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Is the Italian Government effective in relaxing the financial constraints of high technology firms?

Massimo G. Colombo*, Annalisa Croce and Massimiliano Guerini†

Department of Management, Economics and Industrial Engineering, Politecnico di Milano, 20137Milan

The present work analyses the effect of public finance on firm investments in a longitudinal sample of 293 Italian unlisted owner-managed, new technology-based firms (NTBFs), observed over a 10-year period from 1994 to 2003. We find that large, old NTBFs and those located in the north of Italy are not financially constrained, while small, young NTBFs and those located in the south of Italy rely significantly on internal capital to finance their investments. Public finance may play a prominent role for these latter firms. Indeed, empirical evidence shows that receipt of public subsidies by financially constrained NTBFs results in a reduction of investment–cash flow sensitivity in the long run. We interpret these results as an indication of the relaxation of financial constraints. Moreover, we find that, after receiving public finance, young and small firms increase their investment rate while NTBFs located in the southern regions do not. Nonetheless, small and young NTBFs benefit greatly from public intervention, but are less likely to obtain public support than their larger and older peers. Italian policy measures have also paid particular attention to NTBFs located in the south of Italy, but we find that public finance has no effect on the investment rate for southern NTBFs. This evidence raises some doubts about the overall efficacy of Italian governmental intervention in this domain.

Introduction

Several studies in the corporate finance literature focus on the effects of capital market imperfections on firms' ability to raise external capital to finance investments. Information asymmetries might translate into financial constraints, which, in turn, negatively influence firm investment and performance, with obvious negative implications for social welfare. It follows that the removal of such financial constraints is one of the most important objectives of public policy.

The effect of public finance on firm financial constraints has received limited attention in the literature (for exceptions, see Hyytinen and Toivanen, 2005; Czarnitzki, 2006; Colombo *et al.*, 2010a). Furthermore, apart from Colombo *et al.* (2010a), the abovementioned contributions do not explicitly focus on young, small and high technology firms, for which financial constraints are expected to be significantly more binding. In this paper, we aim to fill this gap by focusing on new technology-based firms (NTBFs). These firms play a crucial role in modern economies (Audretsch, 1995). However, hidden information and hidden action problems make

*Corresponding author. Email: massimo.colombo@polimi.it
†Current address: DESE, Università di Pisa, Pisa, Italy.

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obtaining external financing difficult for these firms (Carpenter and Petersen, 2002a; Hall, 2002). Indeed, because of the technology-intensive nature of their activity and the lack of track record, external investors are not able to gauge, *ex ante*, the quality of their investment projects and to monitor *ex post* the decisions made by entrepreneurs. Moreover, the most typical contractual mechanisms to circumvent asymmetries in information (e.g. collateral) are weakened by the intangibility of their assets (Berger and Udell, 1998). As a consequence, NTBFs are extremely vulnerable to frictions in financial markets (Denis, 2004).

Accordingly, NTBFs have attracted considerable attention from policy makers at local, national and supranational levels (see BEPA, 2008), with the presumption that public subsidies can help these firms overcome these financial constraints. This paper investigates empirically whether public support schemes relax the financial constraints of NTBFs and whether these alleged beneficial effects differ when considering specific NTBF's characteristics (size, age and the geographical area in which the firm is located). The paper will argue that financial constraints are more binding for firms with few collateral assets, no track record and that are located in depressed areas.

The paper analyses investments in fixed and intangible assets within a longitudinal hand-collected dataset consisting of 293 Italian owner-managed privately held NTBFs, observed between 1994 and 2003. The sample is extracted from the Research on Entrepreneurship in Advanced Technologies (RITA) 2004 database, developed at Politecnico di Milano. This database is the most comprehensive source of data on Italian NTBFs presently available. In particular, it contains information on all public subsidies received by sample firms from national governmental institutions during the observation period.

