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How internationalization and competitiveness contribute to get public support to innovation? The Portuguese case

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How internationalization and competitiveness contribute to get public support to innovation? The Portuguese case [1] [2]

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Abstract

A wide range of empirical studies have analyzed which firm characteristics influence government evaluators on the decision to select specific firms for participating in Research and Development and Innovation subsidy programs. However, few authors have provided a precise analysis about the selection process of submitted applications for a public support.

The aim of the present paper is to assess the effectiveness in the selection process and to understand which kind of projects are selected for being subsidized. The analysis is focused on the case study of applications submitted to the Portuguese Innovation Incentive System (SI Innovation) between 2007 and 2013. Once the selection criterion for accessing to this program is essentially based on competitiveness, namely in terms of internationalization and productivity, special attention was given on assessing the determinants of selection process regarding to these topics. Using a counterfactual analysis and Propensity Score Matching estimators, results show that the selection process to SI Innovation is more focused on expecting an increase of the internationalization and productivity of firms than in the efficiency of public expenditures and firm innovativeness.

The conclusions of this paper could be useful for policy makers, once it identifies some failures in selection process, which according to other authors, could explain some disappointing results of public intervention in this field.

JEL Classification: O38, O31, F60

Keywords: Subsidy, Innovation, Internationalization, Competitiveness, Propensity Score Matching.

Note: This article is sole responsibility of the authors and do not necessarily reflect the positions of GEE or the Portuguese Ministry of Economy.

[1] The present paper appears as a continuation of the study carried out for the Portuguese Alentejo region, presented in the 24th APDR Workshop (Santos, Cincera, Neto and Serrano 2016a) and in the RSA Workshop (Santos, Cincera, Neto and Serrano 2016b) and published in the first edition of the Public Policy Portuguese Journal (Santos, Cincera, Neto and Serrano 2016c). This study intends to go further, by extending the analysis to all Portuguese regions and using a different methodological approach (Propensity Score Matching). Additionally, taking into account the aim of the paper we will focus essentially on internationalization and competitiveness criteria.

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1. Introduction

Globalization extends competition behind national boundaries. Firms' survival and growth in a global market depend on their ability to be competitive. One way to achieve competitiveness is through Research and Development and Innovation (RDI). For example, firms can be more competitive if they produce the same product than competitors to a lower cost or if they launch in the market an improved version of product competitor. Once innovation can lead to competitiveness, it can also be an instrument for improving firm competitive position in international market. So, it seems that the concepts of innovation, competitiveness and internationalization are linked together, however, one major obstacle for innovation is access to finance (Canepa and Stoneman 2008; Iammarino et al. 2009; Santos and Cincera 2017).

Public policies to support investment and RDI play a vital role when firms have difficulties in accessing to external finance (Erden and Holcombe 2005; Paunov 2012). However, some studies on public policy impact assessment have demonstrated that public support can have a negative effect on firm performance (e.g. Erden and Holcombe 2005; Aerts and Thorwarth 2008; Bernini and Pelligrini 2011) or even no effects on policy targets (Wallsten 2000; Silva 2011). According to Silva (2011) and Santos, Cincera, Neto and Serrano (2016a, 2016b) one explanation for these findings could linked to selection process to participate on public support programs.

The aim of the present paper is to assess the effectiveness in selection process and to understand which kind of projects are selected for being subsidized. The analysis is focused on the case study of applications submitted to the Portuguese Innovation Incentive System (SI Innovation) between 2007 and 2013. Once the selection criterion for accessing to this program is essentially based on competitiveness, namely in terms of internationalization and productivity, special attention was given on assessing the effectiveness of selection process regarding to these topics.

Methodology is based on counterfactual analysis using Propensity Score Matching (PSM) estimators with Abadie and Imbens (2016) standard error. The PSM is based on a two-steps approach, where the first step consists in estimating the probability to get an application approved to SI Innovation and the second on matching firms with approved and non-approved applications that are as similar as possible for assessing the differences between both groups.

Data used come from the Information System of the National Strategic Reference Framework (NSRF) 2007-2013 Incentive Scheme and from the Portuguese National Statistics Institute (INE).

The novelty introduced in the paper is to include in the analysis the investment project characteristics, namely the expected impact on firm international turnover and productivity. Indeed, in most of the studies done, authors only assess the probability of getting a subsidy taking into account firms' characteristics in the year before receiving the grant, and few authors provide a precise analysis of the selection process of applicants for public support.

The paper is structured in five sections. After the introduction, section 2 provides a description of background theory about the public support to innovation and firm's competitiveness and internationalization, as well as, about the determinants in participating in subsidy programs. Section 3 presents the framework, methodology and data used in the study. Section 4 describes the results obtained. Section 5 concludes and gives some policy recommendations.

2. Background theory

2.1 Public support to innovation and firm's competitiveness and internationalization

One main justification for public intervention in the economy is due to market failures. Under a free market, the production of knowledge is less than the socially desirable, because firms tend to underinvest in Research and Development (R&D) activities due to risk, uncertainty and profit maximization criteria (Arrow 1962). Public support[7] appears as an instrument to incentive and stimulate firms' expenditure on R&D and Innovation (RDI), for improving social well-being.

Although, the first objective of public support to RDI is to increase innovation, government expects also to achieve *a posteriori* a higher performance, growth or competitiveness. According to Schumpeterian theory (Schumpeter 1934), through entrepreneurship, innovation can lead to economic growth, because if innovation is successful it gives firms a competitive advantage over competitors in the markets. On the other hand, as competition pushes firms to innovate for staying or the entry in the market, innovation has a positive effect on consumers welfare by providing a higher diversity and quality of products/services and by offering them to a lower price (reduction of production cost) (Katz and Shapiro 1985; Commission 2007). The importance of innovation, to achieve a sustainable growth and to improve Europe's competitiveness, put it on the heart of Europe 2020 Strategy (EC 2014). Special attention is given to make an efficient use of money and to a well-targeted State aid.

One way to boost the impact of Innovation Policy on economic performance is on international context (Bannò, Morandi and Varum 2013). Actually, firms more active in international market are more likely to innovate (Pamukçu and Cincera 2001), due to higher competition pressure, and they show also a higher performance compared to those operating only on domestic market (Filippetti, Frenz and Ietto-Gillies 2011; Siedschlag and Zhang 2015). On the other hand, innovation is also a way of fostering internationalization, because it helps firm to open new markets (Braunerhjelm 1996; Meliá 2010; Boermans and Roelfsema 2016; Rodil, Vence and Sánchez 2016) or to increase their export intensity (Basile, 2001). Nevertheless, the ability to be active in international market, as the results of an innovation behavior, happens also because innovation lead to firms' competitiveness, in the sense that competitiveness is defined, according to Oxford Dictionary (Oxford 2010), as the ability to do as good as or better than other comparable firms.

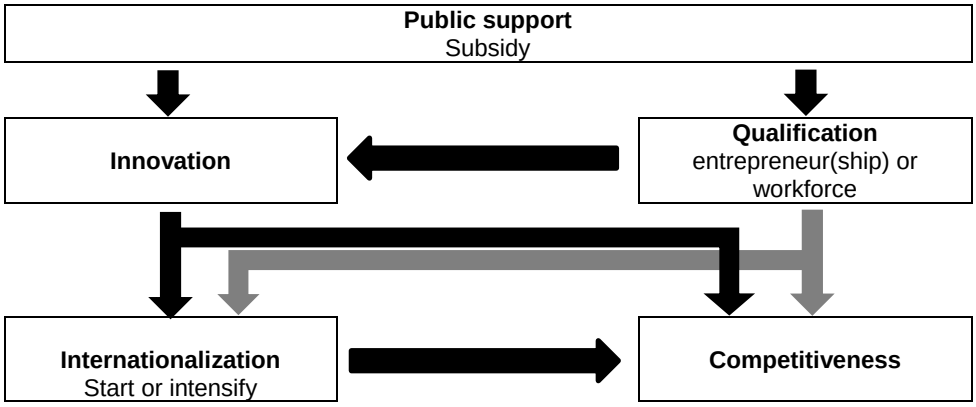
As innovation and internationalization are connected together in both direction, and they are both linked with competitiveness, governments tend to provide direct public support to innovation connecting it with internationalization targets. One example of this kind of measures is the Portuguese SI Innovation for 2007 – 2013[8], assessed in the present paper, which had mains goals the promotion of firm innovation, to boost their internationalization and to stimulate qualified entrepreneurship (Portugal 2007a; Portugal 2007b). As we can see in the Figure I, these three targets usually interact all together. To launch an innovate product or service in the market, firms need to invest but, due to market failures, they are faced to

[7] Public support to RDI can assume a direct or indirect way. Direct public support refers to direct public expenditure to RDI, such as subsidies, grants and R&D infrastructure, whereas indirect public support is linked to fiscal incentives, public procurement, technology transfer and legal framework (Conte, Schweizer, Dierx and Ilzkovitz 2009:13).

