Financial constraints: Do they matter to allocate R&D subsidies?

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Abstract:

In this paper we examine whether subsidies are allocated to financially constrained firms and if they effectively alleviate these constraints, a subject, as far as we know, rarely explicitly explored in the literature. 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 the allocation and effectiveness of subsidies in alleviating financial constraints of firms willing to innovate. Additionally, 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: Subsidies; Financial constraints; R&D investment; R&D policy.

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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 return of innovation is higher than its private return. 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.

Even though the analysis of financial constraints to innovation and whether subsidies foster innovation are two closely related lines of research, the link between them is rather unexplored. Which criteria should prevail when evaluating potential subsidy recipients? Are the criteria for allocating public funds for innovation different from those used by the private

[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 however beyond the scope of this paper, since we are only interested in direct subsidies

sector? One might argue that, regardless of financial constraints, subsidies are desirable as long as they promote innovation. However, it also seems sensible to say that subsidies should be aimed at financially constrained firms.

The goal of this paper is thus to analyse if subsidies to innovation are being allocated to financially constrained firms as well as if they 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 we make in this paper is that regardless of the ultimate innovation policy objective, 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. This dataset comprises detailed information on firms' generic characteristics and balance sheets, matched with three waves of the Community Innovation Survey (CIS), which provide additional variables on innovation, subsidies and self-assessed financial constraints. Portugal is a well suited country of analysis for three main reasons. Firstly, Portugal, like many other Continental European countries, has a bank-centred capital market (cf. Hall and Lerner, 2010, for Anglo-Saxon economies with their more developed stock markets)—banks are the major suppliers of external funds for firms in most economies across the world (Qian and Strahan, 2007). Secondly, the stylized facts for Portugal in terms of firm dynamics seem broadly in line with other European countries (Cabral, 2007). Finally, although the R&D policy in the EU is the sole competence of individual member states, the policy design in each country has to support the general innovation policy strategy and objectives defined at Community level. Therefore, inferences using this representative sample of Portuguese firms may be made with respect to, at least, the Continental European countries.

There is a large body of literature showing the impact of either financial constraints or subsidies on firms' R&D investment and innovation. However, as far as we know, both the

allocation of innovation subsidies to financially constrained firms and their role in alleviating such constraints 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 both to identify whether firms are constrained and to measure the relative degree of constraints (Carreira and Silva, 2010; Silva and Carreira, 2012b). As pointed by Coad (2010), using rather fragile methodologies (on either empirical or theoretical grounds) to derive strong policy conclusions is not uncommon among the empirical literature of this field. 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); 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, while 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 and literature review

2.1. 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 (Nelson, 1959; Arrow, 1962). 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 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.

Even though the imperfect appropriation problem does not occur, it is expected that R&D investment is more financially constrained than, for example, investments in physical capital. Indeed, in opposition to physical capital, this type of investment is not only harder 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). R&D investment is not only uncertain in whether an innovation will be obtained, but also one cannot be sure about the market success of this innovation either. Furthermore, the innovator typically has superior information about the nature and economic potential of an R&D investment than financiers. This information asymmetry 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 innovate. As a consequence, the lemon's premium (thus, 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).

To understand how financial market failure might constrain innovation efforts of firms, consider a simple model of firm-level investment behaviour where the firm will invest in R&D up to the point where the marginal return to R&D equals the marginal cost of R&D capital (Howe and McFetridge, 1976; see also David et al., 2000; Carpenter and Petersen, 2002; Hall, 2002; and Hall and Lerner, 2010, for further assumptions and details). The essential features of the model are illustrated in Figure 1. The horizontal axis gives the R&D investment as well as the flow of finance, while the vertical axes measures both marginal rate of return on investment and the marginal cost of capital. The downward-sloping curve represents the firm's demand for R&D investment funds (marginal rate of return, MRR) and is derived by arranging potential R&D projects in a decreasing order of expected rate of return. The upward-sloping curve describes the supply of funds (marginal cost of capital, MCC) and reflects the opportunity cost

of alternative investment funds for the firm. The horizontal section of the MCC curve represents the cost of internal funds that are available at a constant cost until they are exhausted, at which point the firm must turn to external (debt and equity) finance, which may be substantially more costly as we have seen above.

[Figure 1 near here]

In Figure 1, the firm's level of R&D investment is found at *A*. The model thus predicts that firms that are dependent on external funding are more likely to fail to pursue some innovations than firms that are not (cf. point *B* in Figure 1). If firm obtains a public support in a form of subsidy, the MCC curve will shift to the right, which will permit the undertaking of additional R&D projects, other things being equal. However, it should be noted that if firm is not financially constrained (i.e. firm facing an inelastic MCC curve), the public funding will not have any positive incremental impact upon the level of R&D investment.

2.2. Financial constraints, subsidies to innovation and R&D investment

Within 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 (see Carreira and Silva, 2010; and Hall and Lerner, 2010, for surveys). Some examples using the investment–cash flow sensitivity (Fazzari et al., 1988) 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 the U.S. firms in high-technology industries; Harhoff (1998), who studied German firms in the period 1987–1994, Hall et al. (1999); who compared the French, Japanese and U.S. firms; Bond et al. (2003), who compared the 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.

