FINANCIAL CONSTRAINTS: DO THEY MATTER TO ALLOCATE R&D SUBSIDIES?

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Abstract

We examine whether subsidies are allocated to financially constrained firms and if they effectively alleviate these constraints. We claim that in addition to the usual "public good" arguments behind the allocation of subsidies, the extent to which firms are able to obtain external funding should not be overlooked. Overall, our results question both the allocation and the effectiveness of subsidies in alleviating financial constraints of firms willing to innovate. Additionally, the decision criteria for allocating public funds seem to be similar from those used by the private investors. These results have important implications on the design of future innovation policy.

Keywords: R&D Subsidies; Financial constraints; R&D investment; R&D policy.
JEL Classification: G32; H25; L53; O32; O38.

1. INTRODUCTION

Most governments use a wide range of policy instruments to promote private research and development (R&D) investment.[1] In particular, subsidies to R&D activities have been used by several OECD countries, which became, after regional aid, the largest type of industrial support in developed countries (Takalo et al. (2013)). The 2008 financial crisis and subsequent sovereign debt problems hanging over the European Union (EU) countries has put public budgets under severe pressure, thus, calling for an increased efficiency of public funding programmes. The OECD STI Outlook 2012 pointed out that rather than leading to new objectives or instruments of innovation policy, the economic crisis has changed the balance of those already in place, with a view to *maximising their impact on economic growth* and *saving resources*. This paper contributes to this debate.

There are two key arguments to support why firm's innovation activities should be subsidised: the "public good" and the "financial market failure" thesis. The former states that there are significant spillover effects from such activities to the whole economy and thus the social returns to innovation are higher than private returns (Nelson (1959), Arrow (1962)). The latter relies on evidence that R&D investments and innovation activities are particularly prone to financial constraints (Hall and Lerner (2010)). However, as argued by Klette et al. (2000), a more detailed investigation of these market failures is desirable before conclusions about R&D policy can be drawn.

While it is not very debatable that some firms do not innovate because they are financially constrained, nor that public policy instruments (efficiently or not) tend to help firms to innovate, it is certainly not clear whether policy instruments (namely direct financing instruments) are designed to (and *de facto)* target those that want to innovate but are financially constrained, as well as whether policy instruments are tackling firms' constraints. Which criteria should prevail when evaluating potential

[1] Among which we can mention intellectual property right systems, tax incentives, direct subsidies, public venture capital or loans with low interest rates. An analysis of the existing policy instruments and their potential effects on R&D activities is obviously beyond the scope of this paper, but it is worth noticing that direct instruments might be more beneficial than indirect instruments such as R&D tax incentives, in the case of small and young firms facing financing constraints (Warwick and Nolan, 2014).

subsidy recipients? Are the criteria for allocating public funds for innovation different from those used by the private sector? One could argue that, regardless of financial constraints, subsidies are desirable as long as they promote innovation (because it entails some social returns). However, it certainly seems sensible to say that subsidies should be aimed at financially constrained firms, i.e. those firms that are really in need. Even though the analysis of financial constraints to innovation and the debate on whether subsidies foster innovation are two closely related lines of research, the link between them is rather unexplored in the literature. Shedding some light on this issue, this paper provides additional information to policymakers on how to allocate R&D subsidies.

The goal of this paper is thus to analyse if subsidies to innovation are being allocated to financially constrained firms, conditional on social returns to R&D investment, as well as to test whether such subsidies effectively reduce these constraints. We argue that, in addition to the usual "public good" thesis behind the allocation of innovation subsidies, the extent to which firms are able to obtain external funding should not be overlooked. The point that we make in this paper is that regardless of the ultimate innovation policy objective (e.g. higher social returns to R&D investment), subsidies should be given to those firms in need, that is, those firms that have difficulties in accessing finance—which we define here as financially constrained. Only, then, we can argue that the "financial market failure" is truly being addressed.

To conduct our empirical analysis, we use a large unbalanced panel of Portuguese firms covering the period 1996-2004. Portugal is a well suited country of analysis given the combination of a policy focus on promoting innovation activity on the one hand, with a relative underperformance of business R&D when compared with other developed economies, on the other.[2] Additionally, drawing on this representative sample of Portuguese firms, inferences may be made with respect to at least the Continental

[2] For example, the share of R&D financed by business enterprises in total R&D expenditure in 2001 was 31.5%, less than half the OECD average (63.4%) and significantly lower than that in the EU 28 (55.0%). Conversely, the percentage of R&D financed by the Portuguese government amounted to 61.0%, while it was only 28.9% in OECD economies and 35.1% in the EU (OECD, 2003).

European countries due to three main reasons. First, although the R&D policy in the EU is the sole competence of individual member states, the design of policies in each member country should support the general innovation policy strategy and objectives defined at EU level. Secondly, Portugal, like many other Continental European countries, has a bank-based financial market—banks are the major suppliers of external funds for firms in most economies across the world (Qian and Strahan (2007); cf. Hall and Lerner (2010), for the case of Anglo-Saxon economies that have more developed stock markets). Finally, the stylized facts for Portugal in terms of firm dynamics are broadly in line with other European countries (Cabral (2007)).

There is a large body of literature that analyses the impact of either financial constraints or subsidies on firms' R&D investment and innovation. However, and as far as we know, both the allocation of innovation subsidies to financially constrained firms and their role in alleviating such constraints are research streams that have never been explicitly analysed. At an even more general level, few works have examined the criteria used by government agencies to select R&D projects (e.g. Santamaría et al. (2010)). Moreover, the literature on financial constraints struggles to find a consistent methodology to both identifying whether firms are constrained and measuring the relative degree of constraints (see Silva and Carreira (2012b), for a survey of these methodologies). In order to provide robust findings, we use different methodologies, namely: (i) a self-assessed measure; (ii) the Musso-Schiavo (MS) index; (iii) an adaptation of the MS index to encompass different levels of constraints across industries (weighted MS), a novelty in the literature; and (iv) the Hovakimien-Hovakimien (HH) index.

The paper is organized as follows. Section 2 overviews what is generally known about the role of innovation subsidies and the existence of firms' financial constraints, as well as it formulates the main hypotheses to be tested. In Section 3 we describe the dataset and methodology used, whereas the main empirical results and their discussion can be found in Sections 4. Finally, Section 5 pulls the pieces together and concludes.

2. THEORETICAL BACKGROUND, LITERATURE REVIEW AND HYPOTHESES

2.1. Access to Finance and Firms' Financial Constraints

Although innovation plays a critical role in promoting economic growth, innovative firms often turn out to be financially constrained. Indeed, "innovations are carried out by means of borrowed money" (Schumpeter (1939, p. 223)). Firms' financial constraints are, however, empirically not observable—albeit for subjective firm self-evaluation, it is not directly measurable. As a result, researchers have strived to develop methodologies that consistently allow identifying and measuring such constraints (see, for example, Hubbard (1998), Carreira and Silva (2010) or Coad (2010) for a survey).

The empirical analysis of firms' financial constraints can essentially be traced back to the seminal work of Fazzari et al. (1988), who introduced the well-known investment to cash-flow sensitivity (ICFS) approach. Even though this methodology is, by far, the most commonly employed, it has been seriously challenged both at empirical and theoretical levels (e.g. Kaplan and Zingales (1997), Alti (2003)). Thus, ever since, the empirical literature has strived to find other consistent methodologies to measure constraints. Examples of these measures can be found in Almeida et al. (2004), who suggest the use of cash to cash-flow sensitivities (CCFS), the Euler equation approach proposed by Whited (1992), different composite indexes such as those suggested by Lamont et al. (2001), Whited and Wu (2006) or Musso and Schiavo (2008) and, recently, firm-level cash-flow sensitivities in line with Hovakimien and Hovakimien (2009)—not to mention the use of proxies and, when available, credit ratings (e.g. Czarnitzki (2006), Czarnitzki and Hottenrott (2011)).

There are a number of advantages and disadvantages of using each measure. In fact, due to the nature of financial constraints (firm-specific, time-varying, and not a clear-cut dichotomous phenomenon), finding an objective and consistent measure of constraints may prove to be a serious challenge. To circumvent this challenge, we are some of the very few that make use of different methodologies, a strategy that allows us to robustly identify financial constraints in this paper.

2.2. Why Subsidise Innovative Activities?

The main theoretical arguments for direct public financial support of private innovation efforts and R&D spending (hereafter subsidies for simplicity) can be summarised in two types of market failures, which may lead to an under-investment in innovation activities: spillovers or incomplete appropriability of innovations and financing constraints. Due to the public-good nature of knowledge, the benefits of research spillover to other firms and are only partially appropriated by innovator. The private returns from R&D investment are thus smaller than the social returns and, as a consequence, without government intervention in order to compensate this gap, firms will invest less in innovation than is socially desirable (Becker (2015).

Even if the imperfect appropriation problem did not exist, R&D investment is still expected to be more financially constrained than, for example, investments in physical capital. Indeed, in contrast with physical capital, this type of investment is not only more complicated to use as collateral when resorting to external finance, but is also of a riskier nature and entails significant information asymmetry problems (Hall (2002), Hall and Lerner (2010)). Moreover, it is not guaranteed that an innovation would be obtained as an outcome of R&D investments, nor can one be sure about the market success of such innovation. Furthermore, the innovator typically has more and better information about the nature and economic potential of an R&D investment than potential financiers. This information asymmetry failure may be further amplified if firms try to conceal their R&D projects, fearing any leak of information to competitors that could prove to be fatal in their attempt to be innovative and obtain a market edge. As a consequence, the "lemon's premium" (i.e., the cost of external funds) to finance R&D will be higher than the cost of physical capital investment (Akerlof (1970)). In business surveys, firms generally cite the lack of external finance as a major impediment to their R&D investments (Harhoff and Körting (1998)).

2.3. Financial Constraints, Subsidies to Innovation and R&D Investment

Within the empirical literature on innovation, we identify two different, but closely related lines of research. On the one hand, there is a large body of literature that stresses the impact of financial

constraints as a barrier to R&D investment and innovation (Brown et al. (2012), Hall and Lerner (2010)).[3] On the other, there exists a relatively large literature evaluating the effects of public R&D subsidies on firms' R&D spending and innovation performance (see David et al. (2000), Klette et al. (2000), for surveys). The first main focus of this research branch stream is whether subsidies stimulate ("add to") or substitute ("crowd out") private R&D investment. In general, studies that take into account selection bias issues have found evidence of an additionality effect of public funding upon R&D investment.[4] Several other papers have focused on whether R&D subsidies provide a certification effect, thereby enhancing firms' access to external financing and relieving financial constraints. Indeed, obtaining R&D subsidies provides a positive signal about firms' quality that facilitates firms to access a broader range of funding sources (e.g. Feldman and Kelley (2006)), such as venture capital (e.g. Lerner (1999)) and long-term debt (e.g. Meuleman and De Maeseneire (2012)). However, subsidies may lead to a relative inertia of firms—which may eventually become subsidy dependent, illustrated by the "subsidy persistence" effect found in

[3] Examples, using ICFS as a measure of financial constraints, include Hall (1992), who examined a large panel of U.S. manufacturing firms from 1973 to 1987; Hao and Jaffe (1993) and Himmelberg and Petersen (1994), who analysed U.S. firms in high-technology industries; Harhoff (1998), who studied German firms in the period 1987–1994; Hall et al. (1999), who compared French, Japanese and U.S. firms; Bond et al. (2003), who compared German and U.K manufacturing firms over the period 1985-1994; Bougheas et al. (2003), who examined a large panel of Irish manufacturing firms; and Magri (2010), who analysed the Italian manufacturing firms. Similar results have been documented using other measures of financial constraints. For example, Czarnitzki (2006) and Czarnitzki and Hottenrott (2011), for West German and German firms, respectively, resorting to measures such as price–cost margin (a proxy for cash flow), credit ratings and public funding, found that R&D investment of small- and medium-sized companies (SMEs) is financially constrained. Mueller and Zimmermann (2006), using a panel of German SMEs, have shown that a higher equity ratio is conducive to a higher R&D intensity. Mohnen et al. (2008) and Savignac (2008), using firm self-assessment of financial constraints of Dutch and French firms, respectively, have observed that financial constraints significantly reduce the likelihood of firms having innovative activities. Finally, Silva and Carreira (2012a), using both indirect and direct measures of constraints, found that financial constraints have a perverse effect upon R&D investment and innovation of Portuguese firms.