[8] Under the NSRF for the period 2007 – 2013, the SI Innovation was one of the three transversal incentive systems established with the NSRF, approved by the Council of Ministers Resolution n.° 86/2007 on the 3rd July. The others two system of incentive were the Incentive System for Technology Research and Development (SI IDT) and Incentive System for Qualification and internationalization of SMEs (SI Qualification). Nevertheless, the budget allocated to SI Innovation was almost the double that those foreseen jointly for the two others measures (Comissão de Acompanhamento do POFC 2015).

financial constraints. The SI Innovation provides financial support to firms through subsidized loans[9], which, together with firms qualified human resources (entrepreneur or workforce), helps innovation to be developed or implemented. For your turn, innovation gives to firm a competitive advantage supporting it for starting or intensify his international trade. At last firms, achieve competitiveness due to innovation, internationalization and/or qualified human resources.

Figure I. Interaction and mechanism behind SI Innovation



Source: Authors own elaboration based on Portugal (2007a; 2007b).

2.2 Determinants of participation in innovation and R&D subsidy programs

On Corporate Finance, the evaluation and choice of investment project to finance are essentially based on the Net Present Value, Internal Rate of Return and Pay Back Period[10]. Investors select the project(s) who generate(s) a higher return and with the lower risk. Usually, externalities and socio-economic impact of the project, for the welfare of the society, is not taking into account.

When investment projects are funded by government expenditures, the selection of applicants to financially support needs to take into account the maximization of potential outcomes, not only from an individual point of view but also for the society. This means that government expects not only to help some selected firms to increase, e.g. RDI expenditures, or to grow but also that the public support need to generate spillover effects at regional and/or national level. Bearing in mind this assumption, government reveal a certain preference for companies with a specific profile. According to scientific literature, government usually tends to have two main behaviors in the selection process. The first one is based on "picking the winner" principle, where it selects firms that are already best performers, e.g. with higher level of exportation, patent stock, qualified employees, R&D activities or productivity. The second one consists in financially support firm characterized with higher financial constraints, like for instance smaller firms, or firms located in poorest regions. According to Wallsten (2000: 84), to be effective public R&D programmes "should fund the best proposals among those that are not likely to receive adequate funds from other sources" and not only the best they receive, because this is on the first case where support is more useful.

[9] A subsidized loan is a repayable subsidy, as a loan, but without any interest and finance charges.

[10] Net Present Value (NPV) corresponds to the sum of present value of expected cash flows of the project (positive and negative) that occurs over the life of the project; Internal Rate of Return (IRR) is the rate of return earned by the project based on discounted cash flows; Pay Back Period is the required period of time for nominal cash flow from the project cover the initial amount of investment (Damodaran 2006: 199-211).

Studies in the field of RDI public policy impact assessment (see some examples in Appendix A) identifies as main characteristics for a firm to receive a subsidy: age, size (n.° of employees or sales), productivity, export intensity, previous experience in receiving subsidies, the qualification of human capital, patent stock, past R&D activities and financial health.

As regards to internationalization behavior most of the studies done about Belgium (Aerts and Thorwarth 2008), German (Czarnitzki and Lopes Bento 2014; Hud and Hussinger 2015), French (Sissoko 2011), Spanish (González and Pazó, 2008) and Finnish firms (Karhunen and Huovari 2015) showed that export intensity, measured by the export sales ratio, have a positive effect on the likelihood to receive a public support to RDI. One justification could be that firms more active in foreign markets may also be more innovative than others (Aerts and Thorwarth 2008; Czarnitzki and Lopes Bento 2014; Hud and Hussinger 2015 and are consequently more likely to achieve higher performance and more successful projects (Santos et al 2016:12). Nevertheless, in few cases, such as for Busom (2000) and Almus and Czarnitzki (2003), the experience in international trade also appears to be non-significant determinant in participating in RDI subsidy programs. Taking into account that these studies were done with data before 2000, this could reveal a new reorientation for policy targets after this period. Linked with internationalization, we have foreign ownership which has a positive effect on exporting activities (Aitken et al. 1997; Bernard and Jensen 2004; Alvarez and López 2005; Greenaway et al. 2007; Fakih and Fakih 2013). Indeed, firms that are part of a national or international enterprise group show a higher propensity to benefit from potential spillover effects as a result of network linkages (Czarnitzki and Lopes Bento 2014), which could also influence government evaluators to select this kind of firm (Hud and Hussinger 2015; Santos et al 2016:12).

Firm's productivity, which could be a measure for competitiveness, is an indicator less used in innovation policy impact assessment, as we can see in Table A1 (Appendix A). However, Sissoko (2011) showed that French firms with a higher productivity, measured by Total Factor Productivity[11] (TFP), have a higher probability to be subsidized by the Eureka Program, whereas, the growth of TFP have no effect on it. This could suggest that government preference goes to firms with a previous higher productivity, more than on increasing it, in order to increase the probability to have successful project in the end.

Firm size, measured by the number of employees or sales, could have a positive or negative impact on the probability to receive a public support. Usually, policy instruments are more oriented on providing financial support to Small and Medium-sized firms (SMEs) and to young or start-up companies (Czarnitzki and Lopes Bento 2014), because smaller firms have more difficulties in accessing to external financing (Cincera 2003; Aschhoff 2009; Lee, Sameen and Crowling 2015). Nevertheless, once large firms have a higher innovation capacity and consequently a greater potential to reach positive economic outcomes (Hud and Hussinger, 2015), it could be happening that government also reveal preferences for bigger one based "picking the winner" principle.

A more direct way to measure firm's financial health is using debt to sales ratio (Duguet 2004), cash flow per employee (Aerts and Thorwarth 2008) or credit rating[12] (Hud and Hussinger 2015). Duguet (2004) found for French firms that more financial constraints firms are more likely to receive a subsidy to RDI, as well as, Hud and Hussinger (2015) found that German firms with higher problems to attract external

[11] "Total factor productivity (TFP) is the portion of output not explained by the amount of inputs used in production. As such, its level is determined by how efficiently and intensely the inputs are utilized in production" Comin (2008: 6685).

[12] Credit rating refers to the evaluation of firm to meet its financial obligations. Higher is the score lower is the risk and higher the ability of firm to attract debt capital.

finance might be more likely to apply for subsidies. While Aerts and Thorwarth (2008) based on Belgium firms didn't found any effect on the probability to receive a public support to RDI.

Previous experience in innovation projects, measured by past R&D activities or in other funding programs, could have a positive impact on the probability of receiving a public support, because public authorities tend to follow the "pick the winner" principle, with the aim of minimizing the risk of failure (Czarnitzki and Fier 2002; Aerts and Thorwarth 2008; Aschhoff 2009; Czarnitzki and Lopes Bento 2014; Santos et al 2016:11). Two additional indicators of firm's innovation capacity, which are linked with a higher probability to get a public support, are patent stock and the presence of highly qualified personnel. Patent stock is the result of a successful past R&D activities (Aerts and Thorwarth 2008). On the other hand, the ability to develop and implement an R&D project is also strongly related to the skills of the firm's human capital (Blanes and Busom 2004; Santos el al 2016).