On the other hand, 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; and Klette et al., 2000, for surveys). The first main subject analysed by recent empirical research is whether subsidies stimulate ("add to") or substitute ("crowd out") private R&D investment. In general, the studies addressing selection bias have found evidence of an additionality effect upon R&D investment (i.e. no crowding out effect). 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. Even though subsidies seem to have an additionality effect upon R&D investment, particularly with respect to *research activities*, that are usually

found to be more affected by financial constraints (Czarnitzki et al., 2011), they appear to have a crowding-out effect when it comes to *development activities* (Clausen, 2009).

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—that may eventually become subsidy dependent, illustrated by "subsidy persistence" found in the literature (e.g. Hussinger, 2008; Aschhoff, 2010)—without necessarily improving firms' capability to raise private external funds.

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 are generally agreed to be negatively related with financial constraints (Carreira and Silva, 2010). 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.

2.3. What should we expect?

In this paper, 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. Figure 2 illustrates the rationale behind our hypotheses. Suppose that there are two firms that only differ in their capability to raise external funds—while firm *i* is

financially constrained, firm *j* is not. Under these conditions, the R&D investment of firm *i* and *j* are, respectively, *C* and *D*. Holding the MRR curve constant, the award of a subsidy in the form of a public grant has two effects on the MCC curve: a direct effect by shifting the curve to the right and an indirect effect as a consequence of the certification effect, which implies a change in the slope of upward-sloping section of the curve. Let us now assume that scarce public resources force the policymaker to subsidise only one firm—traditionally, funding will be channelled to that firm that is expected to have a higher probability to innovate. Although both firms face the same technological opportunity, due to information asymmetry between firms and the government agency that administers R&D funds, the unconstrained firm (i.e. firm *j*) can receive the subsidy. In this case, public funding only substitutes private funding—as we have seen, when the MRR curve cuts the MCC curve in the horizontal section, a shock that shifts supply outward has no effect on the level of R&D investment. What if the policymaker choses to finance the constrained firm, instead of the unconstrained one? Now, the supply shift induces an increase in R&D investment (firm *i* moves, for example, from point *C* to point *D* in Figure 2).

[Figure 2 near here]

If unconstrained firm has greater innovative potential than constrained one, the choice is apparently less clear. However, as can be seen in Figure 2, when the MRR curve shifts to the right, the R&D investment of firm *j*, who is on the horizontal section of supply, perfectly increases until *E*, at which point the firm becomes by definition financially constrained.

Both private investors and public agency administering R&D grants are thus trying to evaluate the expected return of R&D projects, therefore it is not surprising that they rank and select the same ranked projects from a portfolio of proposed projects. However, the problem that public agency faces is not only that, it then has to convince itself that each project cannot proceed because the innovator is financially constrained. In fact, it seems sensible to argue that, within firms that want to innovate, public funding should be primarily aimed at those that otherwise would not be able to finance such innovations. Accordingly, one should expect that

the probability of a firm receiving subsidies should undoubtedly depend on its level of financial constraints. If that is not the case, then public funds may not be so different from private funds. This discussion leads us to formulate the following hypothesis:

Hypothesis 1. If there are significant imperfections in capital market, public R&D funding should disproportionately be allocated to financially constrained firms.

A key to our empirical testing strategy is that government agency administering R&D grants try at least to some extent to overcome financial market failure.

Furthermore, one should expect that subsidies (directly and indirectly) increase firms' financial capacity, at least in the short-term (represented in Figure 2 by the shift of the supply curve to the right)—when it comes to long-term financing capability, the effect can be not as clear (cf. certification effect vs. "subsidy persistence"). Accordingly, we put forward the following hypothesis to guide the empirical analysis:

Hypothesis 2. R&D subsidies should reduce firms' financial constraints.

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, and the Portuguese *Community Innovation Survey* (CIS), covering three successive waves, respectively, 1995–1997 (CIS2), 1998–2000 (CIS3) and 2002–2004 (CIS4). Thus, our final dataset is composed of 8,132 CIS observations appended by an unbalanced panel of 7,079 firms observed over the period 1996–2004, corresponding to 30,177 observations.

The use of CIS is crucial to the analysis of public financial support to firms' innovation activity. Among other variables, it contains valuable information on innovation, R&D expenses, subsidies to innovation and, remarkably, a direct measure of financial constraints to innovate—see Table A1 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 not obtain public funding (see Huergo and Trenado, 2010).

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, 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 Carreira and Silva, 2010; and Silva and Carreira, 2012b, for surveys). 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 (as we have seen in Section 2.2), 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, the Euler equation approach proposed by Whited (1992), different composite indexes such as those advanced 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. Bottazzi et al., 2008; 2014; Czarnitzki, 2006; Czarnitzki and Hottenrott, 2011).

There are a number of advantages and disadvantages of using each measure (Silva and Carreira, 2012b). In fact, due to the nature of financial constraints—firm-specific, time-varying, and not a clear-cut dichotomous phenomenon (Musso and Schiavo, 2008)—, finding an objective and consistent measure of constraints may prove to be a serious challenge. Because of this, in this paper we make use of different methodologies to identify financial constraints. Firstly, we construct a direct measure from the information on firms' perception of constraints—available in the CIS survey. Secondly, 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.

