# 037 - O PROCESSO DE SELEÇÃO DE CANDIDATURAS AO SISTEMA DE INCENTIVOS À INOVAÇÃO PORTUGUÊS: QUEM RECEBE O APOIO FINANCEIRO?

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**RESUMO**

As políticas públicas de apoio ao empreendedorismo e à inovação desempenham um papel relevante quando as empresas têm dificuldades de acesso ao financiamento externo. No entanto, alguns autores encontraram evidências de ineficiência no longo prazo em empresas subvencionadas (Bernini and Pelligrini, 2011; Cerqua and Pelligrini, 2014) e de ineficácia dos fundos públicos (Jorge and Suárez, 2011).

O objetivo do presente artigo é de avaliar a eficácia no processo de seleção de candidaturas a um financiamento público destinado a estimular a inovação. Usando um modelo de escolha binário, pretendemos determinar quais os fatores que influenciam a probabilidade de obter um apoio público destinado a financiar um investimento inovador. As variáveis explicativas estão relacionadas com o perfil da entidade promotora, as características do projeto e o ambiente macroeconômico. A análise baseia-se no estudo de caso do Sistema de Incentivo à Inovação (SI Inovação) português, nomeadamente nas candidaturas geridas pelo Programa Operacional Regional do Alentejo, no período 2007-2013.

Os resultados mostram que o processo de seleção é mais focado no impacto esperado do projeto do que no desempenho histórico das empresas candidatas. Fatores que influenciam a decisão de conceder um empréstimo bancário, não parecem influenciar a decisão do avaliador em financiar certos projetos. Um registo histórico de despesas em ID&T não é significativo para determinar a probabilidade de ter uma candidatura aprovada no âmbito do Si Inovação, enquanto aumentar o número de patentes e de postos de trabalho qualificados são fatores relevantes. No entanto, alguns indícios de ineficiência no curto prazo foram encontrados, uma vez obter uma vez ter um apoio financeiro público está relacionado com um menor aumento da produtividade no ano pós-projeto. A nível macroeconómico, períodos marcados por um custo do capital mais elevado nos mercados financeiros estão relacionados com uma maior probabilidade de ter uma candidatura aprovada, fenómeno que pode estar associado à eficácia dos apoios públicos em corrigir falhas de mercado.

**Palavras-chave:** Eficácia, Inovação, Fundos públicos

**THE SELECTION PROCESS OF APPLICATIONS TO THE PORTUGUESE INNOVATION INCENTIVE SYSTEM: WHO GETS FINANCIAL SUPPORT?**

**ABSTRACT**

Public policies to support entrepreneurship and innovation play a vital role when firms have difficulties in accessing external finance. However, some authors have found evidence of long-term inefficiency in subsidized firms (Bernini and Pelligrini, 2011; Cerqua and Pelligrini, 2014) and ineffectiveness of public funds (Jorge and Suárez, 2011).

The aim of the paper is to assess the effectiveness in the selection process of applications to public financial support for stimulating innovation. Using a binary choice model, we investigate which factors influence the probability of obtaining public support for an innovative investment. The explanatory variables are connected to firm profile, the characteristics of the project and the macroeconomic environment. The analysis is based on the case study of the Portuguese Innovation

Incentive System (PIIS) and on the applications managed by the Alentejo Regional Operational Program in the period 2007 – 2013.

The results show that the selection process is more focused on the expected impact of the project than on the firm's past performance. Factors that influence the credit risk and the decision to grant a bank loan do not seem to influence the government evaluator regarding the funding of some projects. Past activities in R&D do not significantly affect the probability of having an application approved under the PIIS, whereas an increase in the number of patents and the number of skilled jobs are both relevant factors. Nevertheless, some evidence of firms' short-term inefficiency was found, in that receiving public financial support is linked to a smaller increase in productivity compared to non-approved firm applications. At the macroeconomic level, periods with a higher cost of capital in financial markets are linked to a greater probability of getting an application for public support approved, which could be associated with the effectiveness of public support in correcting market failings.

**Keywords:** Effectiveness, Innovation, Public funding.

**JEL Code:**L53, O31, O38

## 1. INTRODUCTION

Innovation is at the heart of the Europe 2020 Strategy and special attention is given to increasing the effectiveness and efficiency of innovation policy instruments. Public policies to support entrepreneurship and innovation play a vital role when firms have difficulties in accessing finance. Erden & Holcombe (2005) demonstrated that public investment can have a leverage effect on private investment, especially when access to bank credit is limited. Paunov (2012) also highlighted that, in times of crisis, companies with access to public funding are less likely to reduce or abandon their innovation activities. Indeed, small and innovative firms have more constraints and difficulties in accessing finance, since they tend to have riskier projects and business models (Lee *et al.*, 2015). In the presence of market failings, public support for Research & Development & Innovation (RDI) aims to fill the gap, in order to improve knowledge production and come as close as possible to the socially optimal level.

