστες γνώσεις και δυνατότητες. Εφόσον διαπιστωθούν από τον ερευνητή τυχόν παραλείψεις στα παρεχόμενα στοιχεία, σε σχέση με την ανωτέρω

αίτησή του, ο φορέας υποχρεούται να παράσχει εκ νέου στον ερευνητή διορθωμένο αρχείο, χωρίς άλλη υποχρέωση του ερευνητή.

3. Ο ερευνητής αναλαμβάνει έναντι του φορέα, ρητά και ανεπιφύλακτα, να τηρεί σωρευτικά τις παρακάτω, σύμφωνα με το νόμο, υποχρεώσεις:

α. Να αιτείται από τον φορέα τα απολύτως αναγκαία για το σκοπό της επιστημονικής έρευνας στοιχεία.

β. Να μην παραποιεί με οποιοδήποτε τρόπο τα στοιχεία που παρέχονται από τον φορέα.

γ. Να επεξεργάζεται τα στοιχεία περιοριζόμενος στην απολύτως απαραίτητη για τις ανάγκες της επιστημονικής έρευνας διαδικασία.

δ. Κατά τη διάρκεια διενέργειας της έρευνας, αλλά και μετά το πέρας αυτής, οριστώς, να μην αποκαλύπτει, συζητά, ανταλλάσσει ή μεταβιβάζει τα στοιχεία (ή μέρος των στοιχείων), καθ' οιονδήποτε τρόπο (άμεσο ή έμμεσο) και υπό οιαδήποτε μορφής σε (με) τρίτους, παρά μόνο σε (με) αυτούς που ρητά αναφέρονται στην σύμβαση ότι θα έχουν πρόσβαση.

ε. Κατά τη διάρκεια διενέργειας της έρευνας, αλλά και μετά το πέρας αυτής, οριστώς, να μην αποκαλύπτει, συζητά ή ανταλλάσσει καθ' οιονδήποτε τρόπο (άμεσο ή έμμεσο) και υπό οιαδήποτε μορφής σε (με) τρίτους, παρά μόνο σε (με) αυτούς που ρητά αναφέρονται στην σύμβαση ότι θα έχουν πρόσβαση, κανένα συμπέρασμα που ο ίδιος εξήγαγε από τα στοιχεία, το οποίο μπορεί να οδηγήσει σε παραβίαση του στατιστικού απορρήτου των στοιχείων.

στ. Κατά τη διάρκεια διενέργειας της έρευνας, αλλά και μετά το πέρας αυτής, οριστώς, να τηρεί κατ' απόλυτα εμπιστευτικό τρόπο και να χρησιμοποιεί αποκλειστικά για το σκοπό της επιστημονικής έρευνας τα στοιχεία, καθώς και τα ατομικά δεδομένα που τυχόν θα περιέλθουν εις γνώση του, κατά την επεξεργασία των στοιχείων, απορριπτικής ρητός: α) της χρησιμοποίησής τους για οποιονδήποτε άλλο σκοπό, συμπεριλαμβανομένου οικονομικού, ή άλλου οφέλους προσωπικού ή τρίτων, καθώς και οποιασδήποτε φύσης πολιτικού, συλλογικού ή διαφορετικά οριζόμενου σκοπού ή απόφασης, β) της χρησιμοποίησής τους για τη επιβολή φόρων, δασμών, τελών και συναφών επιβαρύνσεων, γ) της χρησιμοποίησής τους σε οποιαδήποτε διαδικασία ενώπιον φορολογικών, δικαστικών, αστυνομικών, στρατιωτικών ή άλλων διοικητικών αρχών.

4. Ο ερευνητής αναλαμβάνει ρητά κι ανεπιφύλακτα την υποχρέωση έναντι του φορέα όπως καθ' όλη τη διάρκεια της επιστημονικής έρευνας λάβει και τηρεί τα κάτωθι μέτρα φυσικής και λογικής προστασίας (κανονιστικά, διοικητικά, τεχνικά, οργανωτικά), των χορηγούμενων από τον φορέα στοιχείων:

Τα στοιχεία θα είναι ασφαλώς αποθηκευμένα σε δύο φυσικές τοποθεσίες. Η μία θα είναι ο προσωπικός σκληρός δίσκος του ερευνητή ο οποίος είναι κρυπτογραφημένος και πρόσβαση έχει μόνον ο ίδιος. Η άλλη τοποθεσία είναι ο ασφαλής δρομολογητής αποθήκευσης αρχείων backup, Dropbox. Στα αποθηκευμένα στοιχεία στο Dropbox πρόσβαση έχει μόνος ο ερευνητής και η . Για την πρόσβαση στα δεδομένα που είναι αποθηκευμένα στο Dropbox απαιτείται κωδικός που αλλάζει συχνά. Η επικοινωνία μεταξύ Dropbox και ηλεκτρονικού υπολογιστή γίνεται μόνον με κρυπτογραφημένο πρωτόκολλο επικοινωνίας Secure Shell (SSH).

5. Τα στοιχεία διατίθενται στον ερευνητή (ή στο νόμιμο εκπρόσωπο του), ο οποίος αναφέρεται στην πρώτη σελίδα της σύμβασης και υπογράφει τη σύμβαση. Αυτός θα έχει άμεση πρόσβαση στα στοιχεία. Δικαίωμα πρόσβασης στα στοιχεία μπορεί να έχουν και μεμονωμένοι ερευνητές που απασχολούνται από ή συνεργάζονται με τον ερευνητή (ή τον νόμιμο εκπρόσωπο του) για τη διενέργεια της έρευνας, αποκλειστικά και μόνο για το σκοπό της έρευνας και αναφέρονται στη πρώτη σελίδα της σύμβασης. Σε περίπτωση που ο ερευνητής (ή ο νόμιμος εκπρόσωπος του) επιθυμεί να προσθέσει νέους ερευνητές στον κατάλογο των εξουσιοδοτημένων ατόμων που θα έχουν πρόσβαση στα στοιχεία, θα πρέπει να επανυποβάλλει την αίτηση.