Following the approach originally proposed by Fazzari *et al.* (1988), we expect the removal of financial constraints after receipt of a public subsidy to result in an increase in the investment rate and a reduction in investment–cash flow sensitivity in the years following, for this type of firm. To detect financial constraints, we estimate a Euler equation (Bond and Meghir, 1994) that allows control for unobserved investment opportunities and adjustment costs. To take into account the potentially endogenous nature of public finance, we resort to a system generalised method of moments (GMM-SYS) estimator for dynamic panel data models (Arellano and Bover, 1995; Blundell and Bond, 1998). Moreover, we enlarge the usual set of internal instruments through the addition of variables that are a source of exogenous variation for receipt of public subsidies, both across firms and over time, to allow better control for selection based on unobservable characteristics.

The paper is structured as follows. In the next section, the paper briefly reviews the literature on firms' financial constraints and considers the expected effect of public finance on the investment rate and investment–cash flow sensitivity of NTBFs. The paper then presents the sample of firms and illustrates industrial policy measures in Italy that support NTBFs. The econometric approach is then derived and results discussed before key conclusions are offered.

The empirical literature on firm financial constraints

In their seminal work, Modigliani and Miller (1958) show that, if capital markets were perfect, every profitable investment would be financed in equilibrium and the source of financing would be irrelevant. As a corollary, the availability of internal

liquidity (i.e. current cash flows) would not affect the investment pattern of firms (Jorgenson, 1963; Hall and Jorgenson, 1967). Conversely, if investors are less informed than entrepreneurs, firms adhere to a pecking order when financing their investments (Myers and Majluf, 1984). First, they rely on internal sources of funds; then, when internal capital is exhausted, they turn to the external capital source with the lowest cost, which is usually debt (at least for firms with low leverage).

Fazzari *et al.* (1988) argue that while the marginal opportunity cost of internal capital is constant, the debt supply curve is upward-sloping and greater capital market imperfections result in a steeper slope. Under these circumstances, it would be expected that the investments of firms that are financially constrained (facing a steep debt supply curve) would be more sensitive to cash flows. The authors also show that investment–cash flow sensitivity is higher for firms with low dividend pay-outs, which allegedly have more binding financial constraints. Several studies replicate the above analysis by grouping firms according to different proxies of information costs, such as firm age, size, ownership structure and membership of *keiretsu* or business groups (see Hubbard, 1998, for a comprehensive survey). Other studies have considered different types of investments, including R&D expenses (Hao and Jaffe, 1993; Himmelberg and Petersen, 1994; Bougheas *et al.*, 2003; see also the studies surveyed by Hall, 2002).[1]

Nevertheless, the approach proposed by Fazzari *et al.* (1988) has weaknesses. First, Kaplan and Zingales (1997, 2000) have demonstrated that the profit-maximising investment choices of firms do not imply a monotonic relationship between financial constraints and the sensitivity of investments to cash flows (see also Kadapakkam *et al.*, 1998; Cleary 1999, 2006). Moreover, positive investment–cash flow sensitivity may simply derive from lack of proper control for unobserved investment opportunities (see Hubbard, 1998). Finally, Jensen (1986) has pointed out that opportunistic behaviour by managers who misuse a firm's free cash flows could cause overinvestment and lead to a positive relationship between investment rate and level of cash flows in the absence of any financial constraint.

Even though overinvestment and underinvestment problems stem from different theoretical considerations, they generate similar empirical effects and are thus difficult to disentangle. Vogt (1994) has reported evidence that both effects are at work and that overinvestment and underinvestment dominate for larger and smaller firms respectively. Pawlina and Renneboog (2005) also found that the agency costs of ownership influence investment–cash flow sensitivity.

However, it is important to emphasise that, for NTBFs, the sensitivity of investments to cash flows is a more reliable indicator of binding financial constraints than it is for other firms. On the one hand, the investment opportunities faced by NTBFs are likely to depend on the quality of their business ideas, the innovative content of the technologies they are developing and the entrepreneurial talent of their owner-managers. These investment opportunities are unlikely to be positively correlated with current cash flows. Therefore, it is implausible that high investment–cash flow sensitivity results from the superior investment opportunities of the (few) NTFBs that have large positive cash flows. On the other hand, most NTBFs are privately owned. As ownership and control are generally not separate, agency problems tend to be negligible. Therefore, for these firms free cash flow abuses on the part of owner-managers are unlikely and Jensen's (1986) free cash flow argument is not pertinent. Based on these considerations, in what follows we will interpret positive

investment–cash flow sensitivity as a sign of binding financial constraints that negatively affect the investment activity of NTBFs.