Concerning the selection criteria of SI Innovation, the program assessed in this study, it was based on the foreseen impact of the investment project on firms' performance and on regional/country competitiveness. The impact of project on firm's competitiveness was measured through the foreseen increase on productivity[13] and on international turnover, as well as, the foreseen firm's export intensity after project implementation. Once checking the eligibility of the applicants and the project[14], the government evaluator given a score between 0 and 5 for each criterion listed in Table I. Each criterion has a ponderation on the final score, defined on the call for proposal and usually different for micro/small-sized firms and medium/no-SMEs. In the end, all projects are ordered by descending score. The grant is awarded until the budget foreseen in the call for proposal to be totally used. This suggests that applicants to public support have a clear incentive to show in application form the higher justified impact of project, in order to increase the probability to be accepted for the subsidized loan.

Table I. Selection criteria to SI Innovation

A. Quality of the project
A.1. Coherence and relevance of the project
A.2. Innovativeness of the solution proposed
A.3. Level of cross-company cooperation
B. Impact of project on company's competitiveness
B.1. Economic productivity of the project
B.2. Increased representativeness in the international market
C. Contribution of the project to national competitiveness
C.1. Valorization of ICT-oriented project, namely business based on intensive use of technology or on the development of technology or process as a result of R&D activities
C.2. Valorization of international strategy and the diversification of target market
C.3. Creation of highly skilled jobs
D. Contribution of the project to regional competitiveness and territorial economic cohesion
D.1. Suitability of the project to regional strategy objectives and contribution to regional convergence
D.2. Contribution to sustainable creation of wealth and employment in the region

Source: Author's own elaboration based on call for application to SI Innovation (Rede Incentivos QREN 2009).
Note: Under the programme regulations, a highly qualified worker is someone with at least a post-secondary pre-tertiary level of education. ICT means Information and Communication Technologies.

[13] Productivity was measured by: i) gross added value per employee; ii) gross operating surplus by assets ratio; iii) gross value of production by intermediate consumption ratio.
[14] For more details see Portugal (2007a, 2007b, 2009, 2010 and 2012).

The main purpose of the paper is to assess the effectiveness in selection process to SI Innovation based mainly on two indicators used for evaluating the impact on firms' competitiveness: productivity and internationalization. Indeed, some authors (Silva 2011; Santos et al. 2016a, 2016b) point out that some disappointing results of public policy impact[15] could be linked with an ineffective and inefficient granting criterion. Nevertheless, a scientific analysis of determinants on participating on innovation subsidy, program based on foreseen project impact, remains a dimension little explored in research.

3. Methodology and data

The evaluation of public intervention impact, which in the present study coincides with the foreseen project impact, corresponds essentially in assessing the differences between two groups, the treatment group (e.g. subsidized firms) and the control (or non-treated) group. This conceptual framework is called counterfactual analysis, involving a comparison between the outcome of a participant firm (Y_{1i}), which received public support ($D_i = 1$), with the outcome (Y_{oi}) in a situation in which it did not receive a subsidy ($D_i = 0$). Equation (1) refers to the treatment effect for an individual *i*, where D_i is the treatment indicator, equal to 1 if individual *i* receives treatment and 0 otherwise.

$$Y_i = Y_{1i}D_i + Y_{0i}(1 - D_i) = \begin{cases} Y_{1i} \; if \; D_i = 1 \\ Y_{0i} \; if \; D_i = 0 \end{cases} \quad (1)$$

However, the counterfactual situation (Y_{0i}) is not observed, therefore estimating the individual treatment effect Y_i is not possible. Alternatively, we need to use average treatment effects and the most frequently used in the literature is the Average Treatment Effect on the Treated (ATET) (Caliendo and Kopeinig 2008: 34). These effects can be expressed as follows:

$$ATET = E(Y_{1i} - Y_{0i}|D_i = 1) = E(Y_{1i}|D_i = 1) - E(Y_{0i}|D_i = 1) \quad (2)$$

One issue in counterfactual analysis is that assignment of individuals to the treatment and control groups is not random, and so the treatment effect could be biased by the existence of confounding (or covariate) factors (Becker and Ichino 2002: 358). Indeed, public funding is an endogenous variable, because several factors affect the probability of receiving it (Busom 2000: 114). Rosenbaum and Rubin (1983) showed that the use of a propensity score can remove the bias due to all observed covariates. These authors define propensity score (PS) as the conditional probability of receiving treatment, given pre-treatment characteristics. The PS can be described by equation (3), where D = $\{0,1\}$ is the treatment indicator and *X* is the multidimensional vector of pre-treatment characteristics. By giving a score to all individuals in a sample, matching is done between treated and control subjects that are as similar as possible. Making both groups similar in the pre-treatment situation, bias is reduced and the comparison of outcomes is feasible.

[15] For example: i) crowding out effect of private R&D expenditure – when all or part of public expenditures replaces the firm's own investment (see e.g. Busom 2000; Erden and Holcombe 2005; Aerts and Thorwarth 2008; Cavallo and Daude 2011); ii) deadweight effect - firms would have carried out their strategic investment project even in the absence of subsidies (see e.g. Bronzini and de Blasio 2006; Skuras, Tzekouras, Dimara and Tzelepis 2006; Tokila, Haapanen and Ritsilä 2008); iii) subsidized firms' inefficiency – in post-intervention period, subsidized firms show a lower increase of economic performance than non-subsidized firms (see e.g. Bergström 2000; Bernini and Pelligrini 2011; Jorge and Suárez 2011); iv) ineffectiveness of public support in achieve its targets, e.g. no effects on internationalization (Silva 2011), no effects on employment (Wallsten 2000; Sissoko 2011) or in alleviating financing constraints (Sissoko 2011; Silva and Carreira 2012).

$$p(X) \equiv Pr\{D = 1|X\} = E\{D|X\} \quad (3)$$

The estimation of PS (3) is carried out with a probability function based on a Logit or Probit model, when only two alternatives are available: to participate or not in a programme. In model estimation, the choice of covariates to include also matters because this must be done according to some restrictions, namely Conditional Independence Assumption (CMI) and Common Support condition. CMI is based on the hypothesis that the mean of y_0 (effect on untreated) given x (list of co-variants) does not depend on variation of treatment, which implies that this mean is the same for any value of D (Cerulli 2015: 70). CMI is not a directly testable criterion, depending on the selection process for being treated (Khandker, Koolwal and Samad 2010: 56), so to ensure this assumption, Caliendo and Kopeinig (2008: 38) suggested that co-variates should either be fixed over time or measured before participation. Common support condition consists in insuring that treatment observations have a comparison group in the propensity score distribution (Khandker et al. 2010). Linked to this we have also the overlap assumption which assumes that $0 < p(X) < 1$, but never equal to the extreme value: $p(X) \neq 0$ or $p(X) \neq 1$ (Cerulli 2015). One way to check the overlap and common support assumption is by visual analysis of the propensity score density distribution of both groups.

To sum up, the propensity score matching (PSM) assumes to be a two-steps approach, when the first step consists in estimating the propensity score and second to estimate the ATET by matching treated individuals with non-treated ones with similar characteristics of the first group. On the last years, several tools [16] for estimating the PSM in Stata Software was developed, however, the STATA command `teffects psmatch`, based on Abadie and Imbens (2016) suggestions, reveals to provide the most consistent estimations of coefficient standard error. Under the command `psmatch2`, based on Leuven and Sianesi (2003) work, once the estimation of standard errors doesn't take into account that the propensity score is estimated, standard errors can be too large or too small (Abadie and Imbens 2016), leading to reject or to accept a significant effect based on inconsistent standard error.