ΕΚΘΕΣΕΙΣ/ΜΕΛΕΤΕΣ ΒΑΣΕΙ ΤΩΝ ΠΑΡΕΧΟΜΕΩΝ ΣΤΟΙΧΕΙΩΝ

6. Ο ερευνητής αναλαμβάνει έναντι του φορέα, ρητά και ανεπιφύλακτα, να τηρεί σωρευτικά τις παρακάτω υποχρεώσεις:

α. Κατά τη διάρκεια διενέργειας της έρευνας, αλλά και μετά το πέρας αυτής, αορίστως, να μη δημοσιοποιεί ή διαθέτει με οποιονδήποτε τρόπο αποτελέσματα της έρευνας που μπορεί να οδηγήσουν εμμέσως στην αποκάλυψη ατομικών δεδομένων.

β. Να παρέχει στον φορέα αντίγραφο όλων των εκθέσεων/μελετών που έχουν δημοσιευθεί, στις οποίες έγινε χρήση των παρεχόμενων στοιχείων, μέσα σε δεκαπέντε (15) εργάσιμες ημέρες από τη δημοσίευσή τους.

γ. Να αναφέρει, κατά τη δημοσίευση/ανακοίνωση των αποτελεσμάτων του ερευνητικού έργου στο οποίο αναφέρεται η παρούσα σύμβαση, ως πηγή των στοιχείων τον φορέα, με την επισήμανση ότι τα αποτελέσματα και συμπεράσματα είναι του ερευνητή.

ΔΙΑΡΚΕΙΑ ΚΑΙ ΛΥΣΗ ΤΗΣ ΣΥΜΒΑΣΗΣ

7. Η ισχύς της παρούσας σύμβασης αρχίζει από την ημερομηνία της υπογραφής της από αμφότερα τα συμβαλλόμενα μέρη και λήγει την ημερομηνία ολοκλήρωσης της έρευνας.

ΚΥΡΩΣΕΙΣ ΠΑΡΑΒΙΑΣΗΣ ΤΩΝ ΥΠΟΧΡΕΩΣΕΩΝ ΤΟΥ ΕΡΕΥΝΗΤΗ

8. Παραβίαση από τον ερευνητή οιασδήποτε από τις ανωτέρω υποχρεώσεις του- ανεξαρτήτως βαθμού πταίσματος του, οφειλόμενου ακόμη και σε τυχαίο γεγονός- έχει τις ακόλουθες συνέπειες:

α. Ο φορέας έχει δικαίωμα να καταγγείλει, χωρίς προθεσμία, την παρούσα σύμβαση. Στην περίπτωση αυτή, τα αποτελέσματα της καταγγελίας επέρχονται άμεσα και ο ερευνητής, χωρίς καμία όχληση, υποχρεούται άμεσα να παραδώσει στον φορέα όλα εκείνα τα στοιχεία, που ο τελευταίος του χορήγησε για την εκ μέρους του διεξαγωγή της έρευνας/μελέτης.

β. Επιπλέον, ο φορέας δύναται να στραφεί κατά του ερευνητή διεκδικώντας την αποκατάσταση οποιασδήποτε φύσης τυχόν ζημίας του (φορέα), η οποία προκλήθηκε από την ανωτέρω συμπεριφορά του ερευνητή.

ΓΕΝΙΚΕΣ ΔΙΑΤΑΞΕΙΣ

9. Όλοι ο νόμοι της παρούσας σύμβασης συμφωνούνται ως ουσιώδεις και η παράβαση οποιουδήποτε εξ αυτών από τον ερευνητή έχει ως αποτέλεσμα την καταγγελία και άμεση λύση της σύμβασης υπέρ του φορέα. Ρητά συμφωνείται μεταξύ των εδώ συμβαλλόμενων ότι αρμόδια δικαστήρια για την επίλυση οποιασδήποτε διαφοράς περί την ερμηνεία ή εφαρμογή της παρούσας σύμβασης είναι τα Ελληνικά Δικαστήρια.

9^α. Σε περίπτωση διαφοροποίησης μεταξύ της ελληνικής και αγγλικής γλώσσας του παρόντος κειμένου, υπερισχύει το ελληνικό κείμενο.

Η παρούσα σύμβαση συντάχθηκε σε τρία (3) ισόκυρα αντίγραφα και υπογράφεται στη συνέχεια από τους συμβαλλομένους, κάθε ένας εκ των οποίων έλαβε από ένα αντίγραφο.

ΟΙ ΣΥΜΒΑΛΛΟΜΕΝΟΙ

A3. Stata software code, tables, and graphs utilized for the analysis

Stata code 1. Estimation of chi2 (see section: Classification of studies according to their characteristics).

```
. tabulate characteristic positiveimpact, chi2
```

characteristic	positiveimpact		Total
	no	yes	
General business	6	7	13
R&D	4	5	9
Regional development	3	2	5
Sectoral development	5	3	8
Total	18	17	35

Pearson chi2(3) = 0.8602 Pr = 0.835

```
. clear
```

```
. *(2 variables, 35 observations pasted into data editor)
```

```
. tabulate characteristic positiveimpact, chi2
```

characteristic	positiveimpact		Total
	no	yes	
Up to 3 years	0	8	8
four to 13 years	18	9	27
Total	18	17	35