[4] Empirical contributions comprise, for example, Almus and Czarnitzki (2003), who analysed the effects of public R&D policy schemes on the innovation activities of Eastern Germany firms; Duguet (2004) and González et al. (2005), who examined the effect of R&D subsidies on the private funding of R&D in France and Spain, respectively; Czarnitzki and Licht (2006), who evaluated the effect of public funding on R&D intensity and patent outcome in Germany; Aerts and Schmidt (2008), who examined whether subsidies crowd out firms' R&D investment in Flanders and Germany; Hussinger, 2008, and Czarnitzki and Lopes-Bento (2013), who confirmed earlier results for Germany and Flanders, respectively; Özçelik and Taymaz (2008), who studied the Turkish R&D support programs; and Czarnitzki and Hussinger (2014), who analysed the effects of subsidies on R&D input and output of German firms.

the literature (e.g. Hussinger (2008), Aschhoff (2010))—, without necessarily improving firms' capability to raise private external funds.

Figure 1 depicts the process of innovation of a firm, emphasizing the role played by financial constraints (FC) and public financial support (SUB). The first line of research essentially analyses the impact of financial constraints on innovative activity, or in other words, how much more money an unconstrained firm invests in R&D (i.e. if *R&D* (*Non-FC*) = z > *R&D* (*FC*) = $w \geq 0$). The second line of research has mostly focused on identifying an additionality effect of subsidies upon R&D investment, that is, the extent to which δ and θ are positive and, if so, how big.

[Figure 1 near here]

Although the analysis of financial constraints to innovation and the effect of subsidies on innovation are two closely related lines of research, the link between them is rather unexplored. González et al. (2005), using a panel of Spanish manufacturing firms surveyed during the 1990s, found that most subsidies go to firms that would have performed R&D otherwise, that is, to those that are most likely to be unconstrained firms. Aschhoff (2010), using a sample of German firms from 1994 to 2006, also found that firm's size increases the probability of entering in the funding schemes, a variable that is generally agreed to be negatively related with financial constraints (Carpenter and Petersen (2002), Faggiolo and Luzzi (2006), Oliveira and Fortunato (2006)). Moreover, using a panel of Portuguese firms covering the period 1996–2004, Silva and Carreira (2012a), have questioned the extent to which subsidies effectively alleviate firms' financial constraints.

2.4. What Should We Expect?

The question that we tackle in this paper is however slightly different. We focus on whether subsidies are allocated to financially constrained firms and if they effectively reduce such constraints, a subject, as we have seen, rarely explicitly explored in the empirical literature. Suppose that there are two firms that only differ in their ability to raise external funds (i.e. both firms have same social and private returns to R&D activities). While one is financially constrained the other is not. Additionally, let us assume (for

simplification) that scarce public resources force the policymaker to finance only one firm. Suppose that, due to information asymmetry problems between the firm and the policymaker, the unconstrained firm is a subsidy recipient, while the constrained one is not. Evidently, the latter will likely not be able to innovate. What if the policymaker choses to finance the constrained firm, instead of the unconstrained one? In this situation, both will be able to innovate. The reason lies on the very fact that without public funding the constrained firm may never innovate (i.e. *w* in Figure 1 can be zero), while the unconstrained firm is always able to obtain external funding (by definition).

To model the relationship between financial constraints and R&D subsidies, we propose an analytical framework depicted in Figure 2 (a zoom of the R&D investment decision in Figure 1). Model A looks at the impact of financial constraints upon the probability of a firm receiving subsidies. It describes how public financial support will affect R&D investment, depending on whether it targets a financially constrained or unconstrained firm (Figure 2a). If the subsidy is allocated to financially constrained firm and *effectively* reduces such constraints, the firm's R&D investment will be increased by θ. Alternatively, if the subsidy is allocated to the unconstrained firm, then R&D investment will increase by δ. (The question of whether δ is larger than θ is not explored in this paper.) If subsidies are not effective, then the unconstrained firm continues to invest *z*, while the constrained firm may not be able to invest (assuming w=0; Figure 2b).[5]

[Figure 2 near here]

Therefore, it seems sensible to argue that, within firms that want to innovate (and are faced with innovation opportunities), public funding should take into careful consideration those firms that otherwise would not be able to finance such innovations (financially constrained firms). Accordingly, one should expect that the probability of a firm receiving subsidies should undoubtedly depend on its level of

[5] Subsidy allocations as well as access to finance are dependent upon a number of other factors. Additional explanatory variables are also used as controls in the regressions that help testing these hypotheses. Details on the array of variables used and the expected coefficient estimate signs, are provided in the corresponding sections 3.3.1 and 3.3.2.

financial constraints, conditional on the innovation opportunity and expected returns to R&D investment. If that is not the case, then this form of public financial support may not be that different from the usual sources of private external finance. This discussion leads us to formulate the following hypothesis:

Hypothesis 1: There is a strong positive correlation between the allocation of subsidies and firms' financial constraints.

Furthermore, one should expect that subsidies (directly and indirectly) increase firms' financial capacity, at least in the short-term—when it comes to long-term financing capability, the effect may not be as clear (cf. certification effect vs. "subsidy persistence" debate discussed above). Accordingly, we put forward the following hypothesis to guide the empirical analysis:

Hypothesis 2: Subsidies have a negative and significant impact upon the extent of firms' financial constraints to invest in R&D.

3. DATA AND METHODOLOGY

3.1. Data

To test our hypotheses, we use a large sample of Portuguese firms covering the years 1996 to 2004, some of which have obtained public funding to finance their R&D activities. The raw data is drawn from the combination of three statistical data sources provided by the Portuguese National Statistical Office (INE): *Ficheiro de Unidades Estatísticas* (FUE), that contains generic characteristics (class size, age, economic activity) of all Portuguese firms; *Inquérito às Empresas Harmonizado* (IEH), an annual business survey with information on balance sheets of the universe of Portuguese firms with more than 100 employees and a representative random sample of firms with less than 100 employees—i.e. 7,079 firms observed over the period 1996–2004, corresponding to 30,177 observations—; and the Portuguese *Community Innovation Survey* (CIS), covering three successive waves, respectively, 1995–1997 (CIS2), 1998–2000 (CIS3) and

2002–2004 (CIS4)—i.e. 8,132 observations. After the merge of three statistical data sources and the exclusion of missing observations or unreasonable values (negative values and outliers), the final dataset, is composed of 3,566 observations (see the Table A1 in "Appendix" for further detail).

The use of CIS is crucial to the analysis of public financial support to firms' innovation activity. Among other variables, it contains information on innovation, R&D expenses, subsidies to innovation and a direct measure of financial constraints to innovate—see Table A2 in "Appendix" for a detailed description of the variables used. The main caveat of this dataset is that we do not know which firms applied but did not obtain public funding (see Huergo and Trenado (2010)). The key descriptive statistics (means and standard deviations) for the main variables used in the paper are provided in Table A3 in "Appendix".

3.2. Measuring Financial Constraints

For the purpose of this paper, we define financial constraints as the inability of a firm to raise the necessary funds (usually due to external finance shortage) to finance its (R&D) investments. However, as we have seen in Section 2.1, due to this abstract nature of the concept, there is no clear methodology to determine whether firms are financially constrained and, if so, their relative degree of constraints (see Silva and Carreira (2012b), for a survey). Because of this, we use different methodologies to robustly identify financial constraints: first, we construct a direct measure from the information on firms' perception of constraints—available in the CIS survey; second, we employ the approach suggested by Hovakimien and Hovakimien (2009), the HH index; finally, we resort to the methodology proposed by Musso and Schiavo (2008), the MS index, where we introduce a novelty in order to allow for comparability across industries.

3.2.1. Direct Measure

The first measure employed to assess firms' financial constraints is constructed from a survey question on the extent to which firms perceive that the lack of external finance significantly hampered their innovation

activity (see Table A2 in "Appendix" for further detail). Using firms' self-evaluation of financial constraints has a number of advantages and disadvantages that we summarize below.

The main advantage of using this measure results from the fact that firms are the best informed agents with respect to the quality of their investment projects. Therefore, one should expect that investment opportunities are already taken into account in firms' responses (a challenge in typical measures of constraints). This measure is partly determined by the ability to innovate—a firm will consider itself to be unconstrained if the expected returns to innovation efforts outweighs the costs (including those associated with raising additional funds, if this is a possibility). Hence, innovation opportunities may still need to be taken into account.

The subjective nature of the self-assessed variable means that potential biases, resulting from individuals' perception, may exist. As an example, we might have respondents that feel that their firm is highly financially constrained, when it actually is much less constrained than another firm reporting a low level of constraints.[6] Furthermore, it is worthwhile noticing that the qualitative nature of the underlying question results in an ordinal variable, which requires the appropriate non-linear estimation techniques.

Even though we do not have information on subsidy amounts, we are able to extract (from the CIS surveys) a binary variable that indicates whether or not a firm received subsidies to innovation. It is also worthwhile mentioning that this variable results from a much more objective underlying question than, for example, the survey's question on firms' self-assessed financial constraints. Although in the former firms are asked if they have received public funding, the latter requires that firms reveal their perception on how difficult it is to obtain external finance, which carries a significant amount of subjectivity.

[6] Some studies overcome this problem by using data on the credit requested and effectively granted (e.g. Meuleman and De Maeseneire (2012), Russo and Rossi (2001)), however we do not have access to such information.

3.2.2. HH Index

Alternatively, we also resort to the HH index that avoids the subjectivity and non-linearity problems of our direct measure. This index is an indirect measure that picks the firm-specific relationship between investment and cash-flow, in the light of the well-known approach based on ICFS.

The HH index compares the time average of investment weighted by cash-flow, against the simple time-average of investment. Accordingly, investment receives a higher weight in years when cash-flow is higher, capturing the sensitivity of investment with respect to variations of cash-flow. Therefore, if a firm invests more (less) in years with higher cash flow, the HH index will yield positive (negative) values. The reverse is also true. The index is constructed in the following way:

$$HH_i = \sum_{t=1}^{n}\left[\frac{(CF/K)_{it}}{\sum_{t=1}^{n}(CF/K)_{it}} * \left(\frac{I}{K}\right)_{it}\right] - \frac{1}{n}\sum_{t=1}^{n}\left(\frac{I}{K}\right)_{it}, \quad (1)$$

where *CF* is cash-flow, *I* is investment, *K* is total assets, *n* the number of annual (*t*) observations for firm *i*. However, in order to avoid extreme negative values, all cash-flow observations with negative values are set to zero.[7]

Even though this measure captures firm-level heterogeneity of financial constraints, these are assumed to be constant over time. Therefore, this approach does not account for the possibility that the same firm faces different states of constraints along the timeline, nor does it does not allow to account for endogeneity through lagged regressors. Additionally, this methodology fails to control for investment opportunities and other variables affecting investment, and does not explore marginal effects (see

[7] This is the same procedure as in Hovakimien and Hovakimien (2009). We also eliminate firms for which investment level is only observed once.

D'Espallier et al. (2009), for a critique).[8] Finally, it assumes that ICFS correctly identifies firms' financial constraints (see Kaplan and Zingales (1997)).

3.2.3. MS Index

A good measure of financial constraints should be firm-specific as well as time-varying. In this line, Musso and Schiavo (2008) proposed an index that allows for individual and temporal heterogeneity of constraints. The strategy is to rank firms (according to proxies of financial constraints) in a certain class (e.g. industry) that is believed to be reasonably homogeneous. Therefore, one can build a score of constraints based on the relative rankings of a given number of variables for a certain firm, within a certain class. The motivation for using homogeneous classes is to account for specificities that may affect the relationship of the proxies and the genuine level of constraints. As a result, for a given firm, higher values of the MS index will reflect a higher level of constraints relative to the mean in each class.

The procedure takes two steps. First, we identify a number of proxies of financial constraints.[9] Second, for each of these variables, we compute the relative position (rank) of each firm to the corresponding industry mean. Third, to allow for different degrees of constraints, we build intermediate levels based on the individual rankings—we create five distinct levels according to the quintiles of the

[8] The tests based on Fazzari et al. (1998) rely on the on the assumption that, holding investment opportunities constant, investment responds positively to cash-flow if a firms is financially constrained (no sensitivity should be found for unconstrained firms).