Nevertheless, some authors have found evidence of long-term inefficiency in subsidized firms (Bernini and Pelligrini, 2011; Cerqua and Pelligrini, 2014) and ineffectiveness of public funds (Jorge and Suárez, 2011). According to Bernini and Pellegrini (2011) and Cerqua and Pelligrini (2014), subsidized firms tend to show lower productivity growth than non-subsidized firms, because firms are induced to reach the optimal level of employment in order to obtain the subsidy. Jorge and Suárez (2011) defend that if firms benefiting from R&D subsidies are less efficient, this could mean that the allocation of public resources is not optimal, making it difficult to achieve policy targets and objectives. So it seems that the inefficiency of subsidized firms could be linked to the selection process for awarding public support.

The aim of the present paper is precisely to assess which factors influence the public decision to financially support an innovative investment project. The analysis is focused on the case study of the Portuguese Innovation Incentive System (PIIS) in the Alentejo region, between 2007 and 2013. The methodology is based on a binary choice model. Explanatory variables are connected to: i) Firms' characteristics (size, activity sector, financial performance and risk level); ii) Project or applications' characteristics (amount of investment and expected impact); iii. Macroeconomic factors (Euribor and regional GDP variation).

The structure of the paper is as follows. Section 2 discusses the background and a literature review on the determinants of receiving public support. Section 3 provides a brief presentation of the Portuguese Innovation Incentive System. Section 4 describes the Portuguese Alentejo region in terms of innovation and entrepreneurial trends. Section 5 discusses data collection and the methodological

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approach implemented. Section 6 presents the results. Section 7 presents the main conclusions and some policy recommendations.

## 2. DETERMINANTS OF RECEIVING PUBLIC R&D SUPPORT

Several studies (Czarnitzki and Fier, 2002; Aerts and Thorwarth, 2008; González and Pazó, 2008; Czarnitzki and Lopes Bento, 2011; Hud and Hussinger, 2015), assessing the added value or potential crowding-out effect of public R&D support, started their analysis with an assessment of the probability of receiving a subsidy, in order to control for potential endogeneity issues. Indeed, when we assess the impact of public subsidies, we need to take into account that public funding is an endogenous variable, because for a firm to receive public support it needs to apply for funding, which the government may or may not grant (Busom, 2000:114). However, few authors provide a precise analysis of the selection process of applicants for public support. Most studies are more focused on comparing subsidized and non-subsidized firms and on determining the probability of obtaining public support. In the present paper, we are more focused on understanding when a firm applies for a subsidy which factors influence the decision to grant this.

The literature identifies several determinants affecting the probability of receiving an R&D subsidy (see Appendix A.1.): the age and size of the firm, previous experience of receiving subsidies, the qualification of human capital, patent stock, past R&D activities, export intensity and the firm's relationship with a national or foreign group.

To be effective, the process of selecting applicants for financial public support needs to take into account the maximization of potential outcomes in the funded firms. Bearing in mind this assumption, we expect a certain government preference for companies with a specific profile.

Firm size, measured by the number of employees, could have a positive or negative impact on the likelihood of receiving some public support. Large firms have a greater innovation capacity, which means a higher potential to reach positive economic outcomes (Hud and Hussinger, 2015), but typically, policy instruments are more focused on providing support to small and medium-sized firms (Czarnitzki and Lopes Bento, 2011). Indeed, small firms have more difficulties in gaining access to external finance (Lee *et al.*, 2015).

Young firms also have more limited access to the capital market and insufficient financial resources to invest in innovative projects (Aschhoff, 2009). In order to fill the market gap, innovation policy usually gives special attention to start-up companies (Czarnitzki and Lopes Bento, 2011).

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 (new) 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, 2011). Firms' patent stock is also another indicator of successful R&D activities with an expected positive impact on the probability of getting a subsidy (Aerts and Thorwarth, 2008).

Another indicator of the quality of the firm's innovative capacity is the presence of highly qualified personnel. Indeed, the ability to develop and implement an R&D project is strongly related to the skills of the firm's human capital (Blanes and Busom, 2004).

Firms that are part of an enterprise group are more likely to benefit from potential spillover effects as a result of network linkages (Czarnitzki and Lopes Bento, 2011), which could also influence government evaluators to select this kind of firm (Hud and Hussinger, 2015).

Firms more active in foreign markets, measured by export intensity, may also be more innovative than others (Aerts and Thorwarth, 2008; Czarnitzki and Lopes Bento, 2011; Hud and Hussinger, 2015) and are consequently more likely to achieve higher performance and more successful projects.

In the model developed, we include all the mentioned variables[52] and also others used by banks when assessing credit risk, namely the return on equity and the solvency ratio of applicant firms (see e.g. Louizis *et al.*, 2012; Chaibi and Ftiti, 2015), in order to control for the effectiveness of PIIS in counteracting debt and equity financing constraints. Indeed, firms with historically lower levels of these indicators are less attractive for new investors or banks, because they show lower performance and more financial vulnerability.

Macroeconomic factors in the year of submitting the application, measured by the regional GDP variation and the value of Euribor (Euro Interbank Offered Rate) are also taken into account with the aim of controlling for external factors which affect SMEs' access to finance and growth.