For the present study, we used the PSM estimators with Abadie and Imbens (2016) standard error for quantifying differences on project characteristics, regarding competitiveness criterion, between approved (treatment group) and non-approved applications (control group), submitted by firms with similar characteristics. Firms' competitiveness is measured by the foreseen internationalization performance – Δ international turnover, Δ export intensity (%) and becoming exporter – and productivity performance – Δ labor productivity, TFP in post-intervention period and Δ TFP. The TFP is estimated using a translog Cobb and Douglas (1928) production function, where dependent variable corresponds to firm added value and independent variables to the number of employees (L) and fixed assets (K). Additionally, foreseen impact on innovation performance – Δ R&D expenditures, Δ patent stock and becoming a patented firm[17] – and efficiency ratio of public expenditures will be also analyzed. The efficiency output-input ratio assesses the link between an input (investment) and the foreseen output (Δ international turnover, Δ labor productivity or Δ TFP), being equivalent to a rate of return of investment. Higher is the ratio, higher is the profitability of investment regarding a target output, and more efficiently is used the money.

[16] Such as the commands `teffects psmatch`, `pscore` and `psmatch2`.

[17] Becoming a patented firm refers to a situation where firm has no patent stock before application submission and foreseen at least to proceed to one patent application as the result of the investment project.

The selection of covariates explaining the probability to get an application approved to SI Innovation takes into account simultaneously those cited in the literature in section 2.2. and the respects of CMI assumptions (variables refer to pre-intervention period). The Table II displays the list and description of co-variate included in the propensity score. Dummy variables for year before of application submission, activity sector and regional location of the project were also included in the PS model for capturing regional, sector and time heterogeneity. Additional information about the area's characteristics, such as region NUTS 3 level competitiveness (exportation to gross added value), was also considered in the propensity score, because according to Khandker et al. (2010: 77), "time-varying unobserved heterogeneity could be accounted for with the proper program design [and] controlling for the area characteristics that initially attracted the development projects can correct (…) bias".

Table II. Co-variates description

Variable name	Variable description
Firm size	Number of employees in the firms in the year before the application submission.
Micro or small	Dummy variable for micro or small firms, based on the Commission Recommendation 2003/361**.** Medium or non-SMEs is the omitted reference category.
Firm age	Firm age in the year of application submission.
N° of partner	N° of business partner on firm capital.
Foreign capital	*Has the company any equity participation from non-Portuguese individual(s) or firm(s)?* Dummy variable, where Yes = 1 and No = 0.
Experience on SI	*Has the company submitted an application to the SI Innovation before this one?* Dummy variable, where Yes = 1 and No = 0.
Export intensity	Ratio between international turnover and total turnover in the year before application submission.
Share skilled job	Ratio between the number of highly qualified worker (with at least a post-secondary pre-tertiary level of education) and the total number of employee in the year before application submission.
R&D	*Has the company incurred an R&D expenditure in the year before the application submission?* Dummy variable, where Yes = 1 and No = 0.
Patented	*Has the company already a patent registered at national or European level in the year before the application submission?* Dummy variable, where Yes = 1 and No = 0.
Productivity	Labor productivity (gross added value per employee) in the year before application submission. Values expressed in thousand euro and constant price (base = 2006).
Regional export intensity	Ratio between exportation and gross added value at NUTS 3 level in the year of application submission.
Time fixed effect	Year before application submission. Dummy variable.
Sector fixed effect	Activity sector of the investment project. 20 dummy variables were created, for a list of them see Appendix B.
Region fixed effect	Region NUTS 2 level where the project will be implemented: North, Center, Lisbon, Alentejo or Algarve. Dummy variable.

Source: Authors own elaboration.

As robustness test, Covariant matching with Abadie and Imbens (2016) standard error is used. This technique, also called nearest-neighbor matching, implies that similarity between individuals is based on a weighted function of the covariates for each observation, whereas, with PSM procedures a propensity score is used.

The dataset used on the present study was built with cross-information extracted from the Information System of the NSRF (2007-2013) Incentive Scheme and the Portuguese National Statistics Institute. The first data source provided information about firm and application characteristics. The second source provided information about regional macroeconomic conditions.

4. Results and discussion

4.1 Sample description

After selecting only firms with information for all the dimensions under analysis, the sample has 5,336 observations[18], which corresponds to the number of applications submitted to SI Innovation between 2007 and 2013.

Appendix B reports the descriptive statistics of the sample. The average approval rate is 50%. Application submitted by SMEs represents 89% (micro – 40.4%, small – 29.3% and medium – 19.1%) of the total. Near to 27% was submitted by new firms, created up to one year before application submission and with no economic activity, measured by a turnover equal to zero.

Close to 23% of the application was submitted by firms who have submitted previously another application to the same program.

Applicants to SI Innovation have on average three business partners on firm capital and for 10% of them a part firm capital come from a foreigner owner. Export intensity in pre-intervention period is around 21% and the share of qualified employees about 19%.

Only 5% of firms have at least one patent registered at national or European level and 18% have incurred R&D activities in the year before application submission. Labor productivity (gross added value per employee) is around 18.620€ and 6% of applicants registered a negative value. Taking into account that gross added value is estimated by the difference between firm's income and cost with intermediate consumption, this last situation is justified by the fact that some firm have a higher amount of cost compared to firm income and this especially possible for new firms recently created, with no sales but incurring costs of starting operating.

Concerning the geographical distribution of the sample, 46% is located in North region, 35% in Center, 11% in Alentejo, 4% in Lisbon and 4% Algarve. This distribution is proportional to the size of budget available for each region on the call for proposal.

Among the 20 activity sectors considered, tourism activities (22%), chemical manufacturing industry (12%) and metallurgical manufacturing industry (11%) are the most representative, accounting for 47% of the total applications.

As regards to differences between approved and non-approved applications characteristics, based on t-tests for the equality of means, we can see that both groups are different in almost all the co-variates. Firms with approved applications are bigger, older, with a higher number of business partner and foreign capital. On the hand, except for the share of qualified employee, they show a higher performance, measured by the export intensity, labor productivity and innovativeness (patent stock and R&D activity). Approved applications are also located in region NUTS 3 level with a higher export intensity, compared with non-approved ones.

[18] Original sample has 5,880 observations, however, for some applications relevant information is missing. We excluded also all multi-region projects (destined to be implemented in more than one region NUTS 2 level), due to their small representativeness (34 applications) and the difficulty to matches these observations.

4.2 Determinants of selection process to SI Innovation

4.2.1 Probability to get an approved application

Table III presents the coefficients and marginal effects of Logit estimation[19], as regards to the probability to get an approved application to SI Innovation. The results of Walt test, for joint significance and for omitted variables, as well as, the Hosmer-Lemeshow test and specification link test illustrate that the model is correctly specified, the functional form is correct and no evidence of omitted variable was found. No problem of heteroscedasticity and multicollinearity was detected, based on the White Test (Table III), the results of variance inflation factors (VIF) for the independent variables and correlation matrix (Appendix C).

Table III. Results of logistic regression: Probability to get an approved application to SI Innovation

Variables	Coeff.		Std. Err.	dy/dx	
Firm size (n° employees)	0.001	**	0.000	0.000	**
Firm age	-0.006	**	0.002	-0.001	**
Micro or small firms (D)	-0.485	***	0.080	-0.106	***
Experience in SI Innovation (D)	0.230	***	0.074	0.050	***
Having foreign capital (D)	0.182	*	0.108	0.040	*
N° of business partner on firm capital	0.020		0.013	0.004	
Export intensity (%)	1.789	***	0.397	0.392	***
Export intensity (%) – Squared	-1.590	***	0.432	-0.349	***
Share skilled employees (%)	-0.201	*	0.104	-0.044	*
Having a patent stock (D)	-0.111		0.146	-0.024	
Having incurred R&D expenditures (D)	0.368	***	0.094	0.081	***
Labor productivity	-0.002	**	0.001	0.000	**
Regional export intensity NUTS3 level	0.266		0.190	0.058	
Year fixed effect	YES				
Region NUTS2 level fixed effect	YES				
Sector fixed effect	YES				
Constant	-1.523	***	0.563		
Observations	5,339				
Log pseudolikelihood	-3,352.72				
Pseudo R2	0.094				
MODEL VALIDATION TEST					
Walt test - *H0: All coefficients = 0*	695.9 (0.000)				
Walt test - *H0: Model has no omitted variables*	1.56 (0.212)				
Goodness-of-fit test - *H0: Model fit well data*	6.81 (0.557)				
Specification link test - *H0: Model is correctly specified*	-1.41 (0.160)				
White's test - *H0: homoscedasticity*	1.31 (0.270)				

Source: Author's own elaboration.
Legend: *** coefficient significant at 1%, ** coefficient significant at 5% and * coefficient significant at 10%.
P-value of validation test are reported in parentheses.