[9] The index is constructed based on the following variables: size (total assets), profitability, liquidity (current asset over current liabilities), cash flow generating ability (the maximum amount of resources that a firm can devote to self-financing), solvency (own funds over total liabilities), trade credit over total assets, and repaying ability (financial debt over cash flow). See Muso and Schiavo (2008) and Silva and Carreira (2012b) for further details on proxies of financial constraints and a detailed overview of the use of these specific variables. It is also important to note that both the original MS index and our modified version, both suffer from endogeneity as some of the variable that make up the index can be both a determinant and an outcome of financial constraints (e.g. leverage; solvency), a challenge addressed using lagged values. To avoid extreme values, all variables are winsorized at the 1% level.

relative distribution of each proxy. Finally, we collapse the rankings from all the proxies into a single score of financial constraints for each firm-year.[10]

We should note however that there are two major drawbacks when using this approach. Firstly, if there are non-linearities in the relationship between the proxy and the effective level of constraints, the final score will misrepresent the level of constraints. In this situation, nothing guarantees that the difference between a firm scoring 1 and 2 is the same as the difference between the levels 2 and 3. As a result, the score of constraints must be analysed as an ordinal variable, which has significant implications in the choice of the estimation procedure. Secondly, the disaggregation in relatively homogeneous classes of firms might entail considerable difficulties when comparing firms across classes. As an example, if the index is built on relative rankings for each industry, and if the less constrained firms in industry A are more constrained than the most constrained firm in industry B, one cannot compare the scores of firms in industries A and B because of different benchmarks.[11]

We are able to overcome some of these difficulties by introducing a methodological modification to the original MS measure. We do so by using the appropriate non-linear regression techniques to weight each firm's score by the corresponding industry's average level of financial constraints. To obtain industry average levels of financial constraints, we estimate the CCFS at the industry level, in line with the methodology suggested by Almeida et al. (2004).

On the whole, the measurement of firms' access to finance is vulnerable to a range of methodological challenges. As different measures have complementary advantages and disadvantages, it is hard to clearly point a superior approach. While the direct self-reported measure of FC is both firm-specific and time-varying, it is to some extent subjective and of a qualitative nature. The HH Index is

[10] We collapsed the different variable rankings by summing them over each firm (obtain a score) and we then rescale the index to 1-10, using the deciles of the score distribution.

[11] Note that firms operating in some industries are, on average, more constrained than firms in other industries (Hyytinen and Toivanen (2005)).

firm-specific and easy to compute as data and computational requirements are low, but it does not vary across time, assumes ICFS effectively measures constraints and, most importantly, fails to control for investment opportunities and other relevant variables. The augmented MS Index introduced in this paper has the advantage of being both firm-specific, and time-varying, but may still entail some challenges associated with possible non-monotonic relationships between the proxies used and financial constraints. Overall, despite the distinct advantages and drawbacks of the different measures, one can be confident in findings, should the statistical results be robust across a number of distinct measures of financial constraints.

3.3. Empirical approach

The analysis of the nexus between innovation subsidies and firms' financial constraints reveals a number of difficulties associated with the non-linear nature of the variables of interest (Table A4 in "Appendix"), and with endogeneity problems. Furthermore, the scope for choosing the empirical approach is also largely bounded by the structure of the dataset.

Even though the usual problem related to survey artificial correlation between variables of interest may not be as serious due to the objectivity of our subsidy variable, there are nevertheless reasons to suspect of endogeneity. Firstly, if a firm is financially constrained, it might be seen as a potentially more appropriate target for public policy, as well as there is a higher probability that it applies for subsidies (we do not have data on subsidy requests). Secondly, endogeneity may be present due to potentially correlated unobservables. Among others, we should refer to public policy goals and budgets, firms' applications for subsidy programs and the quality of the underlying project (Jaffe (2002), Schneider and Veugelers (2010)).

The combination of non-linear estimation techniques that accommodate binary and either ordinal or continuous variables and possible endogeneity issues result in the use of distinct estimation techniques. Additionally, if the existence of financial constraints increases the probability of a firm being subsidy recipient, and if subsidies reduce financial constraints, it seems sensible to make use of the panel structure

of our data and introduce lags—we will use lagged balance sheet variables and also test some specifications specification with lagged CIS variables.

3.3.1. Empirical Model

To test hypotheses 1 and 2, we specify a model of two (latent) simultaneous equations to describe the relationship between subsidies and financial constraints as follows:[12]

$$\begin{cases} SUB^{*} = X_1\beta_1 + \alpha_1 FC + \varepsilon_1 \\ FC^{C*} = X_2\beta_2 + \alpha_2 SUB + \varepsilon_2 \end{cases} . \quad (2)$$

where *SUB* is the binary indicator of whether a firm received subsidies, *FC* is a measure of financial constraints, whereas SUB^{*} and FC^{*} are the corresponding unobserved latent variables.[13] The vector X_1 includes a number of variables that may influence the probability of a firm receiving a subsidy, that is: firm size, firm age, percentage of R&D employees, market share, exports, percentage of foreign capital, cooperation with other firms and institutions, share of subsidies by industry and region, registry of patents, and intangibles assets. Table 1 provides an overview of the expected signs of each coefficient.

[Table 1 near here]

Furthermore, in the vector X_2 we include the usual determinants of *FC*. This equation explains financial constraints through the combination of both firms' characteristics and financial variables, that is: firm size, firm age, 2-digit industry dummies; percentage of public and foreign capital, sales growth, cash stocks, cash-flow, leverage, debt and equity issuances, variations of interest paid, returns on financial investments, exports, and market share. All these variables are obtained from balance sheets. Therefore, we use the first lag of these variables to account for the CIS wave span and reduce artificial survey

[12] The model is constructed based on latent variables because our subsidy variable is dichotomous and both the MS index and direct measure of constraints (self-assessment) are of ordinal nature (Table A4 in "Appendix").

[13] When we test the corresponding probit, where we do not control for the possible endogeneity of financial constraints, the ordinal FC variable is collapsed into a binary indicator. Additionally, when we use a specification with the wave lag of financial constraints, we dropped the HH index measure due to lack of time variability by construction.

correlation. Exceptions are percentage of public and foreign capital, sales growth, debt and equity issuances, and variation of interest paid, either because they do not have sufficient annual variation, or their construction is based on the previous period (would imply the loss of all CIS2 observations).

3.3.2. Estimation Strategy

As discussed before, we use different estimation strategies to test our hypotheses. First, we conduct the appropriate linear or non-linear regressions separately to each equation of model (2).[14] However, there may be some degree of endogeneity of the main variables of interest. Thus, second, we also estimate a reduced form equations model (2), assuming $\alpha_2=0$ in the case of testing hypothesis 1 and $\alpha_1=0$ in the case of hypothesis 2, and normalized variance of the errors. This would result in an instrumental variables estimation approach, where X_2 and X_1 would be the set of instruments for testing hypotheses 1 and 2, respectively.[15]

It is however important to note that finding appropriate instruments for subsidies, on the one hand, and financial constraints, on the other, can be rather challenging. This is particularly relevant for the identification of the reduced form equations. Accordingly, we make use of the length in our panel to introduced lagged variables in the single-equation estimations. But this approach also entails some challenges related to the dataset. While we lag all the financial variables included in the vector X_2, this strategy is not feasible in the context of variables resulting from the CIS survey (see Section 3.1).

Finally, to test the robustness of results, we also estimate treatment effects. More specifically, and within the scope of hypothesis 1, we estimate the effect of a firm being financially constrained (treatment) on the subsidy allocation (outcome). In order to further test hypothesis 2, we estimate the effect that

[14] The estimation of marginal effects in some of the non-linear specifications is of rather hard computation and above all interpretation, so we refrain from estimating them. Nevertheless, interest lies in the signal rather than on the magnitude of the effects.

[15] Note that identification would rely on the variables *R&D employees*, *Intangibles*, *Cooperation*, *Share sub. industry*, *Share sub. region* and *Patents* for testing hypothesis 1 and on *Sales growth*, *Cash-flow*, *Cash stocks*, *Leverage*, *Issuances*, *Δ Interest paid*, *Returns financial investments* and *Public capital* for testing hypothesis 2.

receiving a subsidy (treatment) has upon the level of financial constraints (outcome), both by resorting to propensity score matching and a differences-in-differences approach. Propensity scores are calculated using a probit specification and matching performed with replacement (see Table A10 in "Appendix").[16]

4. EMPIRICAL RESULTS

4.1. Descriptive Statistics

There are a remarkable number of firms that face financial constraints (see Table A5 in "Appendix"). Although only 56% of firms report not to be constrained, the HH index is higher than zero for 54% of the observed firms, suggesting the presence of constraints. With respect to the MS and weighted MS indexes, this picture is not as clear because there is no objective threshold distinguishing firms between constrained and unconstrained. Nonetheless, there are a noteworthy number of firms in the higher rankings of the index.

As we can see from Table 2, although 44% of firms report financial constraints (16% reporting high levels of constraints), only 12% are subsidised. Of the highly constrained firms, only 14% receive subsidies, whereas of those that report no constraints, 10% still obtains subsidies. Additionally, of firms that reported the absence of constraints, 25% receive subsidies in the subsequent period. Conversely, 20% of subsidised firms in one period continue to report the highest level of constraints in the following period (only 39% reports not to be constrained). These descriptive statistics provide the first hint that our hypotheses 1 and 2 are questionable.

[Table 2 near here]

This picture does not change if, instead of a subjective self-assessed variable, we use the MS index to measure financial constraints (Table 3). In fact, although 15% of unconstrained firms (lower MS index rank) are subsidised, only 12% of firms in the highest rank of constraints receive subsidies.

[16] In the implementation, balancing property tests suggest that variables *Foreign capital* and *Share of subsidies in region* should be removed from the vector X_1 and that Δ *Interest paid* removed from vector X_2, to ensure that the balancing property holds.

Furthermore, of unconstrained firms in one period, 22% received subsidies in the following one. In this line, the fact that none (0%) of those firms found to be highly constrained in the preceding period received any sort of subsidy in the next period comes up as a striking number. When it comes to the effects of subsidies, if we group firms in the three higher ranks of the index (levels 8-10), we find that 24% of previously subsidised firms continue to face severe financial constraints.

[Table 3 near here]

With respect to the continuous measures of constraints, we test whether the distribution of such variables for subsidy recipients dominates that of non-recipient ones (Table 4). We find that non-subsidised firms have a higher probability to take on higher values of the weighted MS index with respect to the subsidised firms. In other words, non-recipients are in general more financially constrained. The same is not true when it comes to the HH index. In fact, even if we cannot reject the equality of distributions, the negative sign associated with the Fligner-Policello test suggests that, using this measure, subsidised firms are in general more financially constrained.

[Table 4 near here]

Finally, we compare the distributions of the main variables of interest for the subsample of firms that do not receive subsidies, against those that do (Table A3 in "Appendix"). The typical subsidy recipient in our dataset is larger, more export driven, employs a larger share of personnel devoted to R&D, has a larger share of intangible assets, registers patents, cooperates with other private or public institutions and usually belongs to an industry that is more prone to receive subsidies.[17] In terms of industrial activity, subsidies are essentially given to manufacturing firms (73.11%), with a dominant presence of firms in textiles (12.5%), electric, optic and other equipment (11.79%) and chemicals (9.91%).

These descriptive statistics already make a strong case for the rejection of either hypothesis 1 or 2. While they clearly show that subsidies were provided to companies that were not financially constrained,

[17] If we compare the same variables, with respect to their values in the preceding CIS wave, the interpretation of results remains unchanged except for firm exporting behavior. Subsidy recipient firms exported less in the past.

they also indicate that subsidies do not mitigate financial constraints. Nonetheless, we provide more compelling evidence with the econometric analysis that follows.

4.2. Subsidy Allocation

As we can see in Tables 5 and 6, the extent to which a firm is financially constrained appears to have no impact upon the probability that it receives public financial support.[18] This result is robust to different measures and estimations strategies—the financial constraints coefficient is not statistically significant at conventional levels (see also Tables A6 and A7 in "Appendix"). The only exception is found with respect to the use of the HH index (column (4) of Table 5), where financial constraints are found to increase the probability of a firm receiving subsidies (statistically significant at the 5% level). When we introduce a time dimension (the CIS waves), the extent to which a firm is financially constrained *ex-ante* does not also affect the probability that it is subsidy recipient (Table 6). The interpretation of results remains unchanged when we use forward R&D investments as a proxy to control for innovation investment opportunities, either (Table A7 in "Appendix"). As a consequence, these results lead to the rejection of our hypothesis 1 that states that subsidies are being allocated to financially constrained firms.