3.2.1. Direct measure

The first measure employed to assess firms' financial constraints results from a survey question regarding the extent to which firms perceive that the lack of external finance significantly hampered their innovation activity (see the Table A1 in Appendix for further detail). The use of firms' self-evaluation of financial constraints has a number of advantages and disadvantages that we summarize as follows.

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 (a crucial problem in typical measures of constraints) are already taken into account in firms' responses. However, 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.[2] 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 also seems 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. While 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—carries a significant amount of subjectivity.

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:

[2] 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.

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

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.[3]

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. Additionally, this methodology fails to control for investment opportunities and other variables affecting investment, as well as it does not explore marginal effects (see D'Espallier et al., 2009, for a critique).[4] Finally, it assumes that ICFS correctly identifies firms' financial constraints (see Kaplan and Zingales, 1997; Coad, 2010).

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

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

[4] 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).

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 class mean.

The procedure takes two steps. First, we identify a number of proxies of financial constraints.[5] 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 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.[6]

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 is more constrained

[5] 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). To avoid extreme values, all variables are winsorized at the 1% level.

[6] 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.

than the most constrained firm in industry B, one cannot compare the scores of firms in industries A and B because of different benchmarks.[7]

Nevertheless, we are able to overcome these difficulties by using the appropriate non-linear regression techniques, as well as by weighting each firm score by the industry's average level of financial constraints. To obtain industry average levels of financial constraints, we estimate (for each industry) the sensitivity of cash to cash flow, in line with the methodology suggested by Almeida et al. (2004).

3.3. Estimation strategy

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 1), as well as with endogeneity problems.

[Table 1 near here]

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, as well as possible endogeneity issues, result in the use of

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

distinct estimation techniques, outlined as follows. (We also report the estimation results for the corresponding specifications without controlling for endogeneity.)

Finally, 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 (balance sheet variables as well as a specification with lagged CIS variables).

3.3.1. The probability of receiving subsidies

While our subsidy variable is dichotomous, both the MS index and direct measure of constraints (self-assessment) are of ordinal nature (Table 1). Therefore, in order to investigate the impact of financial constraints upon the probability that a firm receives subsidies, we specify a model of two latent simultaneous equations as follows:

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

For logical consistency purposes we set (α_2=0) and additionally normalize the variance of the errors:

$$\begin{cases} SUB^{*} = X_1\beta_1 + \alpha_1 FC + \varepsilon_1 \\ FC^{C*} = X_2\beta_2 + \varepsilon_2 \end{cases}, \quad \begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \end{pmatrix} \sim \Phi_2 \begin{bmatrix} 0 \\ 0 \end{bmatrix} \begin{bmatrix} 1 & \rho \\ \rho & 1 \end{bmatrix}. \tag{3}$$

where *SUB* is the binary indicator of whether a firm received subsidies, *FC* is a measure of financial constraints, while SUB^{*} and FC^{*} are the corresponding unobserved latent variables.[8]

Additionally, the vector X_1 includes a number of variables that may influence the probability of a firm receiving subsidies, that is: firm size, firm age, percentage of R&D

[8] We also test the corresponding probit, where we do not control for the possible endogeneity of financial constraints. In this case the ordinal FC variable is collapsed into a binary indicator. Additionally, we use a specification with the wave lag of financial constraints, even though we have to drop the HH index measure due to lack of time variability by construction.

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.

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

We further extend the model to allow *FC* outcomes to be ordinal and estimate the corresponding simultaneous equations ordered probit model (see Greene and Hensher, 2010, p. 222, for details; and Sajaia, 2008, for STATA implementation).[9] Finally, if there are no omitted or unobservable variables that affect simultaneously *SUB* and *FC* ($\rho=0$), we can estimate the equations separately—this parameter can be used to test exogeneity.

However, some of the measures of financial constraints are continuous (Table 1). Accordingly we drop the latent variable specification and estimate their impact upon the dichotomous subsidy variable using an instrumental variables extension of a probit regression. The instruments used are those corresponding to variables in the vector X_2. This is the case of the HH index, as well as the MS index weighted by industry cash to cash-flow sensitivity. With

[9] Note that since the estimation of marginal effects (in this case) is of rather hard computation and above all interpretation we refrain from estimating them. Nevertheless, interest lies in the signal rather than on the magnitude of the effects.

respect to the latter, even though it is a weighted ordinal variable, we assume it to be continuous. Eventual non-linearity problems are minor due to an extensively large number of different values and since interest lies in the signal rather than the amplitude of the impact. Formally, we assume that the values of this ordinal variable approximate those of the unobserved latent continuous variable ($FC \approx FC^*$).

3.3.2. The impact of subsidies on financial constraints

In order to analyse the impact of subsidies upon firms' financial constraints (ordinal measures), we use the same estimation approach as in the previous section. Accordingly, we specify a simultaneous equations probit model (with the corresponding latent variables specification), that we further extend to the ordered probit case. The same logical consistency constraint applies and we also normalize the variance of the errors. Therefore, we simultaneously estimate the following model:

$$\begin{cases} FC^* = X_2\beta_1 + \alpha_1 SUB + u_1 \\ SUB^* = X_1\beta_2 + u_2 \end{cases}, \quad \begin{pmatrix} u_1 \\ u_2 \end{pmatrix} \sim \Phi_2 \begin{bmatrix} 0 \\ 0 \end{bmatrix} \begin{bmatrix} 1 & \varsigma \\ \varsigma & 1 \end{bmatrix} \tag{4}$$

where the vectors X_1 and X_2 include the same determinants described in the preceding section. Again, if there are no omitted or unobservable variables that affect simultaneously *SUB* and *FC* (ς =0), we can estimate the equations separately—as previously pointed out, this parameter can be used to test exogeneity.