Criteria for identifying financial constraints

The entrepreneurial finance literature argues that NTBFs are likely to be financially constrained. First, because of the technology-intensive nature of their activity, they face hidden information and hidden action problems (Carpenter and Petersen, 2002a; Hall, 2002). On the one hand, it is difficult for external investors to gauge *ex ante* the quality of the investment projects of these firms. Moreover, as imitation by competitors of the innovative ideas of these firms can be very detrimental to their destiny, they are reluctant to disclose relevant information to potential investors (Anton and Yao, 2002). On the other hand, it is also difficult for outsiders to monitor *ex post* the decisions made by entrepreneurs and to discourage opportunism. Further, most of the assets of these firms are firm-specific or intangible. Hence, they cannot be pledged as collateral (Berger and Udell, 1990).

Previous work that used the same dataset found evidence of binding financial constraints for these firms. Bertoni *et al.* (2010) find that the investment activity of NTBFs reacts to internal cash flow shocks, but this sensitivity vanishes once firms obtain venture capital (VC) finance from independent investors. Colombo and Grilli (2007) examine debt financing in a similar sample. Their results conform to the pecking order hypothesis: NTBFs resort to bank debt only when the estimated amount of finance needed by the firm's operations exceeds the amount available internally. It is worth pointing out that our sample is composed of privately held firms; therefore, the dividend pay-out criterion used by Fazzari *et al.* (1988) is much less helpful in this context. However, we might expect that information asymmetries surrounding NTBFs are much more severe when NTBFs have little collateral, no track record and are located in depressed areas where the availability of external capital is low.

In this paper, we use three different criteria for identifying financially constrained firms. We start by classifying firms according to their size. As small firms are typically less known than larger firms, they are often unable to provide audited financial statements and have lower collateral relative to their liabilities; they are more vulnerable to constraints resulting from information asymmetries (Gertler and Gilchrist, 1994). More specifically, the collateral required by the bank is usually linked to the volume of the credit, so that the liquidation value of the collateral exceeds the credit exposure. Therefore, small NTBFs are more likely to be credit rationed, especially if they demand a large amount of credit (Berger and Udell, 2006). Finally, because of fixed costs associated with screening, contracting, monitoring and servicing loans, banks capture scale economies in dealing with larger firms, which tend to be larger borrowers (Avery *et al.*, 1998). Smaller firms and loans do not have such advantages.

The available empirical evidence supports the view that size is a good proxy for the presence of financial constraints. In this vein, Hao and Jaffe (1993) contrast the R&D investments of small and large firms in the United States; they show that the former are liquidity-constrained, while the latter are not (see Harhoff, 1998 for similar results for German firms). Himmelberg and Petersen (1994) analyse a panel data set composed of 179 US small, high-technology firms, not backed by VC, and find an economically large and statistically significant relationship between R&D

investments and cash flows. Using a panel of more than 1600 US small manufacturing firms, Carpenter and Petersen (2002b) document that the growth of firms' total assets closely depends on available cash flow; a cash flow increase of $1 results in a slightly larger increase of firms' total assets. Using a panel of 24,184 UK firms over the period 1993–2003, Guariglia (2008) finds that the investment–cash flow sensitivity monotonically decreases with firm's size.

Second, we split the sample according to NTBF age. We might expect younger firms to be particularly susceptible to information asymmetry effects and thus more financially constrained, since their short track record makes it more difficult for financial institutions to gather information about them and then to judge their quality (Hall, 2002). The available empirical studies support the contention that young NTBFs are financially constrained. Using an unbalanced panel of publicly traded US firms in high technology industries between 1990 and 2004, Brown *et al.* (2009) estimate a dynamic R&D model for high-technology firms and find significant effects of cash flow and external equity for young, but not mature, firms. Again, Guariglia (2008) finds a positive investment–cash flow sensitivity for young and middle-aged firms, generally larger for the former.