## 3. PORTUGUESE INNOVATION INCENTIVE SYSTEM[53]

The analysis is based on the case study of the Portuguese Innovation Incentive System (PIIS) and on the applications managed by the Alentejo Regional Operational Program in the period 2007 – 2013. The PIIS is an instrument of the National Strategic Reference Framework (NSRD) 2007 – 2013, included in the Operational Program for Competitiveness Factors (COMPETE) and funded by the European Regional Development Fund (ERDF). The budget allocated to PIIS is close to 2 billion euros, which represents about 10% of the total NSRD budget and 50% of the total COMPETE budget. Other instruments of COMPETE are namely the Incentive System for Qualification and Internationalization of SMEs and the Incentive System for Technology Research and Development in companies.

The beneficiaries of PIIS are companies from industry, commerce, services, tourism, energy, transport and logistics sectors. The incentive system provides financial support to innovative firms through subsidized loans. However, part of the loan could become non-refundable if the beneficiary achieves the established objectives.

The PIIS was designed with the aim of stimulating investment in innovation and the goals of :i) promoting innovation in businesses through the production of new goods, services and processes that foster their progression in the value chain; ii) making technological improvements and boosting their orientation towards international markets; iii) stimulating qualified entrepreneurship and structural investment in new areas with growth potential.

Assessment for effective project selection regarding the PIIS goals will be made introducing indicators linked to the project's expected impact, such as, the amount of investment, export intensity ratio, variation of skilled jobs and increased productivity.

## 4. ALENTEJO REGION: INNOVATIVE AND ENTREPRENEURIAL CAPACITIES

When the NSRD 2007 – 2013 was designed, the Portuguese Alentejo region NUTS level II was considered as a European region belonging to the Convergence Regions group[54],due to its major structural problems (CCDRA, 2015:2).

The Alentejo accounts for nearly one third of the Portuguese mainland, but its population only represents 7.16 % of the Portuguese total. The region has even a negative development trend - 757 thousand inhabitants in 2011, against 777 thousand inhabitants in 2001 (Census, 2001 and INE, 2015). The Alentejo has a population density which is about a fifth of the national average and an older than average population (INE, 2015).

Concerning education indicators for pre-primary and secondary education and the proportion of females in secondary education, the Alentejo has a more favorable position than the rest of the

[52] Firm as part of an enterprise group is not included in the model because this information is not available in our dataset.

[53]Section based on information on COMPETE Website: http://www.pofc.qren.pt/areas/incentives-to-companies/innovation (accessed on 15th February 2016).

[54]This kind of region is characterized by greater structural problems and a GDP per capita below 75% of the European average and they are consequently the main recipients of EU funds (CCDRA, 2015:2).

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country (INE, 2015). However, when we look at indicators for higher education, the Alentejo's position is less favorable regarding the enrolment rate (19%), the proportion of students enrolled in S&T areas of tertiary education (18.9%) and graduates from tertiary education per 1.000 inhabitants (41.6%), compared to Portugal as a whole (INE, 2015).

Distribution of the employed population according to main occupation shows that the Alentejo has a smaller proportion of the population in activities requiring lower qualifications (INE, 2015).

Between 2007 and 2013, the Alentejo region, like the whole country, was hit by the economic crisis. GDP *per capita* decreased both in value and in relation to the national average, and in fact its contribution to the national GDP was less in 2013 than in 2007. Export intensity and the region's degree of openness also show results below the national average. However, between 2007 and 2013 the region recorded an increase in its labor productivity and its density of enterprises (Table 1).

| Indicators | Portugal | | Alentejo | |
|---|---|---|---|---|
| | 2007 | 2013 | 2007 | 2013 |
| **GDP as % of total Portugal** | 100 | 100,0 | 6,9 | 6,4 |
| **GDP per capita (thousand euros)** | 15,400 | 16,282 | 14,700 | 14,605 |
| **GDP per capita (disparity index \| Portugal=100)** | 100 | 100,0 | 95,6 | 89,7 |
| **Apparent labour productivity (GVA/Employment)** | 27,300 | 33,655 | 30,000 | 34,780 |
| **Density of enterprises (No./km2)** | 12 | 11,9 | 2,2 | 2,4 |
| **Export intensity** | n.a | 27,73 | n.a | 25,91 |
| **Degree of openness** | n.a | 62 | n.a | 46 |
| **GERD as percentage of GDP (%)** | 1,21 | 1,33 | 0,14 | 0,46 |
| **R&D personnel (FTE) in active population (‰)** | 0,6 | 8,8 | 0,3 | 2,9 |
| **Average expenditure on R&D per unit (thousand euros)** | 693,9 | 636,4 | 104,2 | 381,4 |

Table 1. Indicators of enterprises, Portugal and Alentejo (2007 and 2013)

Source: INE (2009, 2015). Legend: GDP - Gross domestic product, GVA - Gross value added; GERD – Expenditure on R&D; R&D - Research and Development; n.a - information not available.

Regarding the innovation capacities of the region, despite a significant increase in expenditure on R&D and R&D personnel between 2007 and 2013, the Alentejo is still far from the national average (Table 1).

As we can see from the brief description of the economic and social panorama of the Alentejo, the present study focuses on a region which, despite some improvement in absolute terms and the financial support of EU funds, is still short of the national average. Therefore, we can possibly question the effectiveness of public financial support and specifically, the selection process to award this.