[19] Probit regression model was also performed (results available under request), but compared to Logit regression model it shows less better results in term of Log likelihood and Pseudo R2.

The interpretation of logit regression results reveals that firm size, measured by the n.° of employees, shows a positive and significant effect on the probability to get an approved application, and firm age reports a negative one. These conclusions could suggest that bigger and younger firms have a higher likelihood to receive the subsidy, however, in both cases, their marginal effect are close to zero which indicates that, although significant, their effects are practically null. Nevertheless, to be a micro or small-sized firm decrease 10.6% the probability to get a subsidized loan. This brings out some ineffectiveness in selection process because firms who have more difficulties to have access to external financing are those who are less likely to be public supported.

Previous experience in the SI Innovation increases by 5% the probability of having an application approved. The positive relationship between experience in subsidies and being a funded firm, was demonstrated by other authors, such as Aerts and Thorwarth (2008), Aschhoff (2009) and Hud and Hussinger (2015), based on the "pick the winner" principle. Nevertheless, in the present study this conclusion is not necessarily good news, as Santos et al (2016c) as highlighted. Indeed, these authors explained that this finding could reveals that: i) public incentive goes more to the same companies; iii) firms could receive more than one subsidized loan under the SI Innovation and; iii) firms more familiar with the application process could easier have access to public support because they know in which factors to put emphasis in the application form.

Having a foreign participation on firm's capital have a positive effect the probability to participated on SI Innovation, findings in line with the González and Pazó (2008), but the opposite results of Bussom (2000), Almus and Czarnitzki (2003), Czarnitzki and Lopes Bento (2014) and Karhunen and Huovari (2015). On the present study, this conclusion could be linked to a strategic decision of government for attracting Foreign Direct Investment (FDI) on the country, and also as mentioned Czarnitzki and Lopes Bento (2014) because firms with foreign capital are more likely to benefit from potential spillover effects as a result of network linkages.

Concerning firm export intensity, we found an inverted U-shaped relationship when most of others authors (Aerts and Thorwarth 2008; Sissoko 2011; Czarnitzki and Lopes Bento; Hud and Hussinger 2015; Karhunen and Huovari 2015) display a positive one. This suggests that experience in foreign trade has a positive effect on the probability to have an application approved but only until a threshold. If we consider that for some firms (12%) the share of export sales is higher than 75% and for a small group of them (2%) the intensity of international turnover is close to 100%, the behavior detected in the model suggests that for firms who are already close to their maximum level of internationalization the project has a lower or even no effect on export intensity. Once the target of the program is to boost the international position of firms through innovation, this finding reveals an effective selection process concerning internationalization criteria.

Labor productivity and the share of qualified employees have both a negative impact on the likelihood function, despite the first variable displays a marginal effect close to zero. These conclusions, are the opposite to the findings of Sissoko (2011) and Karhunen and Huovari (2015) but, in the present study, they could be synonyms of an effective selection process, once public support goes to less performer enterprises, which has more difficulties in accessing to external source of financing.

The innovative capacity of firms, which is assessed by to have incurred an R&D expenditure and to have at least one patented registered in the year before application submission exhibit different behaviors. To have a patent stock have non-significant effect and having incurred R&D expenditures a positive

significant effect on the probability to have an application approved, which is in line with the targets of the program: to support innovative firms in last phases of innovation process, when innovation becomes patented. Government preferences goes, in this case, to firms who have developed R&D activities and need financial support to put the product in the market, and in this light firms with patent stock are less in need.

As regards to the number of business partner on firms' capital and the regional export intensity at NUTS 3 level, both variables are non-significant explaining the model.

Once estimated the propensity score model – first step – and assessing that the coefficients have a coherent signs and interpretation, the matching – second step – can be done.

4.2.2 Internationalization, production and innovation performance in selection process

Table IV presents the so-called Average Treatment Effect on the Treated (ATET), which corresponds to differences between the foreseen impact of approved application compared to their counterpart with similar characteristics. The balancing quality of results was tested by visual analysis of kernel density plots of treated and control group (Appendix D), showing the bias correction before and after matching. The covariates are balanced once their distributions don't vary between groups after matching. As robustness test for matching quality, we also used the balancing test proposed by Becker and Ichino (2002) and result (available under request) show that the balancing hypothesis is satisfied. Concerning CMI and Overlap assumption, figure in Appendix D shows clear evidence that both conditions are also satisfied.

Table IV. ATET: Foreseen impact of investment project to SI Innovation

Foreseen outcomes	PS Matching				C Matching			
	Coef.	AI Robust Std. Err.	Z	P>|z|	Coef.	AI Robust Std. Err.	Z	P>|z|
Internationalization performance								
Δ international turnover	4 118.87	450.07	9.15	0.000	3 368.68	709.75	4.75	0.000
Δ export intensity	0.037	0.01	3.58	0.000	0.022	0.01	2.75	0.006
Becoming exporter	0.016	0.02	1.08	0.282	-0.032	0.01	-2.30	0.022
Productivity performance								
Δ labor productivity	7.24	4.09	1.77	0.077	7.08	4.45	1.59	0.112
TFP	0.126	0.03	3.89	0.000	0.389	0.03	12.59	0.000
Δ TFP	0.486	0.10	4.73	0.000	0.574	0.08	7.19	0.000
Efficiency (output/input) ratio								
CAPEX application	1 670.50	441.64	3.78	0.000	1 946.16	437.80	4.45	0.000
Δ intern. turnover / CAPEX	1.736	0.55	3.16	0.002	0.893	0.45	1.99	0.047
Δ labor productivity / CAPEX	-0.007	0.01	-0.93	0.353	-0.007	0.01	-0.87	0.386
Δ TFP / CAPEX	-0.001	0.00	-2.54	0.011	-0.002	0.00	-4.35	0.000
Innovation performance								
Δ R&D expenditures	-8.18	25.28	-0.32	0.746	1.15	11.00	0.10	0.917
Δ Patent stock	0.135	0.18	0.74	0.458	0.078	0.15	0.52	0.601
Becoming patented	0.010	0.01	0.80	0.422	0.020	0.01	1.99	0.046

Source: Author's own elaboration.
Note: Results correspond to the Average Treatment Effect on Treated (ATET) using 1-to-1 matches per observation in both cases, PS Matching and C Matching. Abadie and Imbens (2016) robust standard error reported. CAPEX (capital expenditure) corresponds to the amount of total investment foreseen in application form. N.° observations: total 5,366; treated 2,680 and non-treated 2,659.

Approved applications show to foreseen a higher increase of international turnover and higher increase of export intensity, however, it seems that becoming an exporter firms is not a priority of SI Innovation. Not significant differences exist between both groups using PSM and negative one is revealed using C-Matching. This could suggest that priority is given to those firms who are already exporter and foreseen increase their international position.

Concerning the foreseen project impact on productivity, approved applications record a higher TFP in post-intervention period and a higher increase of both productivity measures (labor productivity and TFP), using both PSM and C-Matching.

The amount of investment foreseen in application form (CAPEX) is higher for approved applications than for their counterpart. If we take into account that, first, the amount of investment represents the sum of public incentive (percentage of the eligible investment) and private expenditure (equal to the remainder) and, second, the aim of the program is to stimulate innovative investment, it is expected that government will tend to approve applications with a higher amount of expenditure because this implies a greater private effort (Santos et al 2016:19). Additionally, Santos et al. (2015) also found that the amount of funded investment has a positive impact on the likelihood of firm survival. According to these authors, higher investments tend to be better planned because they need a higher additional cash-flow to be economically viable. These findings, could justify why governments prefer to fund projects with a higher amount of investment. Indeed, a higher likelihood for private financial effort and a lower failure rate are synonym of public policy effectiveness (maximization of the outcome).