Pearson chi2(1) = 10.9804 Pr = 0.001

```
. clear
```

```
. *(2 variables, 35 observations pasted into data editor)
```

```
. tabulate characteristic positiveimpact, chi2
```

characteristic	positiveimpact		Total
	no	yes	
All firm sizes	9	13	22
SMEs only	9	4	13
Total	18	17	35

Pearson chi2(1) = 2.6239 Pr = 0.105

. clear

. *(2 variables, 35 observations pasted into data editor)

. tabulate characteristic positiveimpact, chi2

	positiveimpact		
characteristic	no	yes	Total
Local programs	4	4	8
National programs	14	13	27
Total	18	17	35

Pearson chi2(1) = 0.0085 Pr = 0.927

. clear

. *(2 variables, 35 observations pasted into data editor)

. tabulate characteristic positiveimpact, chi2

	positiveimpact		
characteristic	no	yes	Total
Local authorities	10	11	21
Ministry	8	6	14
Total	18	17	35

Pearson chi2(1) = 0.3050 Pr = 0.581

. clear

. *(2 variables, 35 observations pasted into data editor)

. tabulate characteristic positiveimpact, chi2

characteri	positiveimpact		
stic	no	yes	Total
Grants	16	15	31
No grants	2	2	4
Total	18	17	35

Pearson chi2(1) = 0.0037 Pr = 0.952

Stata code 2. Estimation of propensity score (see section: Propensity score matching: use and results).

```
. pscore treated shareholders mngt age educat specialisation
innovation eco exports fdi, pscore(myscore) blockid(myblock) comsup
detail
```

The treatment is treated

treated	Freq.	Percent	Cum.
0	66	48.89	48.89
1	69	51.11	100.00
Total	135	100.00	

Estimation of the propensity score

```
Iteration 0: log likelihood = -93.541533
Iteration 1: log likelihood = -85.6979
Iteration 2: log likelihood = -85.644544
Iteration 3: log likelihood = -85.644529
```

Probit regression	Number of obs	=	135
	LR chi2(9)	=	15.79
	Prob > chi2	=	0.0713
Log likelihood = -85.644529	Pseudo R2	=	0.0844

treated	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]
shareholders	-.5068651	.2369848	-2.14	0.032	-.9713467 -.0423835
mngt	-.239443	.8021648	-0.30	0.765	-1.811657 1.332771
age	.1373774	.3045663	0.45	0.652	-.4595616 .7343164
educat	.0686369	.2711126	0.25	0.800	-.462734 .6000077
specialisa~n	-.1425774	.241625	-0.59	0.555	-.6161537 .3309989
innovation	-.6056815	.2287618	-2.65	0.008	-1.054046 -.1573165
eco	.1415263	.244377	0.58	0.563	-.3374438 .6204963
exports	-.0442015	.2856236	-0.15	0.877	-.6040135 .5156106
fdi	-.6764314	.5279253	-1.28	0.200	-1.711146 .3582831
_cons	.7782575	.884016	0.88	0.379	-.9543819 2.510897

Note: the common support option has been selected

The region of common support is [.22833252, .80824122]

Description of the estimated propensity score in region of common support

Estimated propensity score		
Percentiles	Smallest	
1%	.2445082	.2283325
5%	.2665984	.2445082
10%	.3150425	.2445082
		Obs
		131

25%	.3998846	.2665984	Sum of Wgt.	131
50%	.5104945		Mean	.5215411
		Largest	Std. Dev.	.1582122
75%	.6051313	.7803917		
90%	.7505406	.7932409	Variance	.0250311
95%	.7803917	.800149	Skewness	.1084532
99%	.800149	.8082412	Kurtosis	2.105537

Stata code 3. Test of balancing property of the propensity score (see section: Propensity score matching: use and results).

Distribution of treated and controls across blocks

Blocks of			
the pscore			
for			
treatment	treated		
treated	0	1	Total
-----+-----			
2	22	11	33
3	30	33	63
4	10	23	33
5	0	2	2
-----+-----			
Total	62	69	131

Test that the mean propensity score is not different for treated and controls

Test in block 1

Observations in block 1
 obs: 0, control: 0, treated: 0
 Block 1 does not have observations Move to next block

Test in block 2

Observations in block 2
 obs: 33, control: 22, treated: 11
 Test for block 2
 Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
0	22	.3182756	.0099502	.0466705	.297583	.3389681
1	11	.3098238	.0145953	.0484072	.2773035	.3423442
combined	33	.3154583	.0081241	.0466694	.29891	.3320066
diff		.0084517	.0174437		-.0271249	.0440283

```

diff = mean(0) - mean(1)
Ho: diff = 0
t = 0.4845
degrees of freedom = 31

```

```

Ha: diff < 0
Pr(T < t) = 0.6843
Ha: diff != 0
Pr(|T| > |t|) = 0.6314
Ha: diff > 0
Pr(T > t) = 0.3157

```

The mean propensity score is not different for treated and controls in block 2

Test in block 3

Observations in block 3

obs: 63, control: 30, treated: 33

Test for block 3

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
0	30	.5032126	.0067555	.0370014	.4893961	.5170291
1	33	.517425	.0065909	.0378616	.5039999	.5308501
combined	63	.5106572	.0047667	.0378345	.5011287	.5201857
diff		-.0142124	.0094485		-.0331058	.0046811

```

diff = mean(0) - mean(1)
Ho: diff = 0
t = -1.5042
degrees of freedom = 61

```

```

Ha: diff < 0
Pr(T < t) = 0.0688
Ha: diff != 0
Pr(|T| > |t|) = 0.1377
Ha: diff > 0
Pr(T > t) = 0.9312