For the case of continuous financial constraints measures (HH and weighted MS indexes), we specify a simple treatment effects model to estimate the impact of an endogenous binary treatment (*SUB*) on our fully observed dependent variable (FC):

$$FC = X_2\beta_1 + \alpha_1 SUB + v_1, \tag{5}$$

$$\text{with } SUB \begin{cases} 1, & \text{if } SUB^* = X_1\beta_2 + v_2 > 0 \\ 0, & \text{otherwise} \end{cases}, \text{ and } \begin{pmatrix} v_1 \\ v_2 \end{pmatrix} \sim \Phi_2 \begin{bmatrix} 0 \\ 0 \end{bmatrix} \begin{bmatrix} \sigma^2 & \rho\varsigma \\ \rho\varsigma & 1 \end{bmatrix}.$$

The corresponding models, that assume endogeneity away, are also estimated. Namely, we estimate an ordered probit (for ordinal *FC*) and regular OLS (for continuous *FC*).

4. Empirical Results

4.1. Descriptive statistics

As it is described in Table 2, there is a remarkable number of firms that face financial constraints. While 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 is a noteworthy number of firms in the higher rankings of the index.

[Table 2 near here]

As we can see from Table 3, while 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 3 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 4). In fact, while 15% of unconstrained firms (lower MS index rank) are subsidised, only 12% of firms in the highest rank of constraints receive subsidies. 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 4 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 5). 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 5 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 6). 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.[10] 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%).

[Table 6 near here]

4.2. Subsidy allocation

[10] 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.

As we can see in Tables 7 and 8, the extent to which a firm is financially constrained appears to have no impact upon the probability that it receives public financial support. While in Table 7 we report our estimates that do not account for the possibility of financial constraints being endogenously determined, the results in Table 8 explicitly account and test for such possibility. A striking result that is robust to different measures and estimations strategies is the absence of a statistically significant impact (at the 10% level) of financial constraints upon subsidies. The only exception is found with respect to the use of the HH index in an exogeneity scenario (Table 7, column 4), where financial constraints are found to increase the probability of a firm receiving subsidies (statistically significant at the 5% level). Additionally, when we introduce a time dimension (the CIS waves, Table A2 in Appendix), the extent to which a firm is financially constrained *ex-ante* does not affect the probability that it is subsidy recipient. As a consequence, these results lead to the rejection of our hypothesis 1 that subsidies are being allocated to financially constrained firms. Furthermore, there is no clear evidence suggesting that financial constraints are endogenous since we cannot reject that the equations determining subsidies and financial constraints are independent (ρ=0).

[Table 7 near here]

[Table 8 near here]

Therefore, one might well be subsidising firms that do not necessarily require public funding to undertake their innovation projects, since they are able to obtain private funds. Conversely, constrained firms that are not subsidy recipients will hardly be able to innovate since 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 (Carreira and Silva, 2010), 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 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\lenders take into consideration when deciding to finance the R&D project of a firm. Possibly to ensure the appearance of successful R&D policies, government agencies may use selection criteria that put heavy weight on factors that are positively correlated with high expected private rates of return. However, with this strong pressure to allocate public funds for projects with high marginal rates of return, subsidies may not be that different from private external financing.

4.3. Subsidy efficiency

To test whether subsidies reduces firms' financial constraints, in Table 9 we assume that subsidies are exogenous, while in Table 10 we have endogenous subsidies case. Both specifications yield puzzling results. Regardless 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. The only exception is found when we measure financial constraints through our weighted MS index. Using this approach, there is no statistically significant impact of subsidies on firms' constraints (Tables 9 and 10, column 3). Furthermore, using a specification with CIS wave lagged effects, there is no evidence that firms that receive subsidies are *ex post* financially constrained (Table A3 in Appendix). These results lead to a clear rejection of our hypothesis 2 that subsidies alleviate financial constraints. Finally, using a specification that accounts for the possible endogeneity of subsidies seems sensible. In fact, except for our weighted MS index, we reject that the equations governing subsidies and financial constraints are independent ($\varsigma \neq 0$).

[Table 9 near here]

[Table 10 near here]

Therefore, 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. On the contrary, constraints appear to be amplified if a firm receives subsidies. This finding suggests that subsidies possibly drive the pressure from selection forces away, leading to a relative inertia of subsidised firms.

5. Conclusion

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

As our findings suggest, the extent to which firms are financially constrained is not taken into consideration when allocating public funding. This result is robust to different approaches used to identify and measure financial constraints. Moreover, decision criteria for allocating public funds for innovation seem to be not different from those used by the private investors.

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.

Overall, in this paper we provide robust evidence that allows us to conclude that, when it comes to public funding, innovation policy should definitely take into account the ability of firms to raise external funds. Thus, our findings have serious implications for the design of innovation policy. Accordingly, rethinking the subsidy attribution process should be given due consideration, in particular, put on selection criteria heavy weight on factors that are positively correlated with financial constraints.