[Tables 5 and 6 near here]

Therefore, one might well be subsidising firms that do not necessarily require public funding to undertake their innovation projects, because they are able to obtain private funds. Conversely, constrained firms that are not subsidy recipients will hardly be able to innovate as they lack financial resources. The worrying fact is that, as we have seen in Section 4.1, these firms are not so few.

The impact of size also seems to reinforce this finding. In fact, large firms, which are generally less financially constrained, have a higher probability of receiving a subsidy. This can occur because large firms, as a consequence of having more resources for tracing funding opportunities, may have information

[18] There is no clear evidence suggesting that financial constraints are endogenous because we cannot reject that the equations determining subsidies and financial constraints are independent (ρ=0 in Table A6 in "Appendix").

advantages. Therefore, larger firms may have a higher probability of applying to R&D funding programs than smaller firms.

There are important variables explaining the allocation of subsidies (e.g. size; exports) that are not different from what private investors and lenders take into consideration when deciding to finance the R&D project of a firm.[19] A possible explanation is that for R&D policies appear to be successful, government agencies may use selection criteria that put heavy weight on factors that are positively correlated with high expected private rates of return. However, in this case, subsidies may not be different from private external financing.

These findings are in line with the descriptive statistics and provide compelling evidence that hypothesis 1 should be rejected. In other words, our results suggest that the correlation between subsidies and firms' financial constraints is not significantly positive.

4.3. Subsidy Effectiveness

In Tables 7 and 8 we test whether subsidies reduces firms' financial constraints—in the former we assume that subsidies are exogenous, while in the latter we use the lagged subsidy variables.[20] Both specifications yield puzzling results. Regardless of the measure of financial constraints used, we do not find that subsidies mitigate such constraints. On the contrary, we find a positive and statistically significant impact of subsidies upon the level of constraints in some of the specifications. These results suggest a rejection of our hypothesis 2 that subsidies alleviate financial constraints. The coefficients of other explanatory variables are broadly in line with the expectations described in Table 1.

[Tables 7 and 8 near here]

[19] In fact, comparing our results with the expectations described in Table 1, size and age are two of the key controls that do not exhibit the expect sign.

[20] In Table A8 in Appendix we assume that subsidies are endogenous. The use of this specification seems sensible, since $\varsigma \neq 0$ in columns (1), (2) and (4).

Given the challenges with identifying the right instruments described in Section 3, we further adopt a treatment analysis approach. Accordingly, the group of subsidy recipient firms (treated) is compared to those that do not receive subsidies (non-treated). Using propensity score matching on a wide set of firm characteristics, we are able to disentangle the effects resulting from receiving a treatment.[21] Both the control and treatment groups have common support (Figure 3) and the underlying distributions of propensity scores between the control and treatment group do not differ significantly (see Table A11 and Figure A1 in "Appendix"). In other words, the set of variables used to compute the propensity scores allows us to compare the change in financial constraints amongst the two sets of firms (subsidised and non-subsidised) that have similar characteristics.

[Figure 3 near here]

The results, shown in Table 9 indicate that the average treatment on the treated (ATET) is positive and statistically significant for two out of the four measured financial constraints outcomes—for the remaining, effects are not statistically different from zero. This suggests that, if there is any effect of subsidies upon financial constraints, this should be positive. Overall, the results reinforce the rejection of hypothesis 2 stating that subsidies should alleviate financial constraints.[22]

[Table 9 near here]

The structure of our dataset limits the scope for further investigating these effects using differences-in-differences. Nevertheless, we assign a specific year for the treatment (2000) and focus on

[21] Variables used as firm characteristics for the propensity score matching include size, age, public capital, foreign capital, sales growth, cash stocks, cash-flow, leverage, debt issuances, financial investments, exports and market share.

[22] These results should be taken with a grain of salt. This type of analysis also has some limitations that relate to the underlying assumptions. First, we assume that all factors leading to a firm being subsidised are considered (unconfoundedness). In practice however, we do not have detailed information about the subsidy attribution process, thus some unobservable subsidy attribution criteria as well as policymakers' preferences are likely to be left out. Second, this type of analysis requires the stable unit treatment value assumption (SUTVA, see e.g. Rubin, 1986), which in practice means that treating one firm does not affect the outcome of others and that treatments are comparable. In our case, it is not implausible to assume that treating one firm may affect the outcomes (financial constraints) of others (e.g. when firms are direct competitors) and we cannot guarantee that subsidies are provided in the same conditions and fully comparable across different firms (e.g. exact subsidy amounts might differ).

the second CIS wave (2000) to allow sufficient observations pre- and post-treatment (this yields 295 treated in a total of 10,841 companies). The results remain unchanged, more precisely, firms receiving subsidies in 2000 have seen their financial constraints increased after the subsidy, compared to their previous level of constraints and also *vis a vis* other firms that were not subsidised (Table A9 in "Appendix").

These findings are also in line with the descriptive statistics and provide compelling evidence that hypothesis 2 should be rejected. In other words, our results suggest that public R&D funding does not alleviate financial constraints. In addition, our results suggest a certain accommodation of subsidy recipient firms, driving a subsidy persistence problem with no obvious impact upon the level of constraints. In fact, it is clear that subsidies do not mitigate financial constraints. If there is any effect at all, some of the results suggest that constraints could be amplified if a firm receives subsidies. This puzzling finding is rather interesting per se and possible explanations could be suggested. For example, we are not able to test whether after receiving subsidies, firms identify new innovation opportunities for which they are financially constrained—even though firms should in principle be in a better financial situation, boosted by the subsidy insofar as the support is effective. Another possible explanation relates to the fact that these subsidies are strictly designed to foster innovation, regardless of firms' difficulties in raising external funds. This means that there is no "signalling" effect to investors and that ultimately, funds are not being allocated to those firms in need. The design of the specific "subsidies" may also play an important role. Different forms of public incentives (such as special credit lines and backed debt), may prove to be more effective in reducing constraints. Regrettably, we do not have sufficient information to distinguish these forms of support from subsidies *strictu sensu* (e.g. grants and tax credit). Finally, it also seems plausible to assume that subsidies drive the pressure from selection forces away, leading to a relative inertia of subsidised firms with regards to innovation activity, in line with the views of Schumpeter (Schumpeter, 1939).

5. CONCLUSION

The underlying question throughout this paper is whether subsidies are being allocated to financially constrained firms, as well as whether subsidies alleviate such constraints. For this purpose, we employ different estimation strategies using distinct measures of financial constraints.

As our findings indicate, the extent to which firms are financially constrained is not taken into consideration when allocating public funding. Evidence of this type of subsidy misallocation is clear both from the descriptive statistics and the regression analysis results that are robust to several specifications. Also, this result is robust to different approaches used to identify and measure financial constraints. Moreover, the criteria used to allocate public funds for innovation do not seem to be different from those used by the private investors, which means that any market failures related to funding remain to be addressed. Even though innovation subsidies are generally regarded as having an additionality effect upon R&D investment and a positive impact upon innovation, we raise serious doubts on their role in alleviating firms' financial constraints. In fact, the results described in this paper suggest that, if the provision of public funding for R&D purposes has any effect upon firm's financial constraints, this effect is positive — i.e. subsidies further amplify financial constraints. This raises interesting questions such as the extent to which such effect is a result of misallocation of funding and\or on whether subsidies limit scope of market incentives and selection forces, leading to an accommodation of subsidy recipient firms.

Overall, we provide robust evidence that allows us to conclude that, when it comes to public funding, innovation policy should also take into account the ability of firms to raise external funds. Thus, our findings have serious implications for the design of innovation policy and its specific instruments. Accordingly, rethinking the subsidy attribution process and the design details of related direct policy instruments should be given due consideration. In particular, factors that are positively correlated with financial constraints should be given considerable weight in the selection criteria, to ensure that policy instruments are targeted at those firms effectively in need.

This paper focuses on a new line of research in the literature, insofar as it brings together two distinct and already well established research fields: (*i*) access to finance for innovative activities and (*ii*) innovation policy and related financing policy instruments. The research would certainly benefit from a

number of improvements, namely additional information (*i*) on the specific policy instruments (criteria and amounts) and (*ii*) on the set of firms that were effectively interested and applied for the public financial support. In addition, the question of whether the incremental innovation output of the unconstrained firms is larger than the innovation output of the constrained firms certainly deserves further attention in the future. Any analyses in this area would need to measure innovation output across firms, conditional on innovation opportunities, subsidies and financial constraints, as well as other relevant characteristics. Finally, future research could also investigate the effects that the recent financial crisis had upon the ability of firms to finance their innovation activities, namely looking at whether subsidies and other policy instruments have aimed those companies that are more promising, but also more in need of funding.

APPENDIX

[Tables A1 to A11 near here]

[Figure A1 near here]

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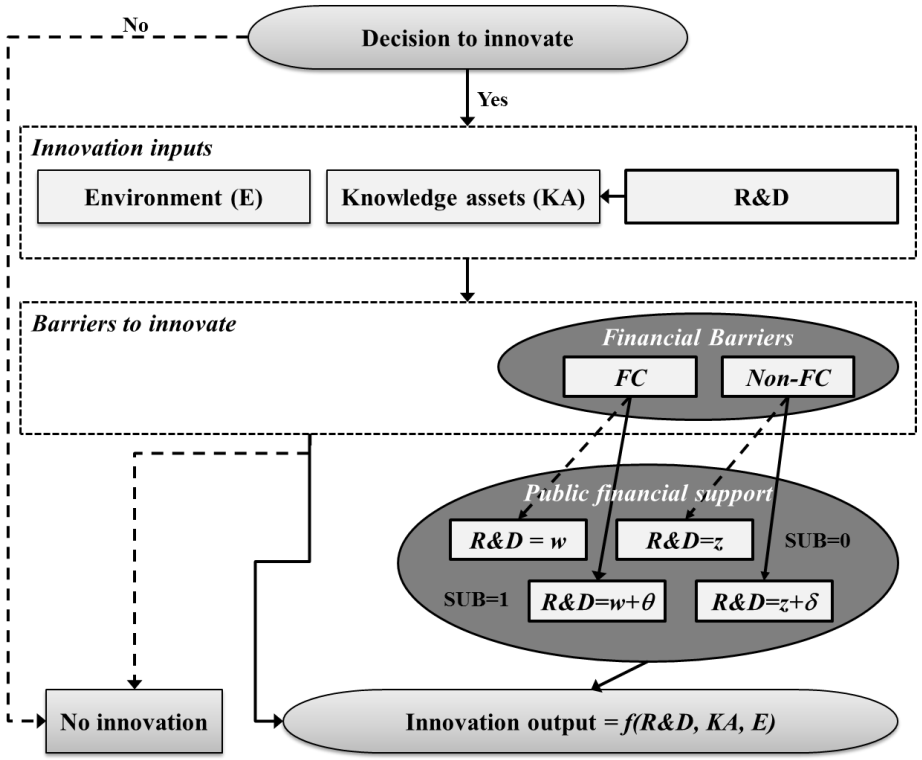
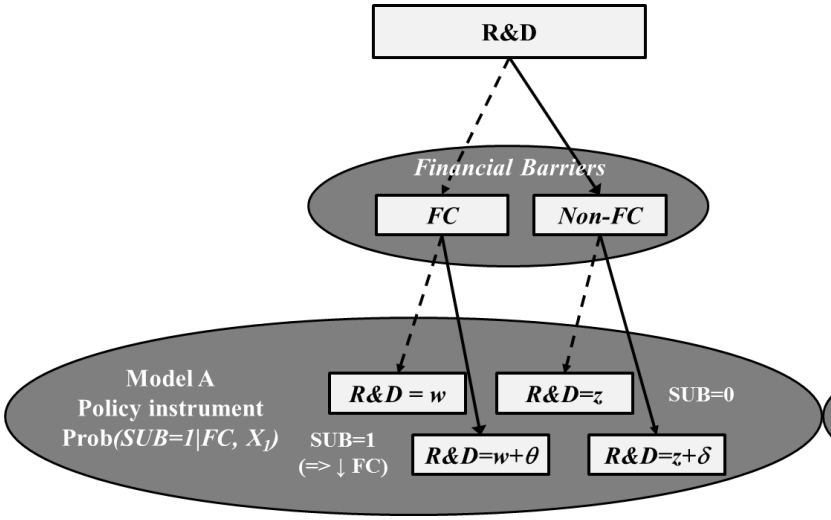


Notes: Financial constraints ≡ FC; Public financial support ≡ SUB; $z > w \geq 0$.