## 5. DATA AND METHODOLOGY

The dataset was built with cross-information provided by the entity in charge of the PIIS in the Alentejo region, Commission for Coordination and Regional Development of the Alentejo (CCDRA) and statistical data from official entities (e.g. Portuguese National Institute of Statistics and PORDATA database).

The sample has 451 observations, which correspond to the number of applications submitted to PIIS by firms located in the Alentejo region. The approval rate is 48%[55]. The total amount of investment approved was 660 million euros associated with 306 million euros of subsidized loans. More than 66% of applications were submitted by micro-sized enterprises. Young enterprises represent almost 62% of the sample. Applications for industry and tourism activities account for nearly 70% of the observations (Figure 1).

[55] This result is even higher than Busom's (2000) finding. The author found an approval rate of 39% for Spanish firms applying for R&D public support.

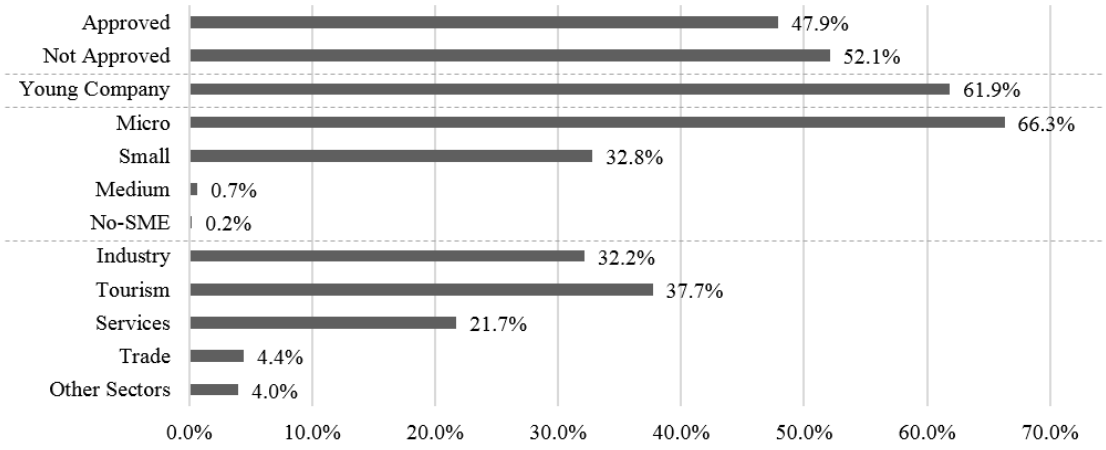


Figure 1. Main description of the sample

Source: Authors' own elaboration based on data from CCDRA (21.10.2014).
Note: The classification of SMEs is based on Commission recommendation of 6 May 2003, concerning the definition of micro, small and medium-sized enterprises.

Using a binary choice model – *cloglog*[56] (1) – the study aims to determine which factors influenced the probability of obtaining public support for an innovative investment.

$$G(x_i'\beta) = 1 - e^{-e^{x_i'\beta}} \quad (1)$$

The explanatory variables are connected to: i) Firms' characteristics (e.g. size, activity sector, financial performance and risk level); ii) Project or application's characteristics (e.g. amount of investment and expected impact); iii. Conjectural factors (Euribor and regional GDP variation).The expected impact of each of them on the probability of obtaining public support, based on the literature review, is presented in Table 2.

| Variable name | Variable description | Expected sign |
|---|---|---|
| ***job_pre*** | Number of employees in the company the year before the application submission | +/- |
| ***Age*** | Age of firms in the year of application submission | +/- |
| ***young_company*** | Companies created after 2007 and with no activity (turnover near to zero). | +/- |
| ***Industry, Tourism Services, Trade Other_sectors*** | Activity sector of the application. Dummy variable. ***Other_sectors*** is the omitted reference category. | +/- |
| ***submit_before*** | *Has the company submitted an application to the Innovation Incentive System before this one?* Dummy variable, where Yes = 1 and No = 0. | + |
| ***ln_investment*** | Total amount of investment foreseen by the company in the application form. Variable expressed as a logarithm. | + |
| ***rd_pre*** | *Has the company a history of R&D activities in the year before the application submission?* Dummy variable, where Yes = 1 and No = 0. | + |
| ***var_patent*** | Variation of the National and European patent number foreseen by the applicant as the result of investment project. | + |
| ***financ_aut_pre*** | Financial autonomy (equity/assets) in the year before the application submission | + |
| ***solvability_pre*** | Solvability ratio (equity/debt) in the year before the application submission | +/- |
| ***roe_pre*** | Return on Equity ratio (net income/equity) in the year before the application submission | +/- |

[56]The complementary log-log (cloglog) regression model is an alternative to the logit and probit ones. "Like the logit and probit model, the complementary log-log transformation ensures that predicted probabilities lie in the interval [0, 1]. Unlike the normal and logistic, the distribution function is not symmetric around zero but is skewed to the right" (Powers and Xie, 2008:64). In the present study the choice between a logit, probit and cloglog method is based on the model with a higher overall proportion of correct predictions. For more details see Appendix A.2.