Finally, the third criterion we use in this work is the geographical area in which the NTBFs operate. In particular, we distinguish between firms located in the north and those located in the south of Italy. The geographical location of the firm may be a good proxy of information asymmetries in the Italian context. Previous studies provide evidence of lower external capital supply for firms located in the south. Guiso *et al.* (2004) build an indicator of financial development in Italy based on whether individuals belonging to a specific region have been denied credit or have been discouraged from applying. They find that financially underdeveloped regions tend to be in the south. Moreover, VC activity is concentrated in the northwestern regions of Italy, while independent and corporate VC investors are less likely to invest in the south of the country (Bertoni *et al.*, 2010). Finally, Sarno (2005) finds that small and medium enterprises located in the less-developed regions of the south face higher liquidity constraints than the firms in central and northern Italian regions. This evidence may be driven by the fact that borrowers in the south are perceived as considerably riskier than borrowers located elsewhere in Italy and the perception that southern banks perform their screening function less efficiently than banks in the rest of the country (Faini *et al.*, 1992; see also Resti, 1997; Usai and Vannini, 2005).

The role of public support in alleviating financial constraints for NTBFs

Several studies have analysed the effects of public support programmes on firm R&D expenditure and various indicators of firm performance, such as growth and productivity (see Lerner, 1999; David *et al.*, 2000, Klette *et al.*, 2000; Wallsten, 2000; Lach, 2002; González *et al.*, 2005; Hussinger, 2008). Results are equivocal on whether public subsidies are effective (Holtz-Eakin 2000). Indeed, public support may simply result in the replacement of market failure with governmental failure. For instance, politicians may use public programmes to reward constituents, rather than to correct market failure (Cohen and Noll, 1991; see also Becker, 1983). Moreover, public interventions may also prevent the emergence of active VC markets by crowding out private funds (Leleux and Surlemont, 2003; Cumming and MacIntosh, 2007). This problem is more likely to occur if government officers, who are

responsible for the allocation of public funds, cherry pick. To avoid accusations of misuse of taxpayers' money, they subsidise only first-class projects that beneficiary firms would have pursued in the absence of any subsidy (see Wallsten, 2000; Lach, 2002).

However, studies that have specifically examined whether public subsidies relax firms' financial constraints are quite rare. An exception in the Italian context is provided by Trovato and Alfò (2006). Using a panel of around 1900 small and medium enterprises over the years from 1989 to 1994 in Italy, they find that subsidised firms have higher leverage than unsubsidised firms; moreover, they present increased capital intensive investments. However, the authors focus on manufacturing industries and their small and medium enterprises are larger (fewer than 250 employees) than those in our study.

We assume that public subsidies may help in relaxing NTBFs' financial constraints if more investment is observed after receipt of the subsidies and a reduction of the sensitivity of investment to cash flows occurs. There are three non-competing explanations for these effects. First, the marginal cost of public funds is lower than for other external sources of finance. Hence, for financially constrained firms, receipt of a public subsidy renders some investment projects profitable that would not be profitable with more expensive capital sources. In addition to this direct effect, public funds may have two additional indirect positive effects on firm investments. First, a financially constrained firm receiving a public subsidy may use it (at least partially) to purchase fixed assets that can then be used as collateral. This alleviates information asymmetry problems, making it easier for the firm to obtain bank debt.

Second, if public subsidies are provided through a selective support scheme administered by a reputable governmental body and there is fierce competition among applicants, they will have a certification effect, signalling to uninformed external parties the quality of the recipient firm.[2] In turn, this signal will alleviate the hidden information problems that make it difficult for these firms to obtain external finance. In accordance with this latter argument, Lerner (1999) shows that US small, high-technology firms receiving awards from the Small Business Innovation Research (SBIR) programme exhibit greater growth over a decade than those included in a matched control sample, but only if they are located in a geographic area with high VC activity.[3] This positive effect seems to be confined to the first award received; the effects of subsequent awards were minimal. In addition, while VC investments did not predict SBIR awards, SBIR awardees were more likely to obtain VC subsequently.