Figure 1. General firm's innovation model

a) Model A: the Probability of Receiving Subsidies



b) Model B: the Impact of Subsidies on Financial Constraint

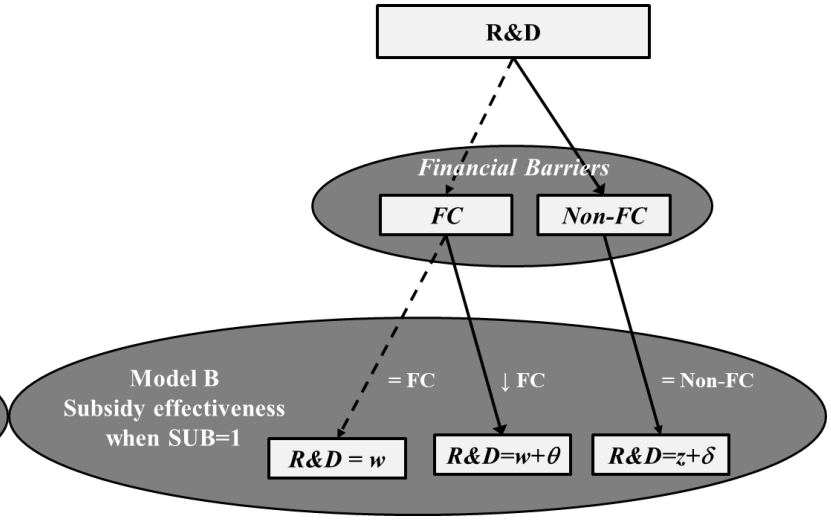


Figure 2. Conceptual model

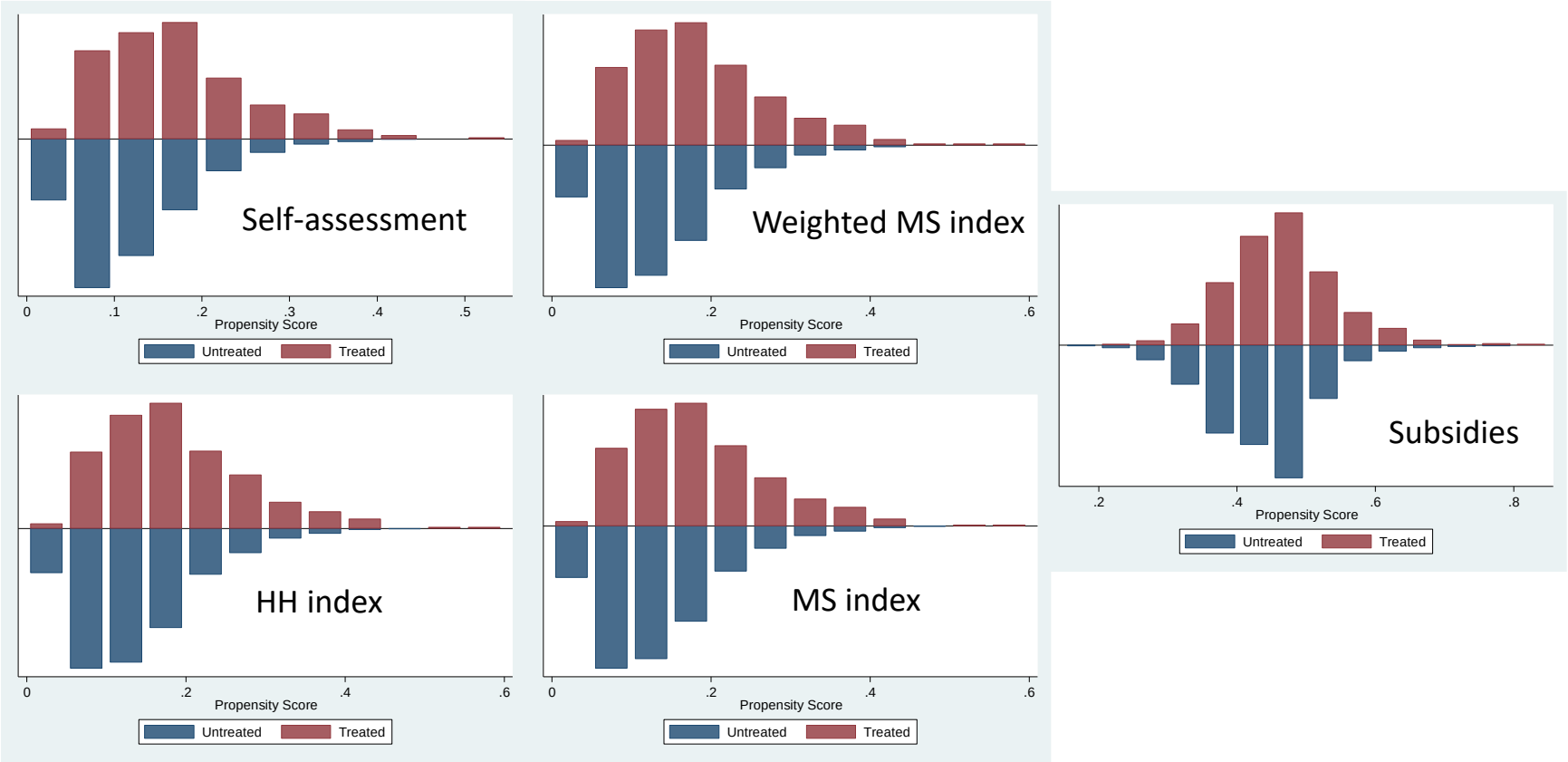


Figure 3. Propensity scores for treated versus untreated companies

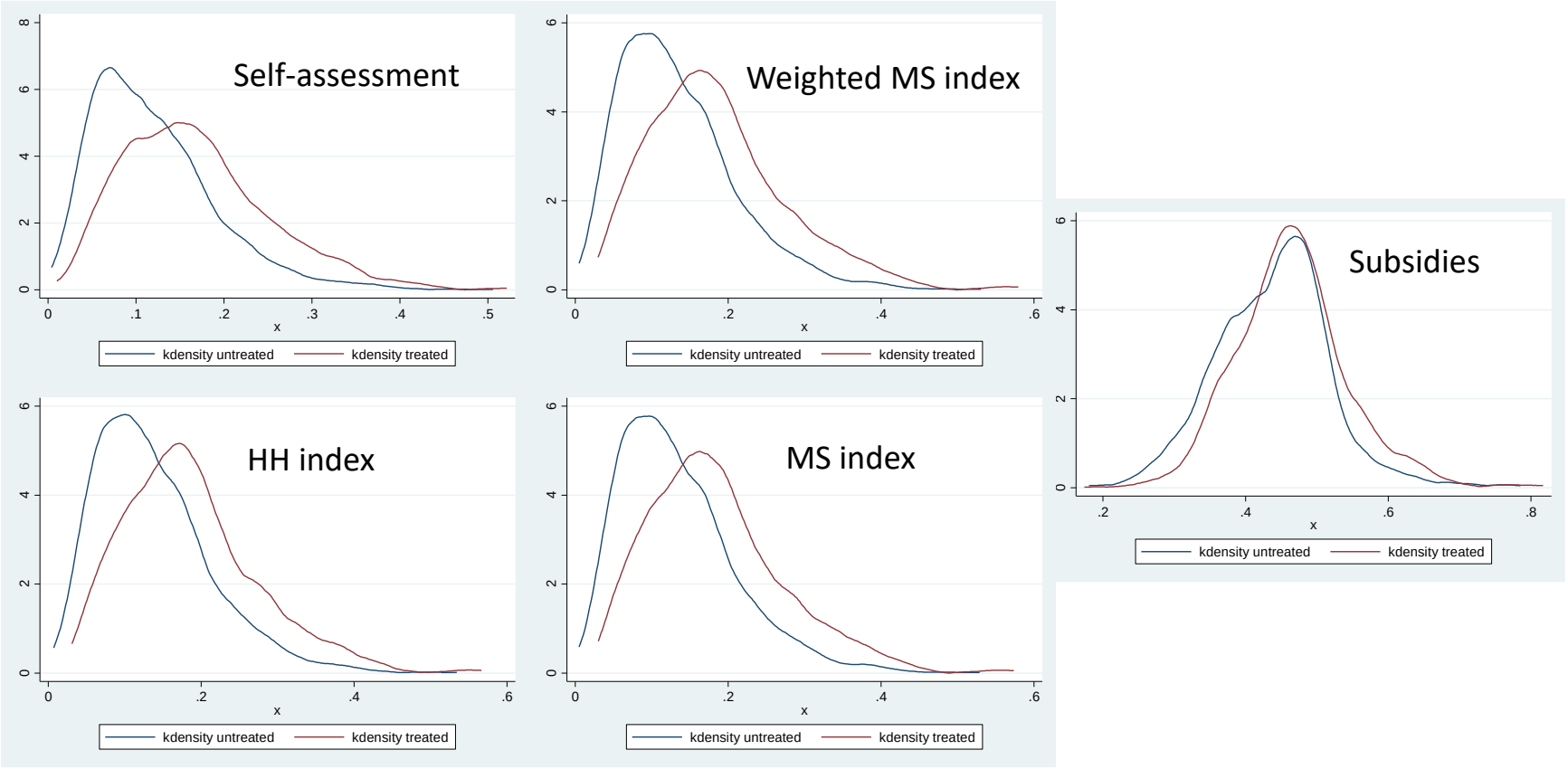


Figure A1. Kernel density estimates of propensity scores for treated and untreated companies

Table 1. Expected coefficient signs

Variables	Expected sign	Rationale
a) Variables in equation 1 (X_1)		
Size *Age*	-	The availability of external funding should increase with the size and age of a firm (Carpenter and Petersen (2002), Faggiolo and Luzzi (2006), Oliveira and Fortunato (2006)). However, policymaking may wish to aim at supporting innovative small and/or young firms for whose financing gaps are more prominent (Wilson and Silva (2013)). If that is the case, one would expect an inverse relationship between subsidies and either size or age.
R&D employees *Intangibles*	+	Companies with higher human capital, intangibles and other forms of knowledge-based assets will tend to perform better in terms of innovation. Policymakers may therefore aim at supporting companies with a wider knowledge base (OECD (2013)).
Cooperation	+	Cooperation, either with other private entities or with public players such as universities and research centres can help in innovative activities. Policymakers tend to favour knowledge diffusion, brought about by cooperation in R&D and innovation activity (see e.g. OECD, 2002 for the case of industry-science co-operation).
Foreign capital	?	Even though foreign capital may embed a non-negligible amount of knowledge transfer, firms that are (partially) owned by foreign companies may likewise have access to other sources of funding, namely capital markets abroad. Therefore, it is not entirely clear what sign one should expect of the corresponding coefficient.
Exports	?	Companies that export or have overseas operations tend not to be financially constrained (Silva and Carreira (2011)). However, governments also tend to prefer supporting companies that export and\or aim at internationalizing, as a way of promoting exports. It is therefore unclear, what sign one should expect of the corresponding coefficient.
Share sub. industry *Share sub. region*	?	Both serve as instruments for subsidies. In the absence of information on public policy budgets, the share of subsidies by industry and region will reflect policy targets that favour certain industries or regions (Schneider and Veugelers (2010)).
Market share	-	In allocating subsidies, policymakers may wish to avoid supporting market leaders and other companies with a higher degree of market power for competition-related motives.
Patents	?	Patents can serve as an indicator, for suppliers of funds, of how innovative a company is. Generally speaking, external funding should increase with the number of patented inventions a firm has (Engel and Keilbach (2007)). However, policymaking may wish to aim at supporting brand new firms, without any patent track record, in their R&D and innovation activity, at least in earlier stages of firm development where private funding is scarce (Wilson and Silva (2013)).
b) Variables in equation 2 (X_2)		
Size *Age*	-	The availability of external funding tends to increase with the size and age of a firm (Carpenter and Petersen (2002), Faggiolo and Luzzi (2006), Oliveira and Fortunato (2006)).
Public capital *Foreign capital*	--	The existence of public capital could result in easier conditions to obtain finance, either directly or through a signalling effect (Guariglia et al. (2010)). Firms that are (partially) owned by foreign companies may likewise have access to other sources of funding, namely capital markets abroad.
Sales growth	-	Sales growth can be regarded as an indicator of good investment opportunities. Good

Variables	Expected sign	Rationale
Cash-flow *Cash stocks*		investment opportunities attract additional funding. Also, sales generate additional cash that can be used to fund R&D investment. Therefore companies with higher sales growth are expected to be less financially constrained.
Leverage	+	Higher debt levels can reduce the scope for additional borrowing as equity tends to be more expensive and\or imply some degree of loss of control. Also, only a minority of firms is able to resort to (private or public) equity markets On the contrary, debt issuances directly reduce the extent to which companies are financially constrained and indicate that a company is still able to issue debt. Finally, Changes in interest paid works as an indicator of companies' credit worthiness.
Issuances	-	
Δ Interest paid	+	
Returns financial investments	-	Higher returns on financial investments indicate that a company has additional sources of revenue beyond cash generated from operational activities. These can be used up to mitigate financial constraints.
Exports	-	Companies that export or have overseas operations tend not to be financially constrained (Silva and Carreira (2011)).
Market share	-	Higher market shares increase the visibility of a company and facilitate access to funding.