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| | | |
|---|---|---|
| ***exp_intens_post*** | Export intensity (exportation/total turnover) foreseen in the year after project investment conclusion. | + |
| ***var_net_inc*** | Variation of net income foreseen as result of the investment project. Values expressed in thousands of euros. | + |
| ***var_product*** | Variation of productivity (variation of net income/variation of job) foreseen as result of the investment project. Values expressed in thousands of euros. | + |
| ***var_job*** | Variation of jobs number foreseen by the applicant as the result of investment project. | + |
| ***var_skill_job*** | Variation of skilled jobs number foreseen by the applicant as the result of investment project. Under the program regulation, a highly qualified worker is a person with at least a post-secondary pre-tertiary level of education. | + |
| ***ln_euribor*** | Euribor 12 months in the year of application submission | +/- |
| ***reg_gdp_var*** | Variation of regional GDP at NUTS II in the year of application submission. | +/- |

Table 2. Variable description and hypotheses

Source: Authors' own elaboration.

## 6. RESULTS AND DISCUSSION

### 6.1. Descriptive statistics

Approved applications, compared with non-approved ones, foresee a statistically significant higher amount of investment and a higher increase in total employees, skilled jobs and number of patents (Table 3). Having experience in the PIIS procedures, measured by the variable of application submitted before, is also higher in the group with applications approved.

| *Variable* | Approved | Not approved | All sample | Diff means | |
|---|---|---|---|---|---|
| ***job_pre*** | 4.991 | 4.804 | 4.894 | 0.186 | |
| ***Age*** | 6.329 | 5.234 | 5.758 | 1.095 | |
| ***young_company*** | 0.620 | 0.617 | 0.619 | 0.003 | |
| ***Industry*** | 0.394 | 0.255 | 0.322 | 0.138 | *** |
| ***Tourism*** | 0.319 | 0.430 | 0.377 | -0.110 | ** |
| ***Services*** | 0.241 | 0.196 | 0.217 | 0.045 | |
| ***Trade*** | 0.032 | 0.055 | 0.044 | -0.023 | |
| ***other_sectors*** | 0.014 | 0.064 | 0.040 | -0.050 | *** |
| ***submit_before*** | 0.194 | 0.106 | 0.149 | 0.088 | *** |
| ***Investment*** | 3058.15 | 1913.12 | 2461.51 | 1145.02 | ** |
| ***rd_pre*** | 0.079 | 0.043 | 0.060 | 0.036 | |
| ***var_patent*** | 0.435 | 0.196 | 0.310 | 0.239 | ** |
| ***financ_aut_pre*** | 0.217 | 0.202 | 0.209 | 0.015 | |
| ***solvability_pre*** | 2.480 | 6.729 | 4.694 | -4.248 | |
| ***roe_pre*** | -0.034 | -0.034 | -0.034 | 0.000 | |
| ***exp_intensity_post*** | 0.506 | 0.374 | 0.437 | 0.132 | *** |
| ***var_net_income*** | 1078.848 | 1184.198 | 1133.742 | -105.350 | |
| ***var_productivity*** | 80.451 | 95.328 | 88.267 | -14.877 | |
| ***var_job*** | 13.912 | 9.434 | 11.579 | 4.478 | *** |
| ***var_skill_job*** | 6.630 | 4.217 | 5.373 | 2.413 | *** |
| ***Euribor*** | 0.014 | 0.014 | 0.014 | 0.000 | |
| ***reg_gdp_var*** | -0.022 | -0.032 | -0.027 | 0.010 | *** |

Table 3. Comparison of means

Source: Authors' own elaboration.
Note: Number of observations 451. Approved applications 216 and not approved 235. ***, **, * indicate if the means are significantly different between 'approved' and 'not approved' application at the level of 1%, 5% and 10% respectively, based on t-Test.

The applicant's profile (*job_pre*, *age*, *young_company* and *rd_pre*) and its historical financial performance or risk (*finance_aut_pre*, *solvability_pre*, *roe_pre*) seem not to be statistically different between the groups – 'approved' and 'not approved' applications.

Applications from *industry*, *tourism* and *other_sectors* are the only ones that are statistically different in the groups.

If we look at indicators which measure the impact of the project on the company's competitiveness (*exp_intensity_post*, *var_net_income*, *var_productivity*), the only variable where the difference of means is statistically significant is the export intensity indicator after project implementation.

Finally,the macroeconomic environment represented by the regional GDP variation at NUTS II level appears to be statistically less unfavourable in areas where the application is approved. The value of Euribor in the year of application submission seems not to be statistically different between the groups.

### 6.2. Model estimation and interpretation of results

The medium-high correlation between some variables (see Appendix A.2.), namely: i) *age, young_company* and *job_pre*; ii) *financ_aut_pre* and *roe_pre*; iii) *var_job* and *var_skill_job;* iv) *var_net_inc, var_skill_job* and *var_product*, make it impossible to include all the variables in the model, due to possible problems of multicollinearity.