```

The mean propensity score is not different for treated and controls in block 3

Test in block 4

Observations in block 4

obs: 33, control: 10, treated: 23

Test for block 4

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
0	10	.721533	.0206017	.0651484	.6749287	.7681374
1	23	.7355058	.0083966	.0402687	.7180923	.7529193
combined	33	.7312716	.0084406	.0484878	.7140786	.7484646
diff		-.0139728	.0184908		-.051685	.0237395

```

diff = mean(0) - mean(1)
Ho: diff = 0
t = -0.7557
degrees of freedom = 31

```

```

Ha: diff < 0
Ha: diff != 0
Ha: diff > 0

```

The mean propensity score is not different for treated and controls in block 4

```
Observations in block 5
obs: 2,  control: 0,  treated: 2
Block 5 does not have controls
Move to next block
The final number of blocks is 5
This number of blocks ensures that the mean propensity score is not different for treated
and controls in each blocks
*****
```

```
*****
obs: 0,  control: 0,  treated: 0
Block 1 does not have observations
Move to next block
```

```

*****
obs: 33, control: 22, treated: 11
Testing the balancing property for variable shareholders in block 2
Two-sample t test with equal variances
-----+-----
Group | Obs Mean Std. Err. Std. Dev. [95% Conf. Interval]
-----+-----
0 | 22 .8636364 .0748868 .3512501 .7079008 1.019372
1 | 11 .9090909 .0909091 .3015113 .7065328 1.111649
-----+-----
combined | 33 .8787879 .0576953 .331434 .7612665 .9963093
-----+-----
diff | -.0454545 .1240802 -.2985178 .2076087
-----+-----
diff = mean(0) - mean(1) t = -0.3663
Ho: diff = 0 degrees of freedom = 31

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.3583 Pr(|T| > |t|) = 0.7166 Pr(T > t) = 0.6417

```

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]
-------	-----	------	-----------	-----------	----------------------

```

-----+-----
      0 |      22      1      0      0      1      1
      1 |      11      1      0      0      1      1
-----+-----
combined |      33      1      0      0      1      1
-----+-----
      diff |      0      0      0      0
-----+-----

      diff = mean(0) - mean(1)                                t =      .
Ho: diff = 0                                           degrees of freedom =      31

      Ha: diff < 0              Ha: diff != 0              Ha: diff > 0
Pr(T < t) =      .      Pr(|T| > |t|) =      .      Pr(T > t) =      .

```

Variable mngt is balanced in block 2

Testing the balancing property for variable age in block 2

Two-sample t test with equal variances

```

-----+-----
      Group |      Obs      Mean      Std. Err.      Std. Dev.      [95% Conf. Interval]
-----+-----
      0 |      22      .7727273      .0914486      .428932      .5825495      .9629051
      1 |      11      .7272727      .1408358      .4670994      .4134711      1.041074
-----+-----
combined |      33      .7575758      .0757576      .4351941      .6032626      .9118889
-----+-----
      diff |      .0454545      .1630733      -.2871357      .3780448
-----+-----

      diff = mean(0) - mean(1)                                t =      0.2787
Ho: diff = 0                                           degrees of freedom =      31

      Ha: diff < 0              Ha: diff != 0              Ha: diff > 0
Pr(T < t) = 0.6089      Pr(|T| > |t|) = 0.7823      Pr(T > t) = 0.3911

```

Variable age is balanced in block 2

Testing the balancing property for variable educat in block 2

Two-sample t test with equal variances

```

-----+-----
      Group |      Obs      Mean      Std. Err.      Std. Dev.      [95% Conf. Interval]
-----+-----
      0 |      22      .3181818      .1016395      .4767313      .106811      .5295526
      1 |      11      .2727273      .1408358      .4670994      -.0410744      .5865289
-----+-----
combined |      33      .3030303      .0812409      .4666937      .1375479      .4685127
-----+-----
      diff |      .0454545      .1749052      -.311267      .4021761
-----+-----

      diff = mean(0) - mean(1)                                t =      0.2599
Ho: diff = 0                                           degrees of freedom =      31

```

Variable educat is balanced in block 2

Two-sample t test with equal variances

Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T < t) = 0.5000	Pr(T > t) = 1.0000	Pr(T > t) = 0.5000

Variable specialisation is balanced in block 2

Two-sample t test with equal variances

Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T < t) = 0.9197	Pr(T > t) = 0.1606	Pr(T > t) = 0.0803

Variable innovation is balanced in block 2

Two-sample t test with equal variances

```

-----+-----
      0 |      22      .3181818      .1016395      .4767313      .106811      .5295526
      1 |      11      .6363636      .15212      .504525      .2974191      .9753081
-----+-----
combined |      33      .4242424      .0873679      .5018904      .2462798      .602205
-----+-----
      diff |              -.3181818      .1794197              -.6841106      .047747
-----+-----
      diff = mean(0) - mean(1)                                t = -1.7734
Ho: diff = 0                                degrees of freedom =      31

      Ha: diff < 0              Ha: diff != 0              Ha: diff > 0
Pr(T < t) = 0.0430              Pr(|T| > |t|) = 0.0860              Pr(T > t) = 0.9570

```

Variable eco is balanced in block 2

Testing the balancing property for variable exports in block 2

Two-sample t test with equal variances

```

-----+-----
      Group |      Obs      Mean      Std. Err.      Std. Dev.      [95% Conf. Interval]
-----+-----
      0 |      22      .8181818      .0841655      .394771      .6431502      .9932135
      1 |      11      .8181818      .1219673      .4045199      .5464216      1.089942
-----+-----
combined |      33      .8181818      .0681818      .3916747      .6793      .9570636
-----+-----
      diff |              0      .1469498              -.2997061      .2997061
-----+-----
      diff = mean(0) - mean(1)                                t = 0.0000
Ho: diff = 0                                degrees of freedom =      31

      Ha: diff < 0              Ha: diff != 0              Ha: diff > 0
Pr(T < t) = 0.5000              Pr(|T| > |t|) = 1.0000              Pr(T > t) = 0.5000