Table 2. Frequencies of FC and SUB: self-assessed levels of financial constraints

	SUB_t				SUB_t				SUB_{t-1}			
	FC_t	0	1	Total	FC_{t-1}	0	1	Total	FC_t	0	1	Total
Frequency		1,781	201	1,982		275	94	369		214	53	267
SUB %	0	89.86	10.14	100	0	74.53	25.47	100	0	80.15	19.85	100
FC %		56.68	47.41	55.58		65.79	68.61	66.49		48.09	39.26	46.03
Total%		49.94	5.64	55.58		49.55	16.94	66.49		36.90	9.14	46.03
Frequency		393	53	446		42	9	51		56	24	80
SUB %	1	88.12	11.88	100	1	82.35	17.65	100	1	70.00	30.00	100
FC %		12.51	12.50	12.51		10.05	6.57	9.19		12.58	17.78	13.79
Total%		11.02	1.49	12.51		7.57	1.62	9.19		9.66	4.14	13.79
Frequency		462	89	551		45	11	56		73	31	104
SUB %	2	83.85	16.15	100	2	80.36	19.64	100	2	70.19	29.81	100
FC %		14.70	20.99	15.45		10.77	8.03	10.09		16.40	22.96	17.93
Total%		12.96	2.50	15.45		8.11	1.98	10.09		12.59	5.34	17.93
Frequency		506	81	587		56	23	79		102	27	129
SUB %	3	86.20	13.80	100	3	70.89	29.11	100	3	79.07	20.93	100
FC %		16.10	19.10	16.46		13.40	16.79	14.23		22.92	20.00	22.24
Total%		14.19	2.27	16.46		10.09	4.14	14.23		17.59	4.66	22.24
Frequency		3,142	424	3,566		418	137	555		445	135	580
SUB %	Total	88.11	11.89	100	Total	75.32	24.68	100	Total	76.72	23.28	100
FC %		100	100	100		100	100	100		100	100	100
Total%		88.11	11.89	100		75.32	24.68	100		76.72	23.28	100

Notes: Frequencies of financial constraints (rows) and subsidies (columns). SUB% (FC%) are relative frequencies within rows (columns) of each cell. For the ordinal FC variable, higher values correspond to higher reported constraints (zero for absence of constraints). For example, the first cells on the first line means that, of unconstrained firms in the current period, 89.86% are non-subsidised firms and 10.14% are subsidised (read in row). The first cells on the second line means that, of non-subsidised firms in the current period, 56.68% are unconstrained ones; and of subsidised firms in the current period, 47.41% are unconstrained ones (read in column). We additionally compare current (t) values of FC and SUB with the corresponding CIS wave lagged values (t-1).

Table 3. Frequencies of FC and SUB: MS Index

	SUB_t				SUB_t				SUB_{t-1}			
	FC_t	0	1	Total	FC_{t-1}	0	1	Total	FC_t	0	1	Total
Frequency		576	102	678		146	40	186		124	27	151
SUB %	1	84.96	15.04	100	1	78.49	21.51	100	1	82.12	17.88	100
FC %		20.19	22.52	20.51		34.03	30.08	33.10		26.16	19.29	24.59
Total%		17.42	3.09	20.51		25.98	7.12	33.10		20.20	4.40	24.59
Frequency		383	61	444		65	21	86		55	13	68
SUB %	2	86.26	13.74	100	2	75.58	24.42	100	2	80.88	19.12	100
FC %		13.42	13.47	13.43		15.15	15.79	15.30		11.60	9.29	11.07
Total%		11.58	1.85	13.43		11.57	3.74	15.30		8.96	2.12	11.07
Frequency		243	35	278		32	22	54		47	9	56
SUB %	3	87.41	12.59	100	3	59.26	40.74	100	3	83.93	16.07	100
FC %		8.52	7.73	8.41		7.46	16.54	9.61		9.92	6.43	9.12
Total%		7.35	1.06	8.41		5.69	3.91	9.61		7.65	1.47	9.12
Frequency		266	41	307		47	12	59		42	12	54
SUB %	4	86.64	13.36	100	4	79.66	20.34	100	4	77.78	22.22	100
FC %		9.32	9.05	9.29		10.96	9.02	10.50		8.86	8.57	8.79
Total%		8.05	1.24	9.29		8.36	2.14	10.50		6.84	1.95	8.79
Frequency		242	53	295		37	12	49		48	14	62
SUB %	5	82.03	17.97	100	5	75.51	24.49	100	5	77.42	22.58	100
FC %		8.48	11.70	8.92		8.62	9.02	8.72		10.13	10.00	10.10
Total%		7.32	1.60	8.92		6.58	2.14	8.72		7.82	2.28	10.10
Frequency		248	38	286		29	11	40		41	12	53
SUB %	6	86.71	13.29	100	6	72.50	27.50	100	6	77.36	22.64	100
FC %		8.69	8.39	8.65		6.76	8.27	7.12		8.65	8.57	8.63
Total%		7.50	1.15	8.65		5.16	1.96	7.12		6.68	1.95	8.63
Frequency		226	35	261		28	5	33		28	19	47
SUB %	7	86.59	13.41	100	7	84.85	15.15	100	7	59.57	40.43	100
FC %		7.92	7.73	7.89		6.53	3.76	5.87		5.91	13.57	7.65
Total%		6.84	1.06	7.89		4.98	0.89	5.87		4.56	3.09	7.65
Frequency		310	36	346		22	10	32		27	16	43
SUB %	8	89.60	10.40	100	8	68.75	31.25	100	8	62.79	37.21	100
FC %		10.87	7.95	10.47		5.13	7.52	5.69		5.70	11.43	7.00
Total%		9.38	1.09	10.47		3.91	1.78	5.69		4.40	2.61	7.00
Frequency		231	35	266		16	0	16		40	8	48
SUB %	9	86.84	13.16	100	9	100	0.00	100	9	83.33	16.67	100
FC %		8.10	7.73	8.05		3.73	0.00	2.85		8.44	5.71	7.82
Total%		6.99	1.06	8.05		2.85	0.00	2.85		6.51	1.30	7.82
Frequency		128	17	145		7	0	7		22	10	32
SUB %	10	88.28	11.72	100	10	100	0.00	100	10	68.75	31.25	100
FC %		4.49	3.75	4.39		1.63	0.00	1.25		4.64	7.14	5.21
Total%		3.87	0.51	4.39		1.25	0.00	1.25		3.58	1.63	5.21
Frequency		2,853	453	3,306		429	133	562		474	140	614
SUB %	Total	86.30	13.70	100	Total	76.33	23.67	100	Total	77.20	22.80	100
FC %		100	100	100		100	100	100		100	100	100
Total%		86.30	13.70	100		76.33	23.67	100		77.20	22.80	100

Notes: Frequencies of financial constraints (rows) and subsidies (columns). SUB% (FC%) are relative frequencies within rows (columns) of each cell. For the ordinal FC variable, higher values correspond to higher reported constraints (MS index methodology). For example, the first cells on the first line means that, of unconstrained firms in the current period, 84.96% are non-subsidised firms and 15.04% are subsidised (read in row). The first cells on the second line means that, of non-subsidised firms in the current period, 20.19% are unconstrained ones; and of subsidised firms in the current period, 22.52% are unconstrained ones (read in column).We additionally compare current (t) values of FC and SUB with the corresponding CIS wave lagged values (t-1).

Table 4. Comparison of distributions: weighted MS index and HH index

Measures	Kolmogorov-Smirnov (D)	Fligner-Policello (U)
Weighted MS index	0.136 (0.000)	5.605 (0.000)
HH index	0.045 (0.395)	-0.571 (0.568)

Notes: We test the equality of distributions of financial constraints between subsidised and non-subsidised firms. The associated P-values are in parentheses. Rejection of the null means that the two distributions are stochastic different.

Table 5. Testing hypothesis 1–subsidy allocation (exogenous financial constraints)

Variables	Self-assessment	MS index	Weighted MS index	HH index
	(1)	(2)	(3)	(4)
FC	0.107 (0.083)	0.008 (0.015)	-0.104 (0.180)	0.551** (0.236)
Size	0.069** (0.033)	0.085** (0.035)	0.084** (0.035)	0.082** (0.036)
Age	0.078 (0.049)	0.054 (0.049)	0.050 (0.050)	0.023 (0.052)
Foreign capital	-0.013 (0.053)	-0.038 (0.054)	-0.046 (0.052)	-0.048 (0.053)
R&D employees	0.177*** (0.048)	0.176*** (0.047)	0.174*** (0.047)	0.173*** (0.048)
Cooperation	0.969*** (0.088)	0.971*** (0.089)	0.975*** (0.089)	0.980*** (0.090)
Exports	0.171** (0.073)	0.182** (0.072)	0.163** (0.074)	0.168** (0.074)
Share sub. by industry	6.941*** (0.558)	7.125*** (0.569)	7.140*** (0.571)	7.148*** (0.577)
Share sub. by region	-0.007*** (0.002)	-0.009*** (0.002)	-0.009*** (0.002)	-0.008*** (0.002)
Market share	-0.906*** (0.290)	-0.998*** (0.285)	-1.015*** (0.294)	-0.887*** (0.269)
Patents	0.084 (0.055)	0.098* (0.057)	0.094* (0.057)	0.091 (0.059)
Intangibles	0.177 (0.391)	0.327 (0.402)	0.368 (0.400)	0.279 (0.414)
Observations	3,566	3,306	3,303	3,110
Log-likelihood	-434.8	-425.8	-425.6	-410.3
Pseudo-R2	0.32	0.33	0.33	0.33
AIC	895.64	877.54	877.28	846.57

Notes: Dependent variable: dichotomous subsidy variable. Regression of model (2) as a single equation probit model using different types of financial constraints: self-assed ordinal variable collapsed into binary (column 1), MS index (column 2), industry weighted MS index (column 3) and HH index (column 4). Robust standard errors in parentheses. ***, **, and * denote statistical significance at the .01, .05, and .10 levels, respectively.

Table 6. Testing hypothesis 1–subsidy allocation (lagged financial constraints)

Variables	Self-assessment		MS index		Weighted MS index	
	(1)		(2)		(3)	
FC_{w-1}	0.182	(0.208)	0.008	(0.033)	-0.657*	(0.351)
Size	0.112	(0.080)	0.121	(0.077)	0.108	(0.078)
Age	-0.026	(0.128)	0.060	(0.122)	0.017	(0.128)
Foreign capital	-0.161	(0.115)	-0.121	(0.104)	-0.125	(0.102)
R&D employees	0.155	(0.103)	0.130	(0.096)	0.121	(0.096)
Cooperation	0.998***	(0.202)	0.988***	(0.189)	1.027***	(0.190)
Exports	0.156	(0.133)	0.144	(0.131)	0.100	(0.137)
Share sub. by industry	11.054***	(1.785)	10.415***	(1.402)	10.642***	(1.456)
Share sub. by region	-0.011**	(0.005)	-0.010***	(0.004)	-0.011***	(0.004)
Market share	-0.662	(0.603)	-1.446**	(0.684)	-1.630**	(0.710)
Patents	0.108	(0.132)	0.162	(0.119)	0.166	(0.120)
Intangibles	-0.475	(0.930)	-0.331	(0.802)	-0.331	(0.810)
Observations	557		616		616	
Log-likelihood	-93.31		-106.1		-105.2	
(Pseudo) R2	0.85		0.83		0.83	

Notes: Dependent variable: dichotomous (lagged) subsidy variable. Regression of model (2) as a single equation probit model using different types of financial constraints: self-assed ordinal variable collapsed into binary (column 1), MS index (column 2) and industry weighted MS index (column 3) (HH index is dropped because it has no time variability by construction). Robust standard errors in parentheses. ***, **, and * denote statistical significance at the .01, .05, and .10 levels, respectively.