The efficiency ratios, which measure the return of investment in term of additional international turnover or productivity level, reveal a partial efficient use of financial resources. Indeed, despite a higher investment return as regards to international turnover for approved applications, some evidence of inefficiency was found concerning productivity. Approved applications show a lower productivity efficiency ratio (Δ TFP/CAPEX) than their counterpart.

The impact on firm innovation performance – measured by foreseen increase in R&D expenditures, variation of patent stock and to become a patented firm – seems to be inexistent or very small. Almost no differences exist between treated and control group for these indicators, which means that approved applications don't foreseen a higher impact on R&D expenditures and patent stock, using both PSM and C-Matching. Although, concerning the likelihood to become a patented firm, only using C-Matching a higher foreseen performance for firms with approved applications was found. These results are surprising, once the target of SI Innovation is to support innovation in the last phase of the process, when R&D become patentable, one expected at least to find a positive effect on patent stock and a more robust evidence to becoming patented.

4.3 Assessing regional differences

As regards to differences between Portuguese regions, Appendix E displays the ATET for the foreseen project impact on the three most representative regions in terms of SI Innovation application: Norte, Centro and Alentejo. The kernel density plots of treated and control group (Appendix D), that covariates are balanced.

The Centro region NUTS 2 level is those who reveal more significant differences between groups and similar conclusion to those found for the all sample, in terms of international and productivity performance, as well as, for efficiency ratio. Nevertheless, concerning innovative performance, approved applications

show a higher increase than non-approved. A similar conclusion as regards to innovation performance was found for Alentejo region, but any significant differences seem to exist between approved and non-approved application in the Norte region for this indicator.

All regions report the same inefficiency, found previously about lower productivity efficiency ratio (Δ TFP/CAPEX) of approved applications compared to their counterpart. Foreseen productivity performance of approved application is also higher in all regions, except for labor productivity indicator.

Norte and Centro region approved application foreseen a significant lower propensity to become exporter, whereas, for Alentejo application no differences seem to exist between groups. Regarding differences between the increase of international turnover and export intensity, in all regions approved applications show a better performance than non-approved ones.

5. Conclusion and policy recommendations

The present paper provides an assessment about the determinants of participating on one of the main Portuguese program destined to financially support innovative investment projects, which are expected to increase firm, region or country competitiveness.

Using a two-step methodology – Propensity Score Matching – the study describes for one hand which firm characteristics influence the decision to approve a submitted application to SI Innovation and secondly it shows which kind of project are selected to be funded.

The share of international turnover in the year before application submission reveals to have a positive effect on the likelihood to get a selected application, however, after a threshold the impact of export intensity reveals to have a negative effect on the selection process. On the other hand, funded projects show a higher foreseen increase on international turnover and on export intensity. However, it seems that approved application to SI Innovation don't forecast to help firm to become an exporter. These results suggest government preference for firms with experience on international market but not close to the frontier (100% of export share), because it's on these cases, where the subsidy has the higher impact with a lower risk, compared to a situation in which firms have no experience in internationalization and want to start exportation.

As regards to the impact of productivity, some evidence exists that selected firms to be funded by SI Innovation are those who recorded in pre-intervention period a lower performance. Additionally, as with internationalization criteria, funded projects are those who report a higher increase on productivity. In this case, public support goes to more need firms (less performer) and are given to projects with a higher expected impact, which reveal an effective selection process.

Nevertheless, the present study also displays some failures in selection process. Surprisingly, for a program that aims to promote innovation, for all sample selected applications seem not to show a higher increase on foreseen innovation performance, at least measured by patent stock. Also, the efficiency output-input ratio, concerning the return of productivity for each euros of investment, reveals that funded projects report a lower ratio which is synonym of inefficiency. Furthermore, results of logistic regression reveal that micro and small-sized firms, which are more financially constraints, are less likely to receive the subsidy.

All these findings, suggest that at least two types of trade-off are done. The first one happens between effectiveness of policy target (increasing productivity) and efficiency of capital expenditure (profitability of investment). The second is linked with the preference to increase internationalization and productivity

instead of innovation performance. Nevertheless, in both cases this behaviour could put in question the final target of SI Innovation: leverage competitiveness, because it's also associated with an efficient use of money and possible with a higher level of innovation.

Policy recommendations go to suggest to include efficiency output-input ratio in selection criterion and to give more priority to micro and small-sized firms.

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Appendix

Appendix A. Benchmark review of literature

Table A1. Benchmark studies focused on the probability of receiving a public subsidy

Country, year, policy orientation and methodology	Impact of explanatory variables
Bussom (2000)	
▪ Spain ▪ 1988 ▪ Innovation Policy ▪ Probit model	▪ Significant variables: (-) n.° employees; (+) age; (+) n.° of patents; (-) firms publicly owned; (-) firms participated by foreign capital. ▪ Non-significant variables: export intensity; firms' strategic decision to fix price; firms strategic decision to R&D as the results of competition; price regulation on market.
Almus and Czarnitzki (2003)	
▪ Germany ▪ 1995 – 1999 ▪ Innovation Policy ▪ Probit model	▪ Significant variables: (+) n.° employees; (-) parent company located abroad; (-) seller's concentration; (+) existence of R&D department. ▪ Non-significant variables: capital intensity, age, export ratio, import ratio, market share and legal form
Duguet (2004)	
▪ France ▪ 1985 – 1997 ▪ Innovation Policy ▪ Logit model	▪ Significant variables: (+) size, measured by sales; (+) private R&D to sales ratio; (+) debt to sales ratio; (+) existence and importance (subsidy rate) of past public support. ▪ Non-significant variables: depending on the year of application, some activity sector.
Aerts and Thorwarth (2008)	
▪ Belgium (Flanders) ▪ 2004 - 2006 ▪ Innovation Policy ▪ Probit model	▪ Significant variables: (+) amount of subsidy received in the past; (+) number of project proposals submitted in the past; (+) export quota. ▪ Not significant variables: n° of employees; firms' patent stock by employees; fixed assets by employees; cash-flow by employees; belonging to a group; domestic or foreign ownership.
González and Pazó (2008)	
▪ Spain ▪ 1990 – 1999 ▪ Innovation Policy ▪ Probit model	▪ Significant variables: (+) firm has received a subsidy in the previous period; (+) n° of employees; (+) capital growth (in equipment and machinery goods); (+) age; (+) technological sophistication in production; (+) foreign capital; (+) domestic export; (+) Navarre and Basque County. ▪ Not significant variables: firm with market power.
Sissoko (2011)	
▪ France ▪ 1997 - 2006 ▪ Innovation Policy ▪ Logit model	▪ Significant variables: (+) Age; (+) N.° of employees; (+) Productivity (TFP); (+) Export intensity; (+) Growth rate of capital investment. ▪ Non-significant variables: loans to sales ratio; growth of TFP.
Czarnitzki and Lopes Bento (2014)	
▪ Germany ▪ 1995 - 2006 ▪ Innovation Policy ▪ Seemingly unrelated Probit model	▪ Significant variables: (-/+) U-shaped relationship with firm size (n° of employees); (+) fixed assets by employee; (+) patent stock by employee; (-) availability of internal funds; (+) firm with an internal R&D lab; (-) firm headquarters in foreign territory; (+) age; (+) export intensity; (+) firm located in eastern region. ▪ Non-significant variables: firm is part of group.
Hud and Hussinger (2015)	
▪ Germany ▪ 2006 – 2010 ▪ Innovation Policy ▪ Probit Model	▪ Significant variables: (+) firms has received a subsidy in the past; (+) patent stock by employees; (+) n° of employees; (+) export sales; (-) firm is part of an enterprise group; (-) age; (+) firm located in eastern region; (-) credit rating; (-) activity sector (mining; manufacturing; energy, water and recycling; wholesale; transportation and consulting). ▪ Non-significant variables: firm group with foreign headquarters; industry-specific sales growth rate; ICT.
Karhunen and Huovari (2015)	
▪ Finland ▪ 2000 - 2012 ▪ Innovation Policy ▪ Probit model	▪ Significant variables: (+) Turnover; (+) N.° of employees; (+) Labor productivity growth (= value added per employee); (+) Exportation experience; (-) Foreign capital ownership; (+) Share of skilled workers; (+) Subsidy history ▪ Non-significant variables: age; firm's employment growth; firm belongs to a larger firm group; applying for patent; region.