```

Variable exports is balanced in block 2

Testing the balancing property for variable fdi in block 2

Two-sample t test with equal variances

```

-----+-----
      Group |      Obs      Mean      Std. Err.      Std. Dev.      [95% Conf. Interval]
-----+-----
      0 |      22      .0454545      .0454545      .2132007      -.0490734      .1399824
      1 |      11      .1818182      .1219673      .4045199      -.089942      .4535784
-----+-----
combined |      33      .0909091      .0508197      .2919371      -.0126073      .1944255
-----+-----
      diff |      -.1363636      .1067565              -.3540951      .0813678
-----+-----
      diff = mean(0) - mean(1)                                t = -1.2773
Ho: diff = 0                                degrees of freedom =      31

```

Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T < t) = 0.1055	Pr(T > t) = 0.2110	Pr(T > t) = 0.8945

Variable fdi is balanced in block 2

Testing the balancing property in block 3

obs: 63, control: 30, treated: 33
 Testing the balancing property for variable shareholders in block 3
 Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
0	30	.4333333	.0920187	.5040069	.2451341	.6215326
1	33	.4242424	.0873679	.5018904	.2462798	.602205
combined	63	.4285714	.0628488	.4988466	.3029385	.5542043
diff		.0090909	.1268622		-.2445858	.2627676
diff = mean(0) - mean(1)				t =	0.0717	
Ho: diff = 0				degrees of freedom =	61	

Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T < t) = 0.5284	Pr(T > t) = 0.9431	Pr(T > t) = 0.4716

Variable shareholders is balanced in block 3

Testing the balancing property for variable mngt in block 3

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
0	30	1	0	0	1	1
1	33	1	0	0	1	1
combined	63	1	0	0	1	1
diff		0	0		0	0
diff = mean(0) - mean(1)				t =	.	
Ho: diff = 0				degrees of freedom =	61	

Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T < t) = .	Pr(T > t) = .	Pr(T > t) = .

Variable mngt is balanced in block 3

Testing the balancing property for variable age in block 3

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
+						
0	30	.7666667	.0785403	.4301831	.6060337	.9272997
1	33	.8181818	.0681818	.3916747	.6793	.9570636
+						
combined	63	.7936508	.0513949	.4079346	.6909138	.8963878
+						
diff		-.0515152	.1035368		-.2585498	.1555195

diff = mean(0) - mean(1)					t = -0.4976	
Ho: diff = 0				degrees of freedom = 61		

Ha: diff < 0		Ha: diff != 0		Ha: diff > 0		
Pr(T < t) = 0.3103		Pr(T > t) = 0.6206		Pr(T > t) = 0.6897		

Variable age is balanced in block 3

Testing the balancing property for variable educat in block 3

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
-----+						
0	30	.2666667	.0821176	.4497764	.0987174	.434616
1	33	.2727273	.0787296	.452267	.1123604	.4330942
-----+						
combined	63	.2698413	.0563725	.4474425	.1571543	.3825282
-----+						
diff		-.0060606	.1137917		-.2336013	.2214801

diff = mean(0) - mean(1)					t = -0.0533	
Ho: diff = 0				degrees of freedom = 61		
Ha: diff < 0		Ha: diff != 0		Ha: diff > 0		
Pr(T < t) = 0.4788		Pr(T > t) = 0.9577		Pr(T > t) = 0.5212		

Variable educat is balanced in block 3

Testing the balancing property for variable specialisation in block 3

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
0	30	.6	.0909718	.4982729	.4139418	.7860582
1	33	.4242424	.0873679	.5018904	.2462798	.602205
combined	63	.5079365	.0634921	.5039526	.3810177	.6348553

```

diff |          .1757576    .1261751          -.0765451    .4280603
-----
diff = mean(0) - mean(1)                                t =    1.3930
Ho: diff = 0                                           degrees of freedom =    61

Ha: diff < 0                Ha: diff != 0                Ha: diff > 0
Pr(T < t) = 0.9157          Pr(|T| > |t|) = 0.1687          Pr(T > t) = 0.0843

```

Variable specialisation is balanced in block 3

Testing the balancing property for variable innovation in block 3

Two-sample t test with equal variances

```

-----
Group |      Obs      Mean   Std. Err.   Std. Dev.   [95% Conf. Interval]
-----+-----
0 |      30   .5666667   .0920187   .5040069   .3784674   .7548659
1 |      33   .5757576   .0873679   .5018904   .397795   .7537202
-----+-----
combined |      63   .5714286   .0628488   .4988466   .4457957   .6970615
-----+-----
diff |          -.0090909   .1268622          -.2627676   .2445858
-----
diff = mean(0) - mean(1)                                t =   -0.0717
Ho: diff = 0                                           degrees of freedom =    61

Ha: diff < 0                Ha: diff != 0                Ha: diff > 0
Pr(T < t) = 0.4716          Pr(|T| > |t|) = 0.9431          Pr(T > t) = 0.5284

```

Variable innovation is balanced in block 3

Testing the balancing property for variable eco in block 3

Two-sample t test with equal variances

```

-----
Group |      Obs      Mean   Std. Err.   Std. Dev.   [95% Conf. Interval]
-----+-----
0 |      30   .3666667   .0894855   .4901325   .1836482   .5496852
1 |      33   .2424242   .0757576   .4351941   .0881111   .3967374
-----+-----
combined |      63   .3015873   .0582863   .4626334   .1850746   .4181
-----+-----
diff |          .1242424   .1165774          -.1088686   .3573534
-----
diff = mean(0) - mean(1)                                t =    1.0658
Ho: diff = 0                                           degrees of freedom =    61

Ha: diff < 0                Ha: diff != 0                Ha: diff > 0
Pr(T < t) = 0.8546          Pr(|T| > |t|) = 0.2907          Pr(T > t) = 0.1454