Table 7. Testing hypothesis 2–subsidy effectiveness (exogenous subsidies)

Variables	Self-assessment	MS index	Weighted MS index	HH index
	(1)	(2)	(3)	(4)
SUB	0.174** (0.074)	0.142** (0.068)	-0.008 (0.016)	0.008* (0.005)
Size	-0.050** (0.023)	-0.124*** (0.021)	-0.012** (0.005)	-0.001 (0.001)
Age	0.051 (0.039)	0.029 (0.033)	-0.026*** (0.007)	-0.007 (0.006)
Public capital	-0.002 (0.001)	-0.000 (0.001)	0.001*** (0.000)	0.000 (0.000)
Foreign capital	-0.003*** (0.001)	-0.004*** (0.001)	-0.000 (0.000)	0.000 (0.000)
Sales growth	-0.121 (0.102)	0.384*** (0.093)	0.021 (0.018)	-0.010 (0.011)
Cash stocks	-1.018*** (0.283)			
Cash-flow	-0.662** (0.318)			
Leverage	0.226** (0.108)			-0.103 (0.072)
Issuances	-0.375** (0.170)	-0.706*** (0.137)	-0.061** (0.027)	0.034 (0.043)
Δ interest paid	12.341*** (3.727)	-3.489 (3.551)	-0.512 (0.787)	1.418 (0.900)
Returns finan. invest.	-11.000 (12.050)	-15.435* (8.392)	-3.908*** (1.143)	0.045 (0.321)
Exports	-0.049 (0.060)	-0.317*** (0.045)	-0.118*** (0.008)	0.009 (0.009)
Market share	-0.165 (0.101)	-0.568*** (0.091)	-0.095*** (0.021)	-0.001 (0.008)
Observations	3,208	3,059	3,056	2,956
Log-likelihood	-1701	-3210		
(Pseudo) R2	0.03	0.03	0.139	0.03
AIC	3474.07	6460.52	525.39	1193.63

Notes: Dependent variable: self-assed financial constraint (column 1), MS index (column 2), industry weighted MS index (column 3) and; HH index (column 4). Regression of model (2) as a single equation ordered probit model in columns 1–2 and regular OLS in columns 3–4, respectively. We deliberately omit variables that are highly correlated with the measure of constraints by construction (columns 2–4). Robust standard errors in parentheses. ***, **, and * denote statistical significance at the .01, .05, and .10 levels, respectively.

Table 8. Testing hypothesis 2–subsidy effectiveness (lagged subsidies)

Variables	Self-assessment	MS index	Weighted MS index
	(1)	(2)	(3)
SUB_{w-1}	0.147 (0.124)	0.387*** (0.107)	0.018 (0.025)
Size	-0.000 (0.053)	-0.188*** (0.056)	-0.052*** (0.013)
Age	0.006 (0.090)	-0.081 (0.074)	-0.043** (0.021)
Public capital	-0.003 (0.002)	0.004* (0.003)	0.003*** (0.001)
Foreign capital	0.000 (0.002)	-0.005*** (0.001)	0.000 (0.000)
Sales growth	-0.103 (0.221)	0.066 (0.211)	-0.028 (0.037)
Cash stocks	-2.060*** (0.644)		
Cash-flow	-0.917 (0.689)		
Leverage	0.127 (0.231)		
Issuances	-0.070 (0.344)	-0.281 (0.265)	0.057 (0.056)
Δ interest paid	16.229* (8.774)	3.275 (7.957)	-1.883 (1.569)
Returns finan. invest.	7.021 (22.640)	-10.695 (13.048)	-3.794** (1.863)
Exports	-0.234** (0.094)	-0.227*** (0.085)	-0.064*** (0.015)
Market share	-0.052 (0.177)	-0.059 (0.161)	-0.060* (0.036)
Observations	556	595	595
Log-likelihood	-383.2	-697.7	
(Pseudo) R2	0.78	0.79	0.202

Notes: Dependent variable: self-assed financial constraint (column 1), MS index (column 2) and industry weighted MS index (column 3). Regression of model (2) as a single equation ordered probit model in columns 1–2 and regular OLS in column 3. We deliberately omit variables that are highly correlated with the measure of constraints by construction (columns 2-3). Robust standard errors in parentheses. ***, **, and * denote statistical significance at the .01, .05, and .10 levels, respectively.

Table 9. Subsidy effectiveness (propensity score matching)

Outcome	Self-assessment	MS index	Weighted MS index	HH index	Subsidy
Treatment	(1)	(2)	(3)	(4)	(5)
a) ATE					
Subsidy (1 vs. 0)					
Coeff.	0.23** (0.08)	0.29 (0.23)	0.00 (0.02)	0.02* (0.01)	
CI	[0.07; 0.39]	[-0.17; 0.75]	[-0.04; 0.04]	[-0.00; 0.04]	
Self-reported FC (1 vs. 0)					
Coeff.					0.03 (0.01)**
CI					[0.00; 0.05]
b) ATET					
Subsidy (1 vs. 0)					
Coeff.	0.19** (0.10)	0.43** (0.20)	-0.00 (0.02)	0.01 (0.01)	
CI	[0.00; 0.38]	[0.04; 0.82]	[-0.03; 0.03]	[-0.01; 0.03]	
Self-reported FC (1 vs. 0)					
Coeff.					0.02 (0.01)
CI					[-0.01; 0.04]
Observations	3,208	3,059	3,056	2,956	3,659

Notes: This table shows the average treatment effect (ATE) and average treatment effect on the treated (ATET) of propensity score matching. Treatment variables: subsidy allocation (columns 1-4) and binary indicator of whether a firm is financially constrained (column 5). Outcome variable: self-assed financial constraint (column 1), MS index (column 2), industry weighted MS index (column 3), HH index (column 4) and subsidy allocation (column 5). Variables used to calculate propensity scores are provided in Table A11 in Appendix. Robust standard errors in parentheses. ***, **, and * denote statistical significance at the .01, .05, and .10 levels, respectively.

Table A1. Structure of dataset

FUE and IEH			CIS waves		
Pattern	Frequency	Percent	Pattern	Frequency	Percent
000000001	731	10.33	001	3986	56.31
101101111	726	10.26	100	1102	15.57
101111110	225	3.18	010	1080	15.26
000000011	205	2.90	011	358	5.06
000001111	192	2.71	101	219	3.09
111101110	185	2.61	110	192	2.71
000010000	174	2.46	111	142	2.01
001101111	169	2.39			
101111111	157	2.22			
Other	4315	60.95			
Total	7079	100	Total	7079	100

Note: Before exclusion of missing observations or unreasonable values (negative values and outliers).

Table A2. Definition of variables

Variables	Description
(i) Generic information (FUE)	
Age	Computed as the difference between the current year and the year of establishment of the firm plus one, in logs.
Industry	Portuguese industrial classification (CAE rev 2.1). Different industry codes are converted into dummy indicators.
Location	European regional classification (NUT). Different region codes are converted into dummy indicators.
Public capital	Percentage of capital owned by the public sector.
Foreign capital	Percentage of capital owned by non-nationals.
(ii) Balance sheets variables (IEH)	
Size	Measured as log of the number of employees.
Capital (K)	Total assets.
Investment (I)	Measured as additions to plant, property and equipment- gross investment, scaled by total assets.
Cash- flow (CF)	Computed as net income before taxes plus depreciation, scaled by total assets.
Cash stock	Measured as total cash holdings, scaled by total assets.
Sales Growth	Measured as changes in total sales from previous period.
Debt and equity issuances	Sum of debt and equity issuances, scaled by total assets. For the year 2001 equity issuances are reported as missing. The reason lies in legal changes that took place with the introduction of Euro (most firms adjusted their equity, not necessarily meaning issuing equity).
Non-cash net working capital	Difference between non-cash current assets and current liabilities, scaled by total assets.
Interest payments	Interest payments of a firm, scaled by total assets. It can be argued to proxy for the credit rating of the firms.
Leverage	Measured as the ration of liabilities to the total value of a firm.
Returns on financial investments	Returns on financial investments of firms, scaled by assets.
Intangible assets	Computed as intangible assets, scaled by total assets. In the absence of a better alternative, this variable is intended to proxy the knowledge stock, through R&D stock and the patent stock of firms (we do not have detailed information neither on patents, nor on highly disaggregated firm accounts);
Exports	Firm exports, scaled by assets.
Market share	This variable is constructed as a firm's sales over total sales of the corresponding firm's industry—at maximum level of industrial classification disaggregation (5-digit).
(iii) Innovation variables (CIS)	
Public Finance (SUB)	Binary variable for firms that received public funding and those that did not. It includes financial support to innovation activities provided by the Portuguese local or central administration, as well as by the EU (through the "Framework Programs"). This support may take the form of subsidies *strictu sensu*, credit guarantees and tax benefits (from the CIS survey we are not able to distinguish them). For the sake of this paper and simplicity we will refer it as "subsidies".
Share of subsidized firms-industry	Computed as the ratio of number of subsidized firms in each industry (2-digit, CAE rev 2.1) to the total number of subsidized firms.
Share of subsidized firms-region	Computed as the ratio of number of subsidized firms in each region (NUT2). Both of these variables serve as instruments for subsidies. The rationale is that, in the absence of

Variables	Description
	information on public policy budgets, the share of subsidies by industry and region will reflect policy goals for certain industries or regions (see Schneider and Veugelers, 2010).
Cooperation	Binary variable that indicates if a firms cooperated with other firms or institutions for the purpose of innovation activities.
Patent	Binary indicator of whether a firm registered any patent during the wave period.
R&D workers	Percentage of employers in the firm that work on R&D.

Note: All continuous variables of interest were winsorized at the 1% level (0.5% each tail) in order to avoid problems with outliers in the estimation procedures. Deflators used include the Industrial Production Price Index and Labour Cost Index, both drawn from INE, and the GDP deflator, drawn from the Portuguese Central Bank (BdP). Nevertheless, no deflators were used when a variable was constructed as a ratio of two nominal values (normalized). In such cases we assume that the price growth rates are homogeneous.

Table A3. Descriptive statistics and characteristics of subsidy recipient vs. non-recipient firms

	Means and Standard Deviations		Nonparametric tests	
	SUB=0	SUB=1	K-S (D)	F-P (U)
	(1)	(2)	(3)	(4)
Size	4.665 (1.168)	5.304 (1.268)	0.227 [0.000]	-10.254 [0.000]
Age	3.018 (0.716)	3.105 (0.746)	0.085 [0.007]	-2.530 [0.011]
Foreign capital (%)	0.679 (0.826)	0.764 (0.751)	0.127 [0.000]	-1.870 [0.062]
R&D employees (%)	0.133 (0.526)	0.611 (1.162)	0.192 [0.000]	-2.793 [0.005]
Cooperation	0.105 (0.307)	0.524 (0.500)	0.418 [0.000]	-6.036 [0.000]
Exports	0.266 (0.512)	0.361 (0.516)	0.204 [0.000]	-6.026 [0.000]
Share of subsidies by industry (%)	0.038 (0.067)	0.166 (0.161)	0.546 [0.000]	-27.287 [0.000]
Share of subsidies by region (%)	38.429 (44.150)	38.786 (38.818)	0.108 [0.000]	0.001 [0.999]
Market share	0.120 (0.179)	0.125 (0.169)	0.063 [0.092]	-1.994 [0.046]
Patents	0.221 (0.558)	0.481 (0.670)	0.233 [0.000]	-3.610 [0.000]
Intangibles	0.034 (0.075)	0.055 (0.084)	0.257 [0.000]	-11.715 [0.000]
Observations	3,142	424		

Notes: Comparison of main explanatory variables between recipient and non-recipient firms (columns 1 and 2). Mean values and standard deviations in parentheses. The values of Kolmogorov-Smirnov (D) and Fligner–Policello (U) statistics are reported in columns (3) and (4), respectively. The associated P-values are in brackets. Rejection of the null means that the two distributions are stochastically different.