Considering that public policy is generally more focused on skilled job creation (*var_skill_job*) and on contribution to added value (*var_product*), we choose to include these two variables in the model. Financial autonomy (*financ_aut_pre*) being one of the requirements in the first stage of the selection process, it seems the most interesting one to study the impact of ROE (*roe_pre*) on the probability of having an application approved by the PIIS. The final model (2) is expressed as follows:

$$\begin{aligned}\Pr(Approved\ application = 1|\dots) &= G[\beta_0 + \beta_1 jobpre + \beta_2 industry + \beta_3 tourism + \beta_4 services + \beta_5 trade \\ &+ \beta_6 submit\ before + \beta_7 loginvestment + \beta_8 rdpre + \beta_9 varpatent \\ &+ \beta_{10} varpatent^2 + \beta_{11} solvabilitypre + \beta_{12} roepre + \beta_{13} exp\ intensity \\ &+ \beta_{14} varproductivity + \beta_{15} varskilljob + \beta_{16} varskilljob^2 + \beta_{17} logeuribor \\ &+ \beta_{18} reggdpvar]\end{aligned} \quad (2)$$

The estimation of function $G(.)$ present in (2) is through the maximum likelihood method and the *cloglog* model (1), because if we compare with the results of other binary choice models, such as the logit and probit ones (see Appendix A.3.), we can see that the overall proportion of correct predictions is higher in the *cloglog* model and so it is the most appropriate.

The result (Table 4) shows that the selection process is more focused on expected project impact than on firms' past performance. Factors that influence the credit risk and the decision to give a bank loan, such as solvability ratio (*solvability_pre)* and return on equity (*roe_pre)*, seem not to influence the government evaluator in funding some projects. Nor does previous experience in R&D activities (*rd_pre_yes*) seem to matter, despite Czarnitzki and Fier (2002) and Aschhoff (2009) finding a positive relationship between firms performing R&D on an occasional or continuous basis and the probability of receiving a subsidy. Indeed, the selection process of PIIS appears to give preference to companies that foresee an increase of patent portfolio (successful innovation) over those showing past R&D activities. However, as we can see in Table 4 the relationship between *var_patent* and the independent variable is not linear.

| Variables | Coefficients (Std. Err) | | Marginal Effects | |
|---|---|---|---|---|
| ***job_pre*** | -0.00617 | (0.00832) | -0.002 | |
| ***Industry*** | 1.720*** | (0.610) | 0.487 | *** |
| ***Tourism*** | 1.180* | (0.609) | 0.334 | * |
| ***Services*** | 1.590*** | (0.612) | 0.450 | *** |
| ***Trade*** | 1.007 | (0.745) | 0.285 | |
| ***submit_before*** | 0.701*** | (0.203) | 0.198 | *** |
| ***ln_investment*** | 0.126* | (0.0652) | 0.036 | * |
| ***rd_pre_yes*** | 0.388 | (0.351) | 0.110 | |
| ***var_patent*** | 0.334** | (0.154) | 0.094 | ** |
| ***var_patent2*** | -0.0351** | (0.0171) | -0.010 | ** |
| ***solvability_pre*** | -0.00157 | (0.00210) | 0.000 | |
| ***roe_pre*** | 0.346 | (0.214) | 0.098 | |

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| | | | | |
|---|---|---|---|---|
| ***exp_intensity*** | 0.993*** | (0.269) | 0.281 | *** |
| ***var_productivity*** | -0.00141** | (0.000580) | 0.000 | ** |
| ***var_skill_job*** | 0.0671*** | (0.0182) | 0.019 | *** |
| ***var_skilljob2*** | -0.000674*** | (0.000229) | 0.000 | *** |
| ***ln_euribor*** | 0.285** | (0.115) | 0.081 | ** |
| ***reg_gdp_var*** | 4.573** | (2.090) | 1.294 | ** |
| ***Constant*** | -2.992** | (1.205) | | |
| ***Observations*** | 434 | | | |
| ***Log likelihood function*** | -253.22751 | | | |

Table 4. Results of model estimation

Source: Authors' own elaboration with STATA output.
Legend: *** coefficient significant at 1%, ** coefficient significant at 5% and * coefficient significant at 10%. Standard errors in parentheses.The results for Reset Test are available in Appendix A.3.

The variation of patent number (*var_patent*) and the variation of skilled job (*var_skill_job*), as the result of the investment project, show an inverted U-shaped relationship with the probability of receiving the public incentive. This means that increasing the number of patents or the number of skilled jobs has a positive effect on the decision to fund an investment project, but at a higher level the effect tends to inverse and the probability of having an application selected decreases. One justification for this trend could be that projects with a higher number of additional patents in the short-term could be more risky and consequently have a higher risk of failure. Indeed, the process of patent registration could be hard and long. Then again, to hire a high number of new skilled workers could also be more risky because it requires a larger additional income in order to justify this and to make new jobs profitable.

The variation in productivity (*var_productivity*) shows a slight negative impact, which means that having a project funded is linked to a low increase in productivity. This finding could suggest long-term inefficiency in funded firms, as other authors (Bernini and Pelligrini, 2011; Jorge and Suárez, 2011; Cerqua and Pelligrini, 2014) also found. One possible explanation could be that in the selection process increased employment has priority over increased net income (see also Table 3 with comparison of means). However, on the other hand, projects with high growth rates may also be too ambitious and sometimes unrealistic in terms of execution, in a country and region affected by the economic crisis, namely between 2009 and 2013.