It seems reasonable to expect that public financial support will have a higher impact when firms are financially constrained. Therefore, in this study, we argue that, for small, young NTBFs and for NTBFs located in the south of Italy, public support may be particularly useful in alleviating the negative effects of capital market imperfections that hold back their innovation investments and growth. First, the size of firms may influence the efficacy of public intervention. Indeed, Hyytinen and Toivanen (2005) show that small Finnish firms operating in industries that are largely dependent on external finance will invest more in R&D and are more growth-oriented when governmental funds are available locally. Second, previous studies on a sample of Italian NTBFs, similar to the sample used in the present work, suggest that public subsidies are particularly relevant for small and young firms. In a companion paper, Colombo *et al.* (2010a) find that public finance leads

to a persistent decrease of investment–cash flow sensitivity for small NTBFs, but has no effect on large NTBFs. Colombo *et al*. (2010b) document that public subsidies obtained through selective support schemes have beneficial effects on total factor productivity of Italian NTBFs, but only if they are obtained in the early years of the NTBF, when adverse selection problems are thought to be more severe. If selective schemes channel public funds to older NTBFs or if support is provided through automatic schemes, the effects are negligible.

Finally, public policies are often targeted to firms located in depressed areas. This implies that the location of firms receiving public subsidies cannot be ignored. For example, Czarnitzki (2006) analyses the effects of firms' internal financial resources, credit rating (interpreted as an inverse proxy of the difficulty of resorting to external finance) and public funds on R&D expenses in a sample composed of small and medium firms located in West and East Germany. In the West German sample, internal financial resources and public subsidies were found to influence R&D positively, while a bad credit rating had the opposite effect. Conversely, in East Germany, where public funds were more widely available than in West Germany, the sensitivity of firms' R&D expenses to internal financial resources was considerably reduced, credit rating played no role and public funds were the driving force of R&D activity. Notably, receipt of public support led to a 60% increase in the probability of a firm being involved in R&D; the corresponding figure for West Germany was 24%.

The sample

This work examines a sample of 293 Italian NTBFs observed from 1994 (or since their founding) up to 2003. Sample firms were established in 1980 or later, were owner-managed at the time of founding and remained so up to January 2004. They operated in the following high-technology sectors of manufacturing and services: computers; electronic components; telecommunications equipment; optical, medical and electronic instruments; biotechnology; pharmaceuticals; advanced materials; aerospace; robotics; process automation equipment; software; Internet and telecommunications services. The unbalanced panel dataset used in the empirical analysis includes 1498 firm-year observations; there are on average five observations per firm. We are interested in assessing the treatment effect of public finance on firm investment. Therefore, we excluded from the dataset the observations relating to firms backed by VC and firms that had been through an initial public offering (i.e. all observations relate to privately held, non-VC-backed firms).

The sample was extracted from the RITA 2004 directory, developed at Politecnico di Milano. In the absence of reliable official statistics, it is the most complete source of data on NTBFs available in Italy and includes 1974 firms. It is important to emphasise that, because of the procedure used to create this directory, lifestyle firms and firms that are created purely for tax-saving objectives are unlikely to be included. These firms are very unlikely to apply for public funds; their exclusion is an important strength of our dataset as it renders the estimates of the counterfactual (i.e. the investment choices that subsidised NTBFs would have made in the absence of public support) more precise. The sample analysed in the present study includes all RITA directory firms that participated in a survey administered in the first semester of 2004 and for which accounting data are available for the entire observation period. The sample is quite large and exhibits considerable heterogeneity in

terms of the characteristics of firms. Moreover, our dataset provides a rich set of industry, location and firm-specific information on sample firms that can be used to build appropriate instruments for receipt of public finance.

Table 1 reports the distribution of sample firms and RITA directory firms across industries, geographic areas and foundation dates. Two chi-squared (χ^2) tests show that there are no statistically significant differences between the distributions of the 293 sample firms across industries and geographical areas and the corresponding distributions of the 1974 RITA directory firms ($\chi^2(4) = 3.81$ and $\chi^2(3) = 5.26$, respectively). Conversely, sample firms are somewhat older than the population from which the sample was drawn (χ^2 (3) = 39.01), with the foundation dates being more (less) concentrated in 1992–1997 (1998–2003). This is probably because all limited liability companies in Italy are obliged by law to publish yearly accounting data, while publication is not mandatory for other firms. Limited liability companies are uncommon among very young NTBFs.