```

Variable eco is balanced in block 3

Testing the balancing property for variable exports in block 3

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
0	30	.8	.0742781	.4068381	.6480842	.9519158
1	33	.8181818	.0681818	.3916747	.6793	.9570636
combined	63	.8095238	.04987	.3958308	.7098351	.9092125
diff		-.0181818	.1006415		-.2194269	.1830633
diff = mean(0) - mean(1)				t = -0.1807		
Ho: diff = 0				degrees of freedom = 61		
Ha: diff < 0		Ha: diff != 0		Ha: diff > 0		
Pr(T < t) = 0.4286		Pr(T > t) = 0.8572		Pr(T > t) = 0.5714		

Variable exports is balanced in block 3

Testing the balancing property for variable fdi in block 3

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
0	30	.0333333	.0333333	.1825742	-.034841	.1015077
1	33	0	0	0	0	0
combined	63	.015873	.015873	.1259882	-.0158567	.0476027
diff		.0333333	.031756		-.0301668	.0968334
diff = mean(0) - mean(1)				t = 1.0497		
Ho: diff = 0				degrees of freedom = 61		
Ha: diff < 0		Ha: diff != 0		Ha: diff > 0		
Pr(T < t) = 0.8510		Pr(T > t) = 0.2980		Pr(T > t) = 0.1490		

Variable fdi is balanced in block 3

Testing the balancing property in block 4

obs: 33, control: 10, treated: 23

Testing the balancing property for variable shareholders in block 4

Two-sample t test with equal variances


```

diff = mean(0) - mean(1)                                t = -0.1161
Ho: diff = 0                                             degrees of freedom = 31

```

```

Ha: diff < 0          Ha: diff != 0          Ha: diff > 0
Pr(T < t) = 0.4542    Pr(|T| > |t|) = 0.9083    Pr(T > t) = 0.5458

```

Variable age is balanced in block 4

Testing the balancing property for variable educat in block 4

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
0	10	.2	.1333333	.421637	-.101621	.501621
1	23	.173913	.0808105	.3875534	.0063224	.3415037
combined	33	.1818182	.0681818	.3916747	.0429364	.3207
diff		.026087	.1506617		-.2811896	.3333635

```

diff = mean(0) - mean(1)                                t = 0.1731
Ho: diff = 0                                             degrees of freedom = 31

```

```

Ha: diff < 0          Ha: diff != 0          Ha: diff > 0
Pr(T < t) = 0.5682    Pr(|T| > |t|) = 0.8637    Pr(T > t) = 0.4318

```

Variable educat is balanced in block 4

Testing the balancing property for variable specialisation in block 4

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
0	10	0	0	0	0	0
1	23	.2608696	.0936183	.4489778	.066717	.4550221
combined	33	.1818182	.0681818	.3916747	.0429364	.3207
diff		-.2608696	.1432677		-.553066	.0313269

```

diff = mean(0) - mean(1)                                t = -1.8209
Ho: diff = 0                                             degrees of freedom = 31

```

```

Ha: diff < 0          Ha: diff != 0          Ha: diff > 0
Pr(T < t) = 0.0391    Pr(|T| > |t|) = 0.0783    Pr(T > t) = 0.9609

```

Variable specialisation is balanced in block 4

Testing the balancing property for variable innovation in block 4

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
0	10	.1	.1	.3162278	-.1262157	.3262157
1	23	.0434783	.0434783	.2085144	-.0466901	.1336467
combined	33	.0606061	.04218	.2423058	-.0253119	.146524
diff		.0565217	.0926963		-.1325335	.245577
diff = mean(0) - mean(1)						
Ho: diff = 0				t =	0.6098	degrees of freedom = 31
Ha: diff < 0 Ha: diff != 0 Ha: diff > 0						
Pr(T < t) = 0.7268		Pr(T > t) = 0.5465		Pr(T > t) = 0.2732		

Variable innovation is balanced in block 4

Testing the balancing property for variable eco in block 4

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
0	10	.3	.1527525	.4830459	-.0455502	.6455502
1	23	.3043478	.0981002	.470472	.1009005	.5077952
combined	33	.3030303	.0812409	.4666937	.1375479	.4685127
diff		-.0043478	.1796036		-.3706518	.3619561
diff = mean(0) - mean(1)						
Ho: diff = 0				t =	-0.0242	degrees of freedom = 31
Ha: diff < 0 Ha: diff != 0 Ha: diff > 0						
Pr(T < t) = 0.4904		Pr(T > t) = 0.9808		Pr(T > t) = 0.5096		

Variable eco is balanced in block 4

Testing the balancing property for variable exports in block 4

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
0	10	.8	.1333333	.421637	.498379	1.101621
1	23	.7391304	.0936183	.4489778	.5449779	.933283
combined	33	.7575758	.0757576	.4351941	.6032626	.9118889

```

-----+-----
diff |          .0608696   .1671256          -.2799854   .4017245
-----+-----
diff = mean(0) - mean(1)                                t =    0.3642
Ho: diff = 0                                           degrees of freedom =    31

Ha: diff < 0                Ha: diff != 0                Ha: diff > 0
Pr(T < t) = 0.6409          Pr(|T| > |t|) = 0.7182          Pr(T > t) = 0.3591

```

Variable exports is balanced in block 4

Testing the balancing property for variable fdi in block 4

Two-sample t test with equal variances

```

-----+-----
Group |      Obs      Mean   Std. Err.   Std. Dev.   [95% Conf. Interval]
-----+-----
0 |      10         0         0         0         0         0
1 |      23         0         0         0         0         0
-----+-----
combined |      33         0         0         0         0         0
-----+-----
diff |          0         0          0         0
-----+-----
diff = mean(0) - mean(1)                                t =      .
Ho: diff = 0                                           degrees of freedom =    31

Ha: diff < 0                Ha: diff != 0                Ha: diff > 0
Pr(T < t) =      .          Pr(|T| > |t|) =      .          Pr(T > t) =      .