Table A4. Variables measuring financial constraints

Measure	Nature	Comments
Self-assessment	Ordinal	Subjective Firm-specific Varies across waves
HH índex	Continuous	Assumes ICFS holds Firm-specific Time invariant
MS índex	Ordinal	Assumes same level of constraints across industries Firm-specific Varies across years
Weighted MS index	Ordinal (assumed continuous)	Firm-specific Varies across years

Table A5. Distribution of financial constraints measures

a) Self-assessment (ordinal Measure)		
	Frequency	Percentage
0 (unconstrained)	1,982	55.58
1	446	12.51
2	551	15.45
3 (high level)	587	16.46
Total	3,566	100
b) MS index (ordinal Measure)		
	Frequency	Percentage
1 (unconstrained)	678	20.51
2	444	13.43
3	278	8.41
4	307	9.29
5	295	8.92
6	286	8.65
7	261	7.89
8	346	10.47
9	266	8.05
10 (high level)	145	4.39
Total	3,306	100
c) Weighted MS index (continuous measure)		
Min	0.046	
25%	0.318	
50%	0.418	
75%	0.568	
Max	1.875	
Mean	0.457	
Std. Dev.	0.223	
Observations	3303	
d) HH index (continuous measure)		
Min	-6.666	
25%	-0.001	
50%	0.000	
75%	0.001	
Max	3.415	
Mean	-0.005	
Std. Dev.	0.207	
HH>0	1692	(54.4%)
Observations	3110	

Table A6. Testing hypothesis 1–subsidy allocation (endogenous financial constraints)

Variables	Self-assessment		MS index		Weighted MS index		HH index	
	(1)		(2)		(3)		(4)	
FC	0.021	(0.251)	0.082	(0.052)	0.388	(1.157)	3.258	(3.862)
Size	0.062*	(0.037)	0.101***	(0.039)	0.081**	(0.036)	0.078*	(0.041)
Age	0.056	(0.055)	0.037	(0.051)	0.050	(0.063)	0.030	(0.046)
Foreign capital	0.178**	(0.077)	0.257***	(0.084)	0.224	(0.150)	0.137	(0.106)
R&D employees	-0.008	(0.055)	-0.015	(0.055)	-0.032	(0.056)	-0.054	(0.046)
Cooperation	0.167***	(0.049)	0.163***	(0.048)	0.176***	(0.052)	0.136	(0.100)
Exports	0.987***	(0.091)	0.964***	(0.095)	0.970***	(0.105)	0.814*	(0.476)
Share sub. by industry	6.795***	(0.559)	6.887***	(0.579)	6.994***	(0.590)	5.904*	(3.291)
Share sub. by region	-0.007***	(0.002)	-0.008***	(0.002)	-0.008***	(0.002)	-0.007*	(0.004)
Market share	-0.926***	(0.299)	-0.853***	(0.305)	-0.969***	(0.312)	-0.804*	(0.444)
Patents	0.075	(0.058)	0.084	(0.059)	0.095	(0.065)	0.059	(0.072)
Intangibles	0.133	(0.414)	0.248	(0.415)	0.219	(0.490)	0.255	(0.388)
ρ	0.016	(0.353)	-0.225	(0.158)	-0.115	(0.255)	-0.621	(1.011)
Observations	3,180		3,059		3,056		2,956	
Log-likelihood	-2108		-3599		-224.9		-89.80	
(Pseudo) R2	0.52		0.51		.		.	
AIC	4314.65		7302.55		517.86		287.59	

Notes: Dependent variable: dichotomous subsidy variable. Regression of simultaneous equations model (2), assuming α_2=0 and normalized variance of the errors, and using different measures of financial constraints: self-assed (column 1), MS index (column 2), industry weighted MS index (column 3) and HH index (column 4). The parameter $\rho \neq 0$ can be used to test endogeneity hypothesis. The instruments used are those corresponding to variables in the vector X_2. Robust standard errors in parentheses. ***, **, and * denote statistical significance at the .01, .05, and .10 levels, respectively.

Table A7. Testing hypothesis 1–subsidy allocation (innovation investment opportunities control)

Variables	MS index		Weighted MS index	
	(1)		(2)	
FC_t	0.05	(0.06)	1.71	(1.54)
FC_{t-1}	-0.09	(0.06)	-2.23	(1.73)
Size	0.11	(0.11)	0.09	(0.12)
Age	0.11	(0.12)	0.09	(0.12)
Foreign capital	-0.20	(0.14)	-0.16	(0.14)
R&D employees	-0.08	(0.10)	-0.09	(0.11)
Cooperation	1.23***	(0.23)	1.25***	(0.24)
Exports	0.33*	(0.19)	0.32*	(0.19)
Share sub. by industry	5.59***	(0.87)	5.53***	(0.87)
Share sub. by region	-0.02***	(0.00)	-0.02***	(0.00)
Market share	-0.84	(0.56)	-0.81	(0.55)
Patents	0.02	(0.25)	0.01	(0.25)
Intangibles	0.99	(1.24)	0.74	(1.26)
Innovation investment opportunities (R&D investment$_{w+1}$)	0.07	(0.06)	0.07	(0.06)
Constant	-1.93**	(0.98)	-1.75*	(1.04)
Observations	323		323	
Log-likelihood	-48.68		-48.68	
(Pseudo) R2	0.44		0.44	

Notes: Dependent variable: dichotomous (lagged) subsidy variable. Main explanatory variable MS index (column 1) and industry weighted MS index (column 2). Robust standard errors in parentheses. ***, **, and * denote statistical significance at the .01, .05, and .10 levels, respectively.

Table A8. Testing hypothesis 2–subsidy effectiveness (endogenous subsidies)

Variables	Self-assessment	MS index	Weighted MS index	HH index
	(1)	(2)	(3)	(4)
SUB	0.476*** (0.175)	0.450*** (0.135)	0.004 (0.028)	0.015* (0.009)
Size	-0.062** (0.024)	-0.128*** (0.023)	-0.013** (0.006)	-0.003 (0.002)
Age	0.048 (0.039)	0.045 (0.034)	-0.026*** (0.007)	-0.008 (0.008)
Public capital	-0.002 (0.001)	-0.002 (0.001)	0.001*** (0.000)	0.000 (0.000)
Foreign capital	-0.003*** (0.001)	-0.005*** (0.001)	-0.000 (0.000)	0.000 (0.000)
Sales growth	-0.115 (0.102)	0.392*** (0.093)	0.021 (0.018)	-0.014 (0.010)
Cash stocks	-1.005*** (0.283)			
Cash-flow	-0.639** (0.317)			
Leverage	0.226** (0.107)			-0.096 (0.066)
Issuances	-0.356** (0.169)	-0.720*** (0.139)	-0.061** (0.027)	0.035 (0.044)
Δ interest paid	12.542*** (3.717)	-4.359 (3.548)	-0.513 (0.786)	1.431 (0.907)
Returns finan. invest.	-10.751 (11.981)	-15.537* (8.386)	-3.885*** (1.142)	0.222 (0.342)
Exports	-0.056 (0.060)	-0.307*** (0.051)	-0.118*** (0.008)	-0.003 (0.003)
Market share	-0.179* (0.101)	-0.604*** (0.094)	-0.096*** (0.021)	0.004 (0.007)
ς	-0.227* (0.119)	-0.251*** (0.090)	-0.041 (0.076)	-0.031* (0.016)
Observations	3,180	3,059	3,056	2,956
Log-likelihood	-2105	-3596	-273.7	-98.13
(Pseudo) R2	0.52	0.51		
AIC	4308.26	7295.69	599.34	

Notes: Dependent variable: self-assed financial constraint (column 1), MS index (column 2), industry weighted MS index (column 3) and; HH index (column 4). Regression of simultaneous equations model (2) in columns 1–2 and corresponding treatment effects model in columns 3–4, assuming α_1=0 and normalized variance of the errors. The parameter $\varsigma \neq 0$ can be used to test endogeneity hypothesis. The instruments used are those corresponding to variables in the vector X_1. We deliberately omit variables that are highly correlated with the measure of constraints by construction (columns 2-4). Robust standard errors in parentheses. ***, **, and * denote statistical significance at the .01, .05, and .10 levels, respectively.

Table A9. Testing hypothesis 2—the effects of subsidies given in 2000 upon financial constraints (differences-in-differences)

Outcome	MS index	Weighted MS index
Effects	(1)	(2)
Differences in treated	-0.79*** (0.17)	-0.14*** (0.01)
	[-1.12; -0.45]	[-0.16; -0.12]
Differences Post-2000	1.46*** (0.02)	0.11*** (0.00)
	[1.42; 1.51]	[0.10; 0.11]
Differences-in-Differences	0.36 (0.26)	0.07*** (0.02)
	[-0.14; 0.87]	[0.02; 0.11]
Constant	4.55*** (0.02)	0.50*** (0.00)
	[4.51; 4.59]	[0.50; 0.51]
No. firms	10,841	10,841
(of which treated)	295	295
Observations	86,455	86,437

Notes: This table shows the results of differences-in-differences calculations for the impact of subsidies provided in the year 2000 upon financial constraints. Measures of financial constraints include the MS index (column 1) and industry weighted MS index (column 2), both time-variant. Treated firms are those that received subsidies in 2000. The table reports the differences-in-differences (row 5) as well as the differences in financial constraints between treated and non-treated firms (row 1) and the differences in constraints for all firms before and after 2000 (row 3). Coefficients are calculated using OLS. Robust standard errors in parentheses. ***, **, and * denote statistical significance at the .01, .05, and .10 levels, respectively.

Table A10. Propensity score estimation

Variables	Subsidies	Financial Constraints
	(1)	(2)
Size	-0.12*** (0.02)	0.23*** (0.03)
	[-0.16; -0.08]	[0.18; 0.28]
Age	0.04 (0.03)	0.07 (0.04)
	[-0.02; 0.10]	[-0.02; 0.15]
R&D employees	-0.05 (0.04)	
	[-0.12; 0.02]	
Cooperation	0.21*** (0.06)	
	[0.09; 0.33]	
Exports	-0.08* (0.04)	0.09 (0.06)
	[-0.16; 0.00]	[-0.02; 0.20]
Share sub. by industry	-0.14 (0.24)	
	[-0.61; 0.32]	
Market share	-0.24** (0.12)	0.17* (0.10)
	[-0.48; -0.01]	[-0.03; 0.37]
Patents	0.20*** (0.04)	
	[0.13; 0.27]	
Intangibles	0.39 (0.28)	
	[-0.17; 0.94]	
Public capital		0.00 (0.00)
		[-0.00; 0.00]
Foreign capital		-0.00** (0.00)
		[-0.00; -0.00]
Sales growth		-0.01 (0.12)
		[-0.25 - 0.23]
Cash stocks		-0.98*** (0.32)
		[-1.61; -0.34]
Cash-flow		1.26*** (0.36)
		[0.56; 1.96]
Leverage		-0.46*** (0.14)
		[-0.73; -0.19]
Issuances		-0.70*** (0.19)
		[-1.08; -0.32]
Returns finan. invest.		-5.75 (10.82)
		[-26.96; 15.46]
Constant	0.29** (0.12)	-2.30*** (0.22)
	[0.05; 0.52]	[-2.74; -1.86]
Observations	3,659	3,382
Log-likelihood	-2,469.30	-1,236.70
Pseudo-R2	0.02	0.06

Notes: Propensity scores were estimated using a Probit model and matching was performed with replacement. Robust standard errors in parentheses. ***, **, and * denote statistical significance at the .01, .05, and .10 levels, respectively.

Table A11. Testing the balancing property in propensity score matching

	Mean			t-test	
Variables	Treated	Control	%bias	t	p>|t|
Size	5.379	5.289	7.5	1.04	0.297
Age	3.137	3.122	2.0	0.28	0.779
Public capital	8.184	7.405	3.5	0.43	0.665
Foreign capital	11.928	12.209	-0.9	-0.13	0.895
Sales growth	-0.0485	-0.053	1.6	0.23	0.821
Cash stocks	0.055	0.057	-2.4	-0.38	0.703
Cash-flow	0.104	0.105	-1.0	-0.15	0.884
Leverage	0.613	0.614	-0.2	-0.04	0.972
Issuances	-0.049	-0.047	-1.0	-0.14	0.892
Returns finan. invest.	0.001	0.001	0.7	0.10	0.921
Exports	0.366	0.356	2.0	0.27	0.786
Market share	0.245	0.241	1.4	0.19	0.846

Notes: Propensity scores were estimated using a Probit model and matching was performed with replacement. Additional tests of the balancing property by blocks of the propensity score distribution are available from the authors upon request.