Our research could be improved if we had 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. Finally, the question whether the incremental innovation output of the unconstrained firms is larger than the innovation output of the constrained firms, certainly deserves our attention in the future.

References

Aerts, K., & Schmidt, T. (2008). Two for the price of one? Additionality effects of R&D subsidies: A comparison between Flanders and Germany. Research Policy, 37(5), 806–822.

Akerlof, G. (1970). The market for 'lemons': quality and uncertainty and the market mechanism. Quarterly Journal of Economics, 84(3), 488–500.

Almeida, H., Campello, M., & Weisbach, M. (2004). The cash flow sensitivity of cash. Journal of Finance, 59(4), 1777–1804.

Almus, M., & Czarnitzki, D. (2003). The effects of public R&D subsidies on firms' innovation activities. Journal of Business and Economic Statistics, 21(2), 226–236.

Alti, A. (2003). How sensitive is investment to cash flow when financing is frictionless? Journal of Finance, 58(2), 707–722.

Arrow, K. (1962). Economic welfare and the allocation of resources for invention. In: R. Nelson, (Ed.), The Rate and Direction of Inventive Activity: Economic and Social Factors (pp. 609–625). Princeton University Press.

Aschhoff, B. (2010). Who Gets the Money? The Dynamics of R&D Project Subsidies in Germany. Journal of Economics and Statistics (Jahrbuecher fuer Nationaloekonomie und Statistik), 230(5), 522-546.

Bond, S., Harhoff, D., & Van Reenen, J. (2003). Investment, R&D and financial constraints in Britain and Germany. Annales d'Économie et de Statistique, 79/80, 435–462.

Bottazzi, G., Secchi, A., Tamagni, F. (2008). Productivity, profitability and financial performance. Industrial and Corporate Change, 17, 711-751.

Bottazzi, G., Secchi, A., Tamagni, F. (2014). Financial constraints and firm dynamics. Small Business Economics, 42(1), 99–116.

Bougheas, S., Goerg, H., & Strobl, E. (2003). Is R&D Financially Constrained? Theory and Evidence from Irish Manufacturing. Review of Industrial Organization, 22(2), 159-174.

Cabral, L. (2007). Small firms in Portugal: a selective survey of stylized facts, economic analysis and policy implications. Portuguese Economic Journal, 6(1), 65–88.

Carpenter, R.E., & Petersen, B.C. (2002). Is the growth of small firms constrained by internal finance? Review of Economics and Statistics, 84(2), 298–309.

Carreira, C., & Silva, F. (2010). No deep pockets: Some stylized results on firms' financial constraints. Journal of Economic Surveys, 24(4), 593–753.

Clausen, T. (2009). Do subsidies have positive impacts on R&D and innovation activities at the firm level? Structural Change and Economic Dynamics, 20(4), 239–253.

Coad, A. (2010). Neoclassical vs evolutionary theories of financial constraints: Critique and prospectus. Structural Change and Economic Dynamics, 21, 206–218.

Czarnitzki, D. (2006) Research and development in small and medium-sized enterprises: the role of financial constraints and public funding. Scottish Journal of Political Economy, 53(3): 335–357.

Czarnitzki, D., & Hottenrott, H. (2011). R&D investment and financing constraints of small and medium-sized firms. Small Business Economics, 36(1), 65–83.

Czarnitzki, D., Hottenrott, H., Thorwarth, S. (2011). Industrial research versus development investment: The implications of financial constraints. Cambridge Journal of Economics, 35(3), 527–544.

Czarnitzki, D., & Hussinger, K. (2014).The Link between R&D Subsidies, R&D Spending and Technological Performance. Journal of Industrial Economics (in press).

Czarnitzki, D., & Licht, G. (2006). Additionality of public R&D grants in a transition economy: the case of eastern Germany. Economics of Transition, 14 (1), 101–131.

Czarnitzki, D., & Lopes-Bento, C. (2013). Value for money? New microeconometric evidence on public R&D grants in Flanders. Research Policy, 42(1), 76–89.

D'Espallier, B., Vandemaele, S., & Peeters, L. (2009). Corporate investment and financing constraints: Analyzing firm-varying investment-cash flow sensitivities. Review of Business and Economics, 54(4), 461–488.

David, P., Hall, B., & Tool, A. (2000). Is public R&D a complement or substitute for private R&D? A review of the econometric evidence. Research Policy, 29(4-5), 497–529.

Duguet, E. (2004). Are R&D subsidies a substitute or a complement to privately funded R&D? An econometric analysis at the firm level. Revue d'Economie Politique, 114 (2), 245–274.

Fazzari, S.M., Hubbard, R.G., & Petersen, B.C. (1988). Financing constraints and corporate investment. Brookings Papers on Economic Activity, 19, 141–195.

Feldman, M.P., & Kelley, M.R. (2006). The ex ante assessment of knowledge spillovers: Government R&D policy, economic incentives and private firm behaviour. Research Policy, 35(10), 1509-1521.

González, X., Jaumandreu, J., & Pazó, C. (2005). Barriers to innovation and subsidy effectiveness. RAND Journal of Economics, 36(4), 930-950.

Greene, W., & Hensher, D. (2010). Modeling Ordered Choices: A Primer. Cambridge: Cambridge University Press.