Source: Authors' own elaboration based on Bussom (2000), Almus and Czarnitzki (2003), Duguet (2004), Aerts and Thorwarth (2008), González and Pazó (2008), Sissoko (2011), Czarnitzki and Lopes Bento (2014), Hud and Hussinger (2015), Karhunen and Huovari (2015).

Appendix B. Descriptive statistics

Table B1. Mean-comparison tests: approved *versus* non-approved applications

	Approved		Non-Approved		Difference of mean		All sample	
Variables	Mean	St. Er.	Mean	St. Er.			Mean	St. Er.
Approved application	-	-	-	-	-		0.502	0.500
N° employees	68.75	3.88	29.74	2.02	39.01	***	49.32	2.21
Firm age	14.07	0.32	11.06	0.29	3.003	***	12.57	0.22
Size: Micro	0.323	0.009	0.486	0.010	-0.163	***	0.404	0.007
Size: Small	0.287	0.009	0.300	0.009	-0.013		0.293	0.006
Size: Micro or small	0.609	0.009	0.785	0.008	-0.176	***	0.697	0.006
Size: Medium	0.228	0.008	0.153	0.007	0.075	***	0.191	0.005
Size: No-SME	0.163	0.007	0.061	0.005	0.101	***	0.112	0.004
Experience in SI Innovation	0.272	0.009	0.191	0.008	0.081	***	0.231	0.006
Having foreign capital	0.120	0.006	0.072	0.005	0.048	***	0.096	0.004
Business partner	3.053	0.054	2.755	0.041	0.298	***	2.904	0.034
Export intensity	0.259	0.007	0.153	0.006	0.106	***	0.206	0.004
Share skilled employees	0.176	0.005	0.199	0.006	-0.023	***	0.188	0.004
Patent stock	0.057	0.004	0.039	0.004	0.018	***	0.048	0.003
R&D expenditures	0.240	0.008	0.116	0.006	0.124	***	0.178	0.005
Labor productivity	19.818	0.624	17.405	0.902	2.412	***	18.616	0.548
Regional export intensity NUTS 3 level	0.321	0.004	0.293	0.003	0.028	***	0.307	0.003
Region: North	0.443	0.010	0.469	0.010	-0.026	*	0.456	0.007
Region: Center	0.376	0.009	0.325	0.009	0.052	***	0.351	0.007
Region: Lisbon	0.028	0.003	0.059	0.005	-0.031	***	0.044	0.003
Region: Alentejo	0.113	0.006	0.102	0.006	0.012		0.108	0.004
Region: Algarve	0.039	0.004	0.045	0.004	-0.006		0.042	0.003
Year: 2006	0.004	0.001	0.004	0.001	0.000		0.004	0.001
Year: 2007	0.185	0.008	0.211	0.008	-0.026	**	0.198	0.005
Year: 2008	0.163	0.007	0.103	0.006	0.060	***	0.133	0.005
Year: 2009	0.169	0.007	0.223	0.008	-0.053	***	0.196	0.005
Year: 2010	0.193	0.008	0.239	0.008	-0.046	***	0.216	0.006
Year: 2011	0.110	0.006	0.059	0.005	0.050	***	0.085	0.004
Year: 2012	0.175	0.007	0.161	0.007	0.015	***	0.168	0.005
Sector: Agriculture and mining industry	0.013	0.002	0.015	0.002	-0.002		0.014	0.002
Sector: Food and beverage manufacturing	0.038	0.004	0.053	0.004	-0.016	*	0.046	0.003
Sector: Fashion manufacturing industry	0.069	0.005	0.058	0.005	0.011	*	0.064	0.003
Sector: Wood manufacturing industry	0.060	0.005	0.038	0.004	0.022	***	0.049	0.003
Sector: Editing manufacturing industry	0.014	0.002	0.021	0.003	-0.007	*	0.017	0.002
Sector: Chemical manufacturing industry	0.151	0.007	0.098	0.006	0.053	***	0.125	0.005
Sector: Metallurgical manufacturing industry	0.168	0.007	0.090	0.006	0.077	***	0.129	0.005
Sector: Electronic manufacturing industry	0.079	0.005	0.040	0.004	0.040	***	0.060	0.003
Sector: Home furniture manufacturing industry	0.032	0.003	0.030	0.003	0.002		0.031	0.002
Sector: Other manufacturing industry	0.015	0.002	0.014	0.002	0.002		0.014	0.002
Sector: Electricity	0.001	0.001	0.006	0.001	-0.004	**	0.004	0.001
Sector: Waste industry	0.027	0.003	0.033	0.003	-0.006		0.030	0.002
Sector: Construction	0.001	0.001	0.009	0.002	-0.008	***	0.005	0.001
Sector: Trade	0.043	0.004	0.044	0.004	-0.001		0.044	0.003
Sector: Transport and logistic	0.005	0.001	0.012	0.002	-0.007	***	0.008	0.001
Sector: TIC	0.047	0.004	0.045	0.004	0.002		0.046	0.003
Sector: Other services	0.021	0.003	0.041	0.004	-0.020	***	0.031	0.002
Sector: Tourism	0.160	0.007	0.282	0.009	-0.122	***	0.221	0.006
Sector: Creative industry	0.053	0.004	0.059	0.005	-0.006		0.056	0.003
Sector: Services to society	0.001	0.001	0.011	0.002	-0.010	***	0.006	0.001

Source: Author's own elaboration. Note: N.° of observations = 5,339, with approved = 2,680 and non-approved=2,659.
Legend: *** coefficient significant at 1%, ** coefficient significant at 5% and * coefficient significant at 10%.

Table B2. Mean-comparison tests: approved *versus* non-approved applications

	Approved		Non-approved		Mean diff.		All sample	
	Mean	Std. Err.	Mean	Std. Err.			Mean	Std. Err.
Internationalization performance								
Δ international turnover	4 691.34	524.86	1 669.33	191.35	3 022.01	***	3 186.28	280.91
Δ export intensity	0.28	0.01	0.28	0.01	0.00		0.28	0.00
Becoming exporter	0.39	0.01	0.49	0.01	-0.10	***	0.44	0.01
Productivity performance								
Δ labor productivity	54.75	1.81	53.65	2.98	1.11		54.20	1.74
TFP	7.33	0.03	6.72	0.02	0.61	***	7.03	0.02
Δ TFP	6.35	0.04	5.80	0.04	0.55	***	6.08	0.03
Efficiency (output/input) ratio								
CAPEX (application form)	3 533.89	429.95	1 659.51	64.35	1 874.38	***	2 600.38	218.54
Δ international turnover / CAPEX	2.30	0.24	1.78	0.19	0.53	*	2.04	0.15
Δ labor productivity / CAPEX	0.07	0.00	0.09	0.01	-0.02	***	0.08	0.00
Δ TFP / CAPEX	0.01	0.00	0.01	0.00	0.00	***	0.01	0.00
Innovation performance								
Δ R&D expenditures	51.04	6.34	45.19	8.76	5.85		48.13	5.40
Δ Patent stock	0.54	0.09	0.40	0.09	0.15		0.47	0.06
Becoming patented	0.09	0.01	0.07	0.01	0.02	**	0.08	0.00

Source: Author's own elaboration.
Note: N. ° of observations = 5,339, with approved application = 2,680 and non-approved= 2,659.