```

Variable fdi is balanced in block 4

Testing the balancing property in block 5

obs: 2, control: 0, treated: 2

Block 5 does not have controls

Move to next block

The balancing property is satisfied

This table shows the inferior bound, the number of treated and the number of controls for each block

```

Inferior |
of block |      treated
of pscore |      0      1 |      Total
-----+-----+-----
.2 |      22      11 |      33
.4 |      30      33 |      63
.6 |      10      23 |      33

```

.8	0	2	2
-----+-----+-----			
Total	62	69	131

Note: the common support option has been selected

```
*****
End of the algorithm to estimate the pscore
*****
```

Stata code 4. Standardized bias (see section: Propensity score matching: use and results).

Stratification

```
qui psmatch2 treated, outcome( productivity) pscore(myscore) caliper(.01) neighbor(1)
. qui psmatch2 treated, outcome( productivity) pscore(myscore) neighbor (1)
. pstest shareholders mngt age educat specialisation innovation eco exports fdi, treated(
treated) both
```

Variable	Unmatched		Mean		%reduct		t-test		V(T) /
	Matched	Treated	Control	%bias	bias		t	p> t	V(C)
shareholders	U	.34783	.54545	-40.3			-2.34	0.021	0.91
	M	.34783	.31884	5.9	85.3		0.36	0.720	1.04
mngt	U	.97101	.98485	-9.4			-0.54	0.589	1.88*
	M	.97101	.97101	0.0	100.0		-0.00	1.000	1.00
age	U	.84058	.78788	13.5			0.78	0.434	0.80
	M	.84058	.86957	-7.4	45.0		-0.48	0.632	1.18
educat	U	.24638	.25758	-2.6			-0.15	0.882	0.97
	M	.24638	.13043	26.5	-935.3		1.75	0.083	1.64*
specialisation	U	.37681	.51515	-27.9			-1.62	0.107	0.94
	M	.37681	.27536	20.5	26.7		1.27	0.206	1.18
innovation	U	.43478	.65152	-44.2			-2.57	0.011	1.08
	M	.43478	.44928	-3.0	93.3		-0.17	0.865	0.99
eco	U	.33333	.33333	0.0			-0.00	1.000	1.00
	M	.33333	.30435	6.1	.		0.36	0.717	1.05
exports	U	.7971	.80303	-1.5			-0.09	0.932	1.02
	M	.7971	.81159	-3.6	-144.4		-0.21	0.832	1.06
fdi	U	.02899	.09091	-26.1			-1.53	0.130	0.34*
	M	.02899	.05797	-12.2	53.2		-0.83	0.407	0.52*

* if variance ratio outside [0.62; 1.62] for U and [0.62; 1.62] for M

Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%Var
Unmatched	0.084	15.79	0.071	18.4	13.5	70.2*	0.92	22
Matched	0.031	5.88	0.752	9.5	6.1	41.3*	1.59	22

* if B>25%, R outside [0.5; 2]

Kernel

```
. qui psmatch2 treated, outcome( productivity) pscore(myscore) caliper(.01) neighbor(1)
. qui psmatch2 treated, kernel outcome( productivity) pscore(myscore)
. pstest shareholders mngt age educat specialisation innovation eco exports fdi,
treated(treated) both
```

Variable	Unmatched		Mean		%reduct		t-test		V(T) /
	Matched	Treated	Control	%bias	bias	t	p> t	V(C)	
shareholders	U	.34783	.54545	-40.3		-2.34	0.021	0.91	
	M	.34783	.35799	-2.1	94.9	-0.12	0.901	0.99	
mngt	U	.97101	.98485	-9.4		-0.54	0.589	1.88*	
	M	.97101	.98123	-6.9	26.1	-0.39	0.697	1.53	
age	U	.84058	.78788	13.5		0.78	0.434	0.80	
	M	.84058	.84396	-0.9	93.6	-0.05	0.957	1.02	
educat	U	.24638	.25758	-2.6		-0.15	0.882	0.97	
	M	.24638	.24036	1.4	46.2	0.08	0.935	1.02	
specialisation	U	.37681	.51515	-27.9		-1.62	0.107	0.94	
	M	.37681	.34737	5.9	78.7	0.36	0.721	1.04	
innovation	U	.43478	.65152	-44.2		-2.57	0.011	1.08	
	M	.43478	.43714	-0.5	98.9	-0.03	0.978	1.00	
eco	U	.33333	.33333	0.0		-0.00	1.000	1.00	
	M	.33333	.32886	0.9		0.06	0.956	1.01	
exports	U	.7971	.80303	-1.5		-0.09	0.932	1.02	
	M	.7971	.79038	1.7	-13.3	0.10	0.923	0.98	
fdi	U	.02899	.09091	-26.1		-1.53	0.130	0.34*	
	M	.02899	.03186	-1.2	95.4	-0.10	0.922	0.91	

* if variance ratio outside [0.62; 1.62] for U and [0.62; 1.62] for M

Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%Var
Unmatched	0.084	15.79	0.071	18.4	13.5	70.2*	0.92	22
Matched	0.002	0.43	1.000	2.4	1.4	11.1	1.39	0

* if B>25%, R outside [0.5; 2]