Hall, B.H. (1992) Investment and research and development at the firm level: does the source of financing matter? NBER Working Paper No. 4096. Cambridge, MA.

Hall, B.H. (2002). The financing of research and development. Oxford Review of Economic Policy, 18(1), 35–51.

Hall, B.H., & Lerner, J. (2010). The financing of R&D and innovation. In B.H. Hall & N. Rosenberg (Eds.), Handbook of the Economics of Innovation (pp. 610–638). Amsterdam: Elsevier.

Hall, B.H., Mairesse, J., Branstetter, L., & Crepon, B. (1999) Does cash flow cause investment and R&D? An exploration using panel data for French, Japanese, and United States scientific firms. In D.B. Audretsch & A.R. Thurik (Eds.), Innovation, Industry Evolution, and Employment (pp. 129–156). Cambridge: Cambridge University Press.

Hao, K.Y., & Jaffe, A.B. (1993) Effect of liquidity on firms' R&D spending. Economics of Innovation and New Technology, 2(4), 275–282.

Harhoff, D. (1998). Are there financing constraints for R&D and investment in German manufacturing firms? Annales d'Economie et de Statistique, 49/50, 421–456.

Harhoff, D., & Körting, T. (1998). Lending relationships in Germany: empirical evidence from survey data. Journal of Banking and Finance, 22(10-11), 1317–1353.

Himmelberg, C.P., & Petersen, B.C. (1994). R&D and internal finance: a panel study of small firms in high-tech industries. Review of Economics and Statistics, 76(1), 38–51.

Hyytinen A., & Toivanen, O. (2005). Do financial constraints hold back innovation and growth? Evidence on the role of public policy. Research Policy, 34(9), 1385–1403

Hovakimien A., & Hovakimien, G. (2009). Cash flow sensitivity of investment. European Financial Management, 15(1), 47–65.

Howe, J.D., & McFetridge, D.G. (1976). The determinants of R&D expenditures. Canadian Journal of Economics, 9(1), 57–71.

Hussinger, K. (2008). R&D and subsidies at the firm level: An application of parametric and semi-parametric two-step selection models. Journal of Applied Econometrics, 23(6), 729–747.

Huergo, E., & Trenado, M. (2010). The Application for and the Awarding of Low-Interest Credits to Finance R&D Projects. Review of Industrial Organization, 37(3), 237-259.

Jaffe, A. (2002). Building program evaluation into the design of public research-support programs. Oxford Review of Economic Policy, 18(1), 22–34.

Kaplan, S.N., & Zingales, L. (1997). Do investment-cash flow sensitivities provide useful measures of financing constraints? Quarterly Journal of Economics, 112(1), 169–215.

Klette, T., Moen, J., & Griliches, Z. (2000). Do subsidies to commercial R&D reduce market failures? Microeconomic evaluation studies. Research Policy, 29 (4), 471–495.

Lamont, O., Polk, C., & Saa-Requejo, J. (2001). Financial constraints and stock returns. Review of Financial Studies, 14(2), 529–554.

Lerner, J. (1999). The Government as Venture Capitalist: The Long-Run Impact of the SBIR Program. Journal of Business, 72(3), 285–318.

Magri, S. (2010). The financing of small innovative firms: The Italian case. Economics of Innovation and New Technology, 18(2), 181–204.

Meuleman, M., & De Maeseneire, W. (2012). Do R&D subsidies affect SMEs' access to external financing? Research Policy, 41(3), 580– 591

Mohnen P., Palm, F.C., Loeff, S., & Tiwari, A. (2008) Financial constraints and other obstacles: are they a threat to innovation activity? De Economist, 156(2), 201–214.

Mueller, E., & Zimmermann, V. (2009). The importance of equity finance for R&D activity? Small Business Economics, 33(3), 303–318.

Musso, P., & Schiavo, S. (2008). The impact of financial constraints on firm survival and growth. Journal of Evolutionary Economics, 18(2), 135–149.

Nelson, R. (1959). The simple economics of basic scientific research. Journal of Political Economy, 67(3), 297–306.

OECD (2012). *OECD Science, Technology and Industry Outlook 2012*. Paris: OECD Publishing. DOI 10.1787/sti_outlook-2012-en

Özçelik, E., & Taymaz, E. (2008) R&D support programs in developing countries: The Turkish experience. Research Policy, 37(2), 258–275

Qian, J., & Strahan, P. (2007). How laws and institutions shape financial contracts: the case of bank loans. Journal of Finance, 62(6), 2803–2834.

Russo, P., & Rossi, P. (2001). Credit constraints in Italian industrial districts. Applied Economics, 33(11), 1469–1477.

Sajaia, Z. (2008). Maximum likelihood estimation of a bivariate ordered probit model: Implementation and Monte Carlo simulations. Stata Journal, 4(1), 1–18.

Santamaría, L., Barge-Gilb, A., & Modrego, A. (2010). Public selection and financing of R&D cooperative projects: Credit versus subsidy funding. Research Policy, 39(4), 549–563

Savignac, F. (2008). Impact of financial constraints on innovation: What can be learned from a direct measure? Economics of Innovation and New Technology, 17(6), 553–569.

Schneider C., & Veugelers, R. (2010). On young highly innovative companies: Why they matter and how (not) to policy support them. Industrial and Corporate Change, 19(4), 969–1007.