Appendix C. Collinearity Diagnostics

Table C1. Variance Inflation Factors (VIF) and correlation matrix

#	Variables	VIF	1	2	3	4	5	6	7
1	Firm size (n° employees)	1.30	1.00						
2	Firm age	1.40	0.33	1.00					
3	Micro and Small firms	1.51	-0.38	-0.41	1.00				
4	Experience in SI Innovation	1.05	0.12	0.12	-0.13	1.00			
5	Having foreign capital	1.10	0.20	0.08	-0.23	0.02	1.00		
6	Business partner	1.03	-0.02	0.15	-0.09	0.04	0.01	1.00	
7	Export intensity	1.47	0.33	0.38	-0.41	0.16	0.22	0.06	1.00
8	Share skilled employees	1.04	-0.04	-0.06	0.06	0.04	0.00	-0.01	-0.03
9	Patent stock	1.06	0.12	0.12	-0.14	0.04	0.03	0.02	0.15
10	R&D expenditures	1.39	0.30	0.31	-0.41	0.18	0.15	0.06	0.39
11	Labor productivity	1.11	0.15	0.25	-0.20	0.05	0.08	0.02	0.21
12	Regional export intensity	1.08	0.11	0.14	-0.17	0.07	0.04	0.05	0.24
	MEAN VIF	1.21							

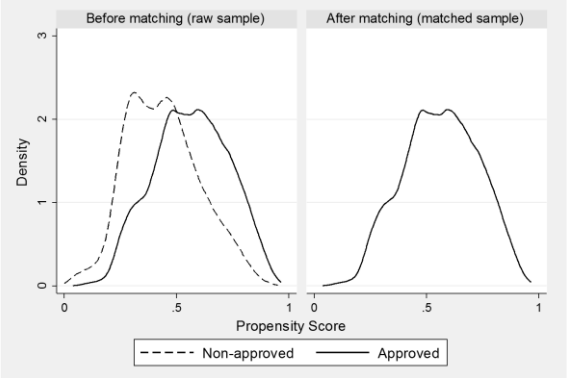
#	Variables	8	9	10	11	12
1	Firm size (n° employees)					
2	Firm age					
3	Micro and Small firms					
4	Experience in SI Innovation					
5	Having foreign capital					
6	Business partner					
7	Export intensity					
8	Share skilled employees	1.00				
9	Patent stock	0.06	1.00			
10	R&D expenditures	0.07	0.22	1.00		
11	Labor productivity	0.10	0.05	0.20	1.00	
12	Regional export intensity	-0.05	0.05	0.14	0.05	1.00

Source: Author's own elaboration. Note: N.° of observations = 5,339.

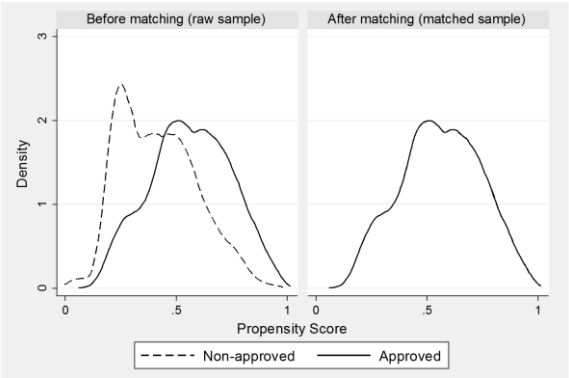
Appendix D. Assessing balancing quality

Figure D1. Kernel density plots for raw and balanced data

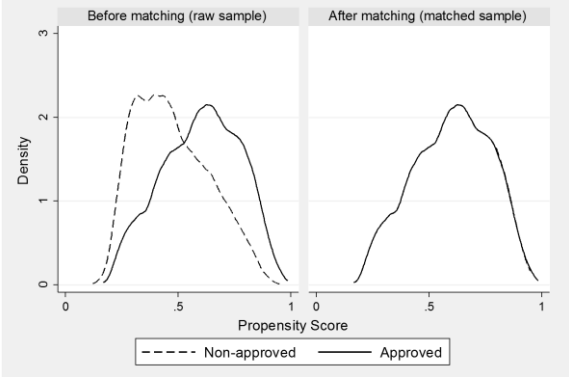
All Portuguese region



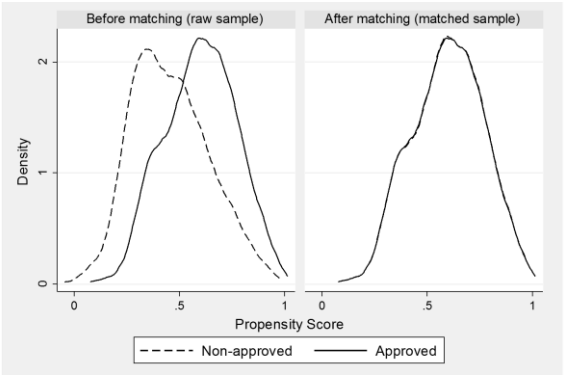
North region



Center region



Alentejo region



Appendix E. Differences between approved and non-approved application by region

Table E1. ATET: Foreseen impact of investment project to SI Innovation, by region NUTS 2 level

	North				Center				Alentejo			
	PS Matching		C Matching		PS Matching		C Matching		PS Matching		C Matching	
	Coef.	AI Rob. Std. Err.	Coef.	AI Rob. Std. Err.	Coef.	AI Rob. Std. Err.	Coef.	AI Rob. Std. Err.	Coef.	AI Rob. Std. Err.	Coef.	AI Rob. Std. Err.
Exportation												
A1	2 762 ***	718.4	3 051 ***	535.6	4 032 *	2 094.4	3 612 ***	901.1	3 515 +	2 331	821.7	1 633
A2	0.023 +	0.01	0.009	0.01	0.050 ***	0.02	0.032 **	0.01	0.059 **	0.03	0.045 *	0.03
A3	-0.023	0.02	-0.040 *	0.02	0.032	0.02	-0.044 *	0.02	0.026	0.04	-0.046	0.04
Productivity												
A4	7.47 **	3.63	5.562	6.82	11.90 ***	4.13	7.723 *	4.44	-8.30	19.80	-27.29	28.93
A5	0.142 **	0.06	0.382 ***	0.05	0.031	0.05	0.433 ***	0.05	0.044	0.10	0.471 ***	0.09
A6	0.353 ***	0.14	0.514 ***	0.11	0.866 ***	0.19	0.730 ***	0.13	0.148	0.19	0.373 *	0.20
Efficiency												
A7	743.5 ***	270.7	974.3 ***	176.4	2 136 **	958.3	2 452 ***	953.9	2 607 ***	876.1	2 972 ***	910.9
A8	0.659 **	0.27	0.756 ***	0.24	1.332 +	0.86	0.925 **	0.37	2.898 +	1.85	-0.403	1.12
A9	-0.003	0.01	-0.015	0.01	0.007	0.01	-0.009	0.01	0.010	0.02	-0.042 +	0.03
A10	0.000	0.00	-0.001 *	0.00	-0.002 **	0.00	-0.003 ***	0.00	-0.003 +	0.00	-0.004 **	0.00
Innovation												
A11	11.77	8.30	11.29	8.30	11.85	36.70	13.24	17.74	3.68	29.47	-48.14	56.03
A12	0.309	0.22	-0.072	0.30	0.152 **	0.07	0.139 **	0.06	0.368 *	0.21	0.322 +	0.22
A13	0.002	0.02	0.019	0.02	0.018	0.02	0.023	0.02	0.043 *	0.02	0.020	0.03

Source: Author's own elaboration.
Legend: *** coefficient significant at 1%, ** coefficient significant at 5%, * coefficient significant at 10% and + coefficient significant at 15%.
Abadie and Imbens (2016) robust standard error reported.
Note: Results correspond to the Average Treatment Effect on Treated (ATET) using 1-to-1 matches per observation and C- Matching. N.° observations: North - total 2,432; treated 1,186 and non-treated 1,246. Center - total 1,862; treated 1,009 and non-treated 853. Alentejo - total 569, treated 304 and non-treated 267.
A1 = Δ international turnover; A2 = Δ export intensity; A3 = Becoming exporter; A4 = Δ labor productivity; A5 = TFP; A6 = Δ TFP; A7 = CAPEX; A8 = Δ international turnover / CAPEX ; A9 = Δ labor productivity / CAPEX ; A10 = Δ TFP / CAPEX ; A11 = Δ R&D expenditures; A12 = Δ Patent stock; A13 = Becoming patented

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