Radius

```
. qui psmatch2 treated, outcome( productivity) pscore(myscore) caliper(.1) neighbor(1)
. qui psmatch2 treated, radius caliper (0.1) outcome( productivity) pscore(myscore)
. pstest shareholders mngt age educat specialisation innovation eco exports fdi, treated
(treated) both
```

Variable	Unmatched Matched	Mean Treated Control	%reduct %bias	t-test t	V(T) / V(C)
shareholders	U .34783 M .34783	.54545 .35262	-40.3 -1.0	-2.34 -0.06	0.021 0.953
mngt	U .97101 M .97101	.98485 .983	-9.4 -8.1	-0.54 -0.47	0.589 0.641
age	U .84058 M .84058	.78788 .81394	13.5 6.8	0.78 0.41	0.434 0.682
educat	U .24638 M .24638	.25758 .24977	-2.6 -0.8	-0.15 -0.05	0.882 0.964
specialisation	U .37681 M .37681	.51515 .36771	-27.9 1.8	-1.62 0.11	0.107 0.913
innovation	U .43478 M .43478	.65152 .44022	-44.2 -1.1	-2.57 -0.06	0.011 0.949
eco	U .33333 M .33333	.33333 .32091	0.0 2.6	-0.00 0.15	1.000 0.877
exports	U .7971 M .7971	.80303 .79724	-1.5 -0.0	-0.09 -0.00	0.932 0.998
fdi	U .02899 M .02899	.09091 .03159	-26.1 -1.1	-1.53 -0.09	0.130 0.929

* if variance ratio outside [0.62; 1.62] for U and [0.62; 1.62] for M

Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%Var
Unmatched	0.084	15.79	0.071	18.4	13.5	70.2*	0.92	22
Matched	0.003	0.52	1.000	2.6	1.1	12.2	1.18	11

* if B>25%, R outside [0.5; 2]

Stata code 5. Average Treated on Treated (see section: Propensity score matching: use and results).

Stratification

```
atts productivity treated shareholders mngt age educat specialisation innovation eco
exports fdi, pscore(myscore) blockid(myblock) comsup boot reps(10) dots
```

ATT estimation with the Stratification method

Analytical standard errors

n. treat.	n. contr.	ATT	Std. Err.	t
67	64	-3022.422	96200.483	-0.031

Bootstrapping of standard errors

```
command: atts productivity treated shareholders mngt age educat specialisation
innovation eco exports fdi, pscore(myscore) blockid(myblock) comsup
```

```
statistic: atts = r(atts)
```

.....

note: label truncated to 80 characters

```
Bootstrap statistics                                Number of obs    =      135
                                                    Replications    =       10
```

Variable	Reps	Observed	Bias	Std. Err.	[95% Conf. Interval]
atts	10	-3022.422	-2034.052	93099.19	-213627.4 207582.6 (N)
					-158019.6 124366.6 (P)
					-158019.6 124366.6 (BC)

Note: N = normal

P = percentile

BC = bias-corrected

ATT estimation with the Stratification method

Bootstrapped standard errors

n. treat.	n. contr.	ATT	Std. Err.	t

67	64	-3022.422	93099.186	-0.032
----	----	-----------	-----------	--------

Kernel

```
. attk productivity treated shareholders mngt age educat specialisation innovation eco
exports fdi, pscore(myscore) comsup boot reps(10) dots
The program is searching for matches of each treated unit.
This operation may take a while.
ATT estimation with the Kernel Matching method
```

n. treat.	n. contr.	ATT	Std. Err.	t
69	62	-8270.627	.	.

Note: Analytical standard errors cannot be computed. Use the bootstrap option to get bootstrapped standard errors.

Bootstrapping of standard errors

```
command:      attk productivity treated shareholders mngt age educat specialisation
innovation eco exports fdi , pscore(myscore) comsup bwidth(.06)
statistic:    attk      = r(attack)
.....
```

note: label truncated to 80 characters

Bootstrap statistics	Number of obs	=	135
	Replications	=	10

Variable	Reps	Observed	Bias	Std. Err.	[95% Conf. Interval]
attk	10	-8270.627	60716.64	85265.25	-201154 184612.8 (N)
					-60942.36 193269.1 (P)
					-60942.36 150143.6 (BC)

Note: N = normal
P = percentile
BC = bias-corrected

ATT estimation with the Kernel Matching method
Bootstrapped standard errors

n. treat.	n. contr.	ATT	Std. Err.	t
69	62	-8270.627	85265.249	-0.097

Radius

```
attr productivity treated shareholders mngt age educat specialisation innovation eco
exports fdi, pscore(myscore) comsup boot reps(10) dots radius(0.1)
```

The program is searching for matches of treated units within radius.
This operation may take a while.

ATT estimation with the Radius Matching method

Analytical standard errors

n. treat.	n. contr.	ATT	Std. Err.	t

69	62	-73.620	93559.713	-0.001

Note: the numbers of treated and controls refer to actual matches within radius

Bootstrapping of standard errors

```
command:      attr productivity treated shareholders mngt age educat specialisation
innovation eco exports fdi , pscore(myscore) comsup radius(.1)
statistic:    attr      = r(attr)
.....
```

note: label truncated to 80 characters

Bootstrap statistics	Number of obs	=	135
	Replications	=	10

Variable		Reps	Observed	Bias	Std. Err.	[95% Conf. Interval]
-----+-----						
attr		10	-73.61988	45880.96	98958.38	-223933 223785.8 (N)
						-120035.6 193626.8 (P)
						-120035.6 145560.1 (BC)

Note: N = normal
P = percentile
BC = bias-corrected

ATT estimation with the Radius Matching method

Bootstrapped standard errors

n. treat.	n. contr.	ATT	Std. Err.	t

69	62	-73.620	98958.379	-0.001

Note: the numbers of treated and controls refer to actual matches within radius