The sample-splitting criteria developed above are applied to the sample in the following ways. A firm-year observation falls in the large firms or small firms category if, in that particular year, the focal firm has total assets above or below the overall median (i.e. firms might move between the two subsamples as their size changes over time). Looking at the age criterion, a firm-year observation falls in the young firms or old firms category if the age of the focal firm is above or below the overall median of age, calculated as the difference between the year of the observation and the foundation date of the NTBF. Finally, a firm falls in the north or south

Table 1. Distribution of sample firms across industries, geographical areas and foundation date

Industry	RITA directory		Sample	
	n	%	*n*	%
ICT manufacturing	427	21.6	60	20.5
Automation equipment and robotics	212	10.7	30	10.3
Biotechnology, pharmaceutics and advanced materials	96	4.9	14	4.8
Software	539	27.3	94	32.1
Internet and telecommunications services	700	35.5	95	32.3
Total	1974	100.0	293	100.0
Geographical area	**RITA directory**		**Sample**	
	n	%	*n*	%
Northwest	853	43.2	145	49.3
Northeast	447	22.6	65	22.1
Centre	366	18.6	45	15.3
South	308	15.6	38	13.3
Total	1974	100.0	293	100.0
Foundation date	**RITA directory**		**Sample**	
	n	%	*n*	%
1980–1985	345	17.5	52	17.7
1986–1991	350	17.7	61	20.7
1992–1997	622	31.5	129	44.2
1998–2003	657	33.3	51	17.4
Total	1974	100.0	293	100.0

category if it is located in the northern or southern regions of Italy.[4] Table 2 reports the average values of total assets, age and localisation (the dummy variable north equals 1 if the NTBF is located in the north part of the country), according to the subsamples considered in this study.

It is quite interesting that the average value of total assets is higher for old firms and for those located in the north of the country. In fact, the average value of total assets for a young firm is 1174,000 euro, while a NTBF belonging to the old category presents a mean value of 2817,000 euro. We performed a t-test on such differences, finding that they are significant at the 99% confidence level. We observe that small firms are younger than large firms (6.74 and 11.52 years respectively), and that firms located in the north of Italy are older than those located in the south (9.49 and 8.28 years respectively). Finally, we report that 76% of large firms are located in the northern regions, but only 65% of small firms. Finally, old firms are located in the northern regions with a frequency of 75% and young firms with a frequency of 66%. Again, t-tests confirm that all such differences are statistically significant at the 99% confidence level. Therefore, we may expect similar results for young, small NTBFs, and NTBFs located in the south of Italy.[5] Finally, a total of 66 sample NTBFs received public support from the Italian Government in the period 1994–2003. However, since there are firms that have received more than one subsidy over the observation period, we observe that, out of the 1498 observations in the dataset, there are 85 firm-year observations in which one or more public subsidies were granted to the focal NTBF. Table 3 reports the distribution of received subsidies according to our splitting criteria.

From these figures, it is apparent that public subsidies were not ubiquitous among Italian NTBFs. Moreover, the treatment was not random. The larger firm category accounts for 59 of these observations, while only 26 are smaller firms. Hence, large firms are much more likely to obtain public subsidies than small firms (7.87% and 3.48% respectively). We also observe that older firms received a subsidy in 7.20% of firm-year observations, while the likelihood of receiving a public subsidy for younger firms is only 4.30%. This difference may be attributed to the cherry picking of Italian governmental bodies in charge of administering support schemes. Alternatively, high administrative costs may have discouraged smaller, younger and resource-constrained firms from applying for support. The high rate of subsidy for firms in the south compared with firms in the north is hardly surprising

Table 2. Mean values of firm size, age and geographical area by splitting sample criteria