The export intensity ratio after project implementation (*exp_intensity*) shows, as expected, a positive impact on the probability of having an application funded, as Aerts and Thorwarth (2008) and Czarnitzki and Lopes Bento (2011) also found. Indeed, one goal of the program is to boost firms' presence in international markets.

The amount of investment (*ln_investment*) has a positive impact on the probability of being funded. 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. This conclusion is also in line with Aerts and Thorwarth (2008:13), who found that receiving a subsidy has a positive impact on R&D efforts because funded companies show higher R&D expenditure than non-funded ones. Similarly, Santos *et al.* (2015) also find that the amount of funded investment has a positive impact on the probability of firm survival, because higher investments tend to be better planned. Because they are more risky, they need a higher additional cash-flow to be economically viable. So when governments choose to fund projects with a higher amount of investment, this tends to maximize the outcome: higher private effort and low failure rate.

Previous experience in the PIIS (*submit_before)* increases by 19.8% 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 our model this conclusion is not necessarily good news. On one hand, this could reveal that the public incentive goes more to the same companies, and that firms could receive more than one subvention under the PIIS. Or it could reveal that firms familiar with the application process, with more defendable, but not necessarily more viable projects, have a higher probability of obtaining public support.

Company size, measured by the number of employees (*job_pre)*, seems not to influence the probability of having an application approved, contrary to the literature (Appendix A.1.). However, this finding is not very surprising because our sample is mainly composed of micro and small companies (Figure 1), and the average number of employees in both groups (approved and not approved applications) is almost the same and around 5 workers (Table 3).

The activity sector of the investment project also matters, particularly if it is in the industry, tourism and services sector. Compared to other sectors (reference category), applications in these areas have a higher probability of being approved, possibly because the regional policy is more focused on developing innovation in these sectors, due to regional specialization, namely in agri-business and tourism activities. Then again, services is a sector with high added value and growth potential.

The model shows that when firms have a higher cost of financing their project in the financial market, represented by the Euribor (*ln_euribor*), the probability of having an application approved increases. This conclusion could illustrate the mechanism of public support in trying to reduce the cost of innovation and in counteracting the financial market's failings.

In periods of economic growth (*reg_gdp_var*) the probability of getting a subsidy increases, which could mean that the public instrument is not effective in the period when it approves projects, because an inverse relationship should be the case. In periods of economic crisis, the aim of the public instrument is to improve conditions for launching more projects in the regions.

## 7. CONCLUSION

The Portuguese Innovation Incentive System was an important instrument of the NSRD 2007 – 2013, developed with the aim of stimulating innovation and promoting competitiveness. Between 2007 and 2013, 451 applications to PIIS were submitted under the Alentejo Regional Operational Program. The approval rate was 48%. Entities in charge of evaluating applications showed on average an effective selection process, particularly when the incentive is supposed to counteract financial market failings. Indeed, an interesting finding was that when firms have a higher cost of financing investment, the public policy instrument seems to provide additional financial support to innovative firms, in order to be more competitive. On the other hand, some firm characteristics that influence credit risk, such as size, profitability and solvency ratio, are not relevant factors in the PIIS selection process. However, government evaluators are also cautious, selecting projects with a low potential failure risk, in order to maximize the expected outcome for society.

Nevertheless, government preference for promoting employment is shown to be higher than the impact on firm productivity, which in the long-run could mean firm inefficiency. The Portuguese Innovation Incentive System seems to be more focused on short-term results, such as increasing the number of jobs and intensifying the external commercial relationship, than on the sustainability of the outcome. This finding could be useful for policy-makers in order to redirect policy objectives towards promoting efficiency in subsidized firms and putting the effectiveness of the instrument for job creation in the background. Increasing employment in the short-term in a country and/or region with a high unemployment rate is important, but supporting the creation of new jobs sustainable for firms' needs remains the priority.

In future research, special attention will be given to explaining the determinants of financial performance in subsidized firms, in order to better understand the long-term firm inefficiency

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phenomena in the subsidized context. It could also be interesting to assess the differences between performance in firms subject to more and less financial constraints.