Silva, F., & Carreira, C. (2012a). Do financial constraints threat the innovation process? Evidence from Portuguese firms. Economics of Innovation and New Technology, 21(8), 701–736.

Silva, F., & Carreira, C. (2012b). Measuring firms' financial constraints: A rough guide. Notas Económicas 36, 23–46.

Takalo, T., Tanayama, T., & Toivanen, O. (2013). Estimating the benefits of targeted R&D subsidies. Review of Economics and Statistics, 95(1), 255–272.

Whited, T.M. (1992). Debt, liquidity constraints, and corporate investment: Evidence from panel data. Journal of Finance, 47(4), 1425–1460.

Whited, T.M., & Wu, G. (2006). Financial constraints risk. Review of Financial Studies, 19(2), 531–559.

FIGURES

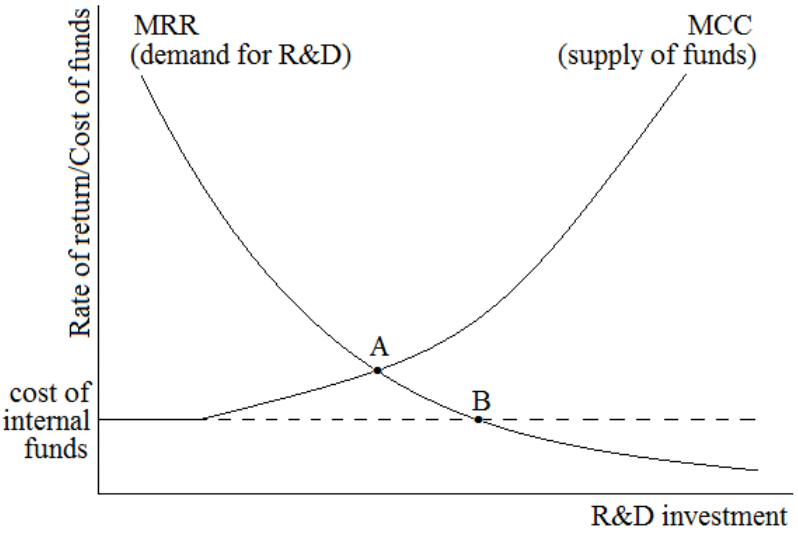

Figure 1. The effect of financial market failure

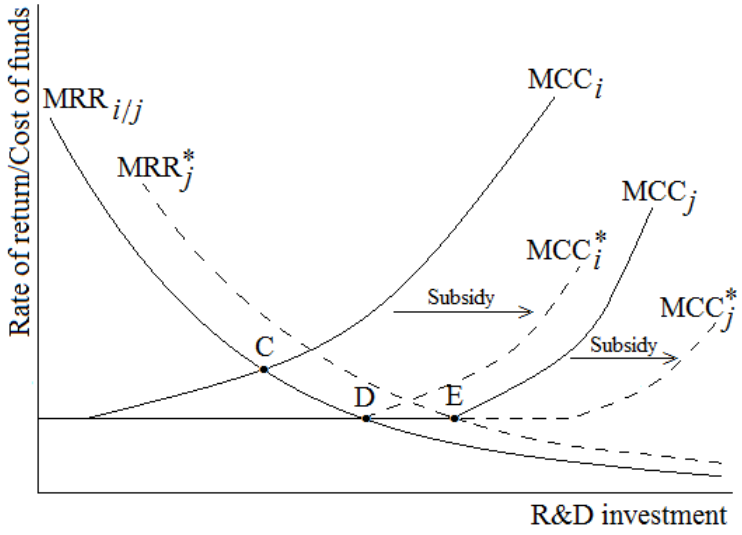

Figure 2. The impact of subsidy

TABLES

Table 1. Variables measuring financial constraints

Measure	Nature	Comments
Self-assessment	Ordinal	Subjective Firm-specific Varies across waves
HH index	Continuous	Assumes ICFS holds Firm-specific Time invariant
MS index	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 2. Measures of financial constraints

Ordinal Measures			**Continuous Measures**	
Self-assessment	Frequency	Percentage	Weighted MS index	
0	1,982	55.58	Min	0.046
1	446	12.51	25%	0.318
2	551	15.45	50%	0.418
3	587	16.46	75%	0.568
Total	3,566	100	Max	1.875
			M	0.457
			Σ	0.223
			Observations	3303
MS index			HH index	
1	678	20.51	Min	-6.666
2	444	13.43	25%	-0.001
3	278	8.41	50%	0.000
4	307	9.29	75%	0.001
5	295	8.92	Max	3.415
6	286	8.65	M	-0.005
7	261	7.89	Σ	0.207
8	346	10.47	HH>0	1692
9	266	8.05		(54.4%)
10	145	4.39	Observations	3110
Total	3,306	100		

Table 3. Frequencies of FC and SUB: Self-assessed levels of financial constraints

		SUB_w				SUB_w				SUB_{w-1}		
	FC_w	0	1	Total	FC_{w-1}	0	1	Total	FC_w	0	1	Total
Frequency	0	1,781	201	1,982	0	275	94	369	0	214	53	267
SUB %		89.86	10.14	100		74.53	25.47	100		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	1	393	53	446	1	42	9	51	1	56	24	80
SUB %		88.12	11.88	100		82.35	17.65	100		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	2	462	89	551	2	45	11	56	2	73	31	104
SUB %		83.85	16.15	100		80.36	19.64	100		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	3	506	81	587	3	56	23	79	3	102	27	129
SUB %		86.20	13.80	100		70.89	29.11	100		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	Total	3,142	424	3,566	Total	418	137	555	Total	445	135	580
SUB %		88.11	11.89	100		75.32	24.68	100		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). We additionally compare current (w) values of FC and SUB with the corresponding CIS wave lagged values (w-1).