	Total sample	Small	Large	Young	Old	North	South
Total assets (thousand €)	1951.06	256.79	3640.81	1174.52	2817.54	2274.44	1168.44
Age	9.13	6.74	11.52	4.76	14.01	9.49	8.28
North	0.71	0.65	0.76	0.66	0.75	1	0

Notes: A firm *i* is considered small/large in year *t* if its size, measured by total assets, is smaller/higher than median size, measured pooling all the observations in the sample. A firm *i* is considered young/old in year *t* if its age is smaller/higher than median age, measured pooling all the observations in the sample.
In the North category we include the following Italian regions: Valle d'Aosta; Piemonte; Lombardia; Liguria; Emilia Romagna; Friuli-Venezia Giulia; Trentino-Alto Adig; Veneto.
In the South category we include: Lazio; Marche; Toscana; Umbria; Abruzzo; Basilicata; Calabria; Campania; Molise; Puglia; Sardegna; Sicilia.

Table 3. Number of firm year observations in which the NTBF received at least one subsidy by firm size, age and geographical area

	Number of firm year observations	Number of firm year observations in which the NTBF received at least one subsidy	
		n	%
Small	748	26	3.48
Large	750	59	7.87
Young	790	34	4.30
Old	708	51	7.20
North	1060	55	5.19
South	438	30	6.85
Total	1498	85	5.67

Notes: As for Table 2.

(6.85% and 5.19% respectively). Indeed, one of the most prominent objectives of Italian policy measures has traditionally been the support of firms located in the depressed areas of the South. Data provided by the Ministry of Industry for the period 2000–2003 clearly document the importance of this objective.[6]

The econometric methodology

To analyse the investment–cash flow sensitivity, the literature proposes several econometric models (Hubbard, 1998; Bond and Van Reenen, 2007). As discussed above, current cash flows measure the availability of internal capital, but may also be related to a firm's investment opportunities. In the latter case, one cannot interpret the correlation between investments and cash flows as documentation of financial constraints. Although this problem is less severe for NTBFs than for mature firms, it is important to control for unobserved investment opportunities. For this purpose, the model has an estimate using a Euler equation, following Bond and Meghir (1994), and we insert the dummy variable $PUB\_FIN_{i,t-1}$, which indicates whether firm i received public subsidies in year t-1. More precisely, $PUB\_FIN_{i,t-1}$ switches from 0 to 1 in the year that follows the one in which the focal firm obtains the subsidy and equals 1 up to the end of the observation period. Therefore, the econometric specification we use is as follows:

$$\frac{I_{i,t}}{K_{i,t-1}} = \alpha_i + \tau_t + \gamma_1\left(\frac{I_{i,t-1}}{K_{i,t-2}}\right) + \gamma_2\left(\frac{I_{i,t-1}}{K_{i,t-2}}\right)^2 + \gamma_3\left(\frac{CF_{i,t}}{K_{i,t-1}}\right) + \gamma_4\left(\frac{S_{i,t}}{K_{i,t-1}}\right) + \gamma_5\left(\frac{D_{i,t}}{K_{i,t-1}}\right)^2 + \gamma_6 PUB\_FIN_{i,t-1} + \gamma_7 PUB\_FIN_{i,t-1}\left(\frac{CF_{i,t}}{K_{i,t-1}}\right) + \varepsilon_{i.t}, \quad (1)$$

where $I_{i,t}$ is the level of investments in tangible and intangible assets of firm i in period t,[7] $K_{i,t}$ is the end-of-period-t book value of firm i's total assets, $CF_{i,t}$ is firm i's cash flow in period t after taxes but before dividends,[8] $S_{i,t}$ is firm i's sales during period t and $D_{i,t}$ is firm i's end-of-period-t total debt. Table 4 provides a detailed description of the variables considered in this work.