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## Appendix

Appendix A.1. Benchmark

| Authors | Country | Methodology | Variables (significance and impact) |
|---|---|---|---|
| **Czarnitzki and Fier (2002)** | Germany | Probit (firm-level) | **Significant variables**: (+) n° of employees, (+) share of employees with university degree in the field of business administration; (+) firm located in eastern region; (+) firm with continuous R&D activities; (-) population density where firm is located; (-) traffic activity in relation to other business services<br>**Not significant variables**: share of employees with university degree in the field of natural science and engineering; age; sectorial/industry growth rates where firm operated; firm legal forms with limited liability; industry dummy – wholesale, retail trade, ICT services, technical services. |
| **Blanes and Busom (2004)** | Spain | Multinomial logit (firm-level) | Doing R&D and participating in R&D programs results<br>**Significant variables:** (+) share of university graduates and engineers in the firm; (+) n° of employees; (+) domestic firm.<br>**Not significant variables**: age; firm's cash flow. |
| **Aerts and Thorwarth (2008)** | Belgium (Flanders) | Probit (firm-level) | **Significant variables**: (+) amount of subsidy by project; (+) number of project proposals submitted; (+) export quota.<br>**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 | Probit (firm-level) | **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.<br>**Not significant variables**: firm with market power. |
| **Aschhoff (2009)** | Germany | Logit (firm-level) | **Significant variables**: (+) previous experience in subsidy scheme; (+) firm received subsidy from other sources; (+) n.° of employees; (+) firm performed R&D on an occasional or continuous basis; (+) share of employees with a university degree; (+) deviation of firm patent stock from industry mean; (-) firm is part of domestic company group; (-) firm has foreign headquarters.<br>**Not significant variables**: change in the n° of employees; age; firm located in eastern region. |
| **Czarnitzki and Lopes Bento (2011)** | Germany | Probit (firm-level) | **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.<br>**Not significant variables**: firm is part of group. |
| **Hud and Hussinger (2015)** | Germany | Probit (firm-level) | **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).<br>**Not significant variables**: firm group with foreign headquarters; industry-specific sales growth rate; ICT. |

Table A.1. Benchmark studies focused on the probability of receiving a public subsidy

Source: Authors' own elaboration based on Czarnitzki and Fier (2002), Blanes and Busom (2004), Aerts and Thorwarth, (2008), González and Pazó (2008), Aschhoff (2009), Czarnitzki and Lopes Bento (2011), Hud and Hussinger (2015).

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Table A2. Correlation matrix

Appendix A.2. Correlation matrix

| | *job_pre* | *age* | *young_comp* | *sub_bef* | *invest* | *rd_pre* | *var_patent* | *fin_aut_pre* | *solv_pre* | *roe_pre* | *exp_int* | *var_skill* | *var_job* | *var_prod* | *var_net_inc* | *euribor* | *reg_gdp* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***job_pre*** | 1 | | | | | | | | | | | | | | | | |
| ***age*** | **0.6149** | 1 | | | | | | | | | | | | | | | |
| ***young_company*** | **-0.5633** | **-0.6019** | 1 | | | | | | | | | | | | | | |
| ***submit_before*** | 0.0313 | 0.0998 | -0.0115 | 1 | | | | | | | | | | | | | |
| ***investment*** | -0.0403 | -0.0807 | 0.1229 | -0.0005 | 1 | | | | | | | | | | | | |
| ***rd_pre*** | 0.2744 | 0.1416 | -0.2545 | 0.0593 | -0.0217 | 1 | | | | | | | | | | | |
| ***var_patent*** | -0.054 | -0.0865 | 0.036 | 0.0585 | -0.0271 | 0.2836 | 1 | | | | | | | | | | |
| ***financ_aut_pre*** | 0.1414 | 0.2224 | -0.2209 | 0.0522 | 0.0981 | -0.1029 | -0.2294 | 1 | | | | | | | | | |
| ***solv_pre*** | -0.0221 | -0.0174 | 0.0460 | -0.0213 | 0.0185 | -0.0163 | -0.019 | 0.1473 | 1 | | | | | | | | |
| ***roe_pre*** | 0.0822 | 0.0904 | -0.1132 | -0.0729 | -0.0014 | -0.1972 | -0.246 | **0.6157** | 0.0057 | 1 | | | | | | | |
| ***exp_intensity*** | -0.0356 | -0.1104 | 0.0648 | -0.0617 | 0.0741 | 0.0536 | 0.1174 | -0.043 | -0.0312 | -0.0985 | 1 | | | | | | |
| ***var_skill_~b*** | -0.1141 | -0.1590 | 0.1719 | -0.0035 | 0.3253 | -0.0521 | 0.0334 | -0.0345 | -0.0086 | -0.0173 | 0.2138 | 1 | | | | | |
| ***var_job*** | 0.085 | -0.1558 | 0.1211 | -0.0191 | **0.4489** | 0.0461 | 0.152 | 0.0468 | 0.0123 | 0.0035 | 0.2128 | **0.6287** | 1 | | | | |
| ***var_productivity*** | 0.0505 | -0.0438 | -0.0059 | 0.05 | 0.0823 | 0.0556 | 0.0638 | 0.0099 | -0.0067 | 0.0071 | 0.248 | 0.1944 | 0.0355 | 1 | | | |
| ***var_net_income*** | 0.0094 | -0.0812 | 0.0754 | 0.0165 | 0.131 | 0.0258 | 0.0311 | -0.0295 | -0.0006 | 0.0045 | 0.2099 | **0.5728** | 0.3700 | **0.7184** | 1 | | |
| ***euribor*** | 0.0476 | 0.0059 | -0.0005 | -0.1704 | 0.0826 | 0.0693 | 0.0388 | 0.0207 | 0.0807 | 0.0346 | -0.2329 | 0.0054 | 0.0194 | -0.1079 | -0.0563 | 1 | |
| ***reg_gdp_var*** | -0.0154 | -0.0504 | 0.0453 | -0.0774 | 0.0287 | -0.0004 | -0.0208 | 0.0996 | 0.0159 | 0.0686 | 0.0608 | -0.0096 | -0.0064 | -0.0902 | -0.0701 | -0.0029 | 1 |