Table 4. Frequencies of FC and SUB: MS index

		SUB_w				SUB_w				SUB_{w-1}		
	FC_w	0	1	Total	FC_{w-1}	0	1	Total	FC_w	0	1	Total
Frequency	1	576	102	678	1	146	40	186	1	124	27	151
SUB %		84.96	15.04	100		78.49	21.51	100		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	2	383	61	444	2	65	21	86	2	55	13	68
SUB %		86.26	13.74	100		75.58	24.42	100		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	3	243	35	278	3	32	22	54	3	47	9	56
SUB %		87.41	12.59	100		59.26	40.74	100		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	4	266	41	307	4	47	12	59	4	42	12	54
SUB %		86.64	13.36	100		79.66	20.34	100		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	5	242	53	295	5	37	12	49	5	48	14	62
SUB %		82.03	17.97	100		75.51	24.49	100		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	6	248	38	286	6	29	11	40	6	41	12	53
SUB %		86.71	13.29	100		72.50	27.50	100		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	7	226	35	261	7	28	5	33	7	28	19	47
SUB %		86.59	13.41	100		84.85	15.15	100		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	8	310	36	346	8	22	10	32	8	27	16	43
SUB %		89.60	10.40	100		68.75	31.25	100		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	9	231	35	266	9	16	0	16	9	40	8	48
SUB %		86.84	13.16	100		100	0.00	100		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	10	128	17	145	10	7	0	7	10	22	10	32
SUB %		88.28	11.72	100		100	0.00	100		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	Total	2,853	453	3,306	Total	429	133	562	Total	474	140	614
SUB %		86.30	13.70	100		76.33	23.67	100		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). We additionally compare current (w) values of FC and SUB with the corresponding CIS wave lagged values (w-1).

Table 5. 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 6. 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 stochastic different.

Table 7. 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	

Notes: Estimates of a probit regression of subsidies on different types of financial constraints: self-assed ordinal variable collapsed into binary (column 1); MS index and industry weighted MS index (columns 2 and 3, respectively); HH index (column 4). Robust standard errors in parentheses. ***, **, and * denote statistical significance at the .01, .05, and .10 levels, respectively.

Table 8. 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)
P	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	

Notes: Estimates of simultaneous equations specification in line with equation (3) using different measures of financial constraints: self-assed (column 1); MS index and industry weighted MS index (columns 2 and 3, respectively); HH index (column 4). Robust standard errors in parentheses. ***, **, and * denote statistical significance at the .01, .05, and .10 levels, respectively.

Table 9. Subsidy efficiency: 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\R2	-1701	-3210	0.139	0.030

Notes: Estimates of an ordered probit regression (columns 1-2) and a regular OLS (columns 3-5) of the impact of subsidies on different types of financial constraints: self-assed (column 1); MS index and industry weighted MS index (columns 2 and 3, respectively); HH index (column 4). We deliberately omit variables that are highly correlated with the measure of constraints by construction (columns 2-5). Robust standard errors in parentheses. ***, **, and * denote statistical significance at the .01, .05, and .10 levels, respectively.

Table 10. Subsidy efficiency: 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)
ϱ	-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

Notes: Estimates of simultaneous equations specification (columns 1-2) and treatment effects (columns 3-5), in line with equations (4) and (5), respectively. We use different measures of financial constraints: self-assed (column 1); MS index and industry weighted MS index (columns 2 and 3, respectively); HH index (column 4). We deliberately omit variables that are highly correlated with the measure of constraints by construction (columns 2-5). Robust standard errors in parentheses. ***, **, and * denote statistical significance at the .01, .05, and .10 levels, respectively.

Appendix

Table A1. 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—using CAE rev 2.1 as reference. 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)	

Variables	Description
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 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 A2. Subsidy allocation: lagged effect

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	

Notes: Estimates of a probit regression of subsidies on different types of financial constraints: self-assed ordinal variable collapsed into binary (column 1); MS index and industry weighted MS index (columns 2 and 3, respectively); HH index is dropped because it has no time variability by construction (see Section 3.1.2). Robust standard errors in parentheses. ***, **, and * denote statistical significance at the .01, .05, and .10 levels, respectively.

Table A3. Subsidy efficiency: lagged effect

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)	-0.2810.265)	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 \ R^2	-383.2	-697.7	0.202

Notes: Estimates of an ordered probit regression (columns 1-2) and a regular OLS (columns 3-5) of the impact of subsidies on different types of financial constraints: self-assed (column 1); MS index and industry weighted MS index (columns 2 and 3, respectively); HH index is dropped because it has no time variability by construction (see Section 3.1.2). We deliberately omit variables that are highly correlated with the measure of constraints by construction (columns 2-5). Robust standard errors in parentheses. ***, **, and * denote statistical significance at the .01, .05, and .10 levels, respectively.