If there are capital market imperfections and the external capital supply curve of NTBFs is upward-sloping, we expect γ_3 to be positive, indicating financial constraints. The coefficient γ_6 captures the increase in the average investment rate

Table 4. Variables description

Variable	Description
$I_{i,t}$	Increase from t-1 to t in the book value of tangible and intangible assets net of depreciation of firm i
$CF_{i,t}$	Cash flow of firm i at the end of period t after taxes but before dividends
$S_{i,t}$	Sales of firm i at the end period t
$D_{i,t}$	Sum of short- and long-term debt of firm i at the end of period t
$K_{i,t}$	Book value of tangible and intangible assets of firm i at the end of period t
$PUB\_FIN_{i,t-1}$	Dummy variable that equals 1 from the year that follows the one in which the focal firm obtains the subsidy up to the end of the observation period
$PUB\_FIN\_Area_i$	Share of RITA NTBFs that obtained public funds out of the total number of RITA NTBFs that are located in the same geographical area as firm i
$PUB\_FIN\_Sector_i$	Share of RITA NTBFs that obtained public funds out of the total number of RITA NTBFs that operate in the same industry as firm i
SUB_GDP_t	Ratio between the amount of yearly subsidies transferred to the private sector by the Italian government and GDP

of a subsidised NTBF in the years following the receipt of the subsidy. The coefficient γ_7 measures the effect of public finance on investment–cash flow sensitivity. More specifically, the effect of public finance on financial constraints can be gauged through a simple linear test on the parameters of the models. Indeed, after receiving public finance, internal cash flow in these firms should no longer have any effect on the investment rate (i.e. the coefficient of $CF_{i,t}/K_{i,t-1}$ should not be positive and significant). Following this line of reasoning, we performed the following Wald tests of the null hypothesis that a change in cash flow does not affect the investment rate: $\gamma_3 = 0$ for firms that did not obtain any public subsidies, and $\gamma_3 + \gamma_7 = 0$ for firms that obtained public subsidies. Finally, the effect of public finance on investment level can be evaluated in a similar way by performing Wald tests of the following null hypothesis $\gamma_6 = 0$.

Table 5 reports some descriptive statistics for the variables used in our models. All of these variables are normalised against the beginning-of-period-t stock of fixed and intangible assets. As firms in our sample are relatively young and small, this value is sometimes close to zero, producing extremely skewed and leptokurtic distributions of the variables. The presence of these outliers could severely bias our results. To avoid this problem, we winsorised all variables (see Dixon, 1960) with a 2% cut-off for each tail. In other words, for each variable we calculated the values corresponding to the 2nd and 98th percentiles of its distribution and assigned these values to all observations falling beyond them. This approach is useful because it reduces the impact of outliers and allows the use of a larger number of observations than would be possible if outliers were deleted. Furthermore, it has already been used in the investment literature (e.g. Baker and Stein, 2003), notably to assess investment–cash flow sensitivity (e.g. Cleary, 1999, 2006; Bertoni *et al.*, 2010). Other cut-offs for winsorising were computed (1% and 5%), but a 2% cut-off offers the best compromise between smoothing extreme values and maintaining suf-

ficient variance. Descriptive statistics for winsorised variables are also reported in Table 5.

We estimate Equation (1) for the total sample and for the subsamples according to the splitting criteria (size, age and geographical area). The main objective of the econometric analysis is to assess the treatment effect of public finance on firm investment rates and investment–cash flow sensitivity, depending on firm type. In order to deal with the potentially endogenous nature of the public finance variable ($PUB\_FIN_{i,t-1}$), we resort to a two-step GMM-SYS estimation (Arellano and Bover, 1995; Blundell and Bond, 1998) with finite-sample correction (Windmeijer, 2005). In addition to lagged levels of the series as instruments for first differences equations, the GMM-SYS estimator employs additional moment conditions using first differences as instruments for variables in levels. We consider covariates in the original Euler equation and all public finance variables to be endogenous; therefore, instruments start from t-2. In order to avoid finite sample bias and measurement errors, we limit the instrument set with moment conditions in the interval between t-2 and t-4 (see Bond, 2002).

Moreover, we enlarge the usual set of internal instruments through the addition of variables that are a source of exogenous variation for receipt of public subsidies, in order to control for selection effects. Indeed, if NTBFs that face better future investment opportunities are also more (or less) likely to obtain public finance, an upward (or downward) bias for the estimated coefficients of $PUB\_FIN_{i,t-1}$ will follow. Similarly, if future shocks that positively affect both investments and cash flows are positively (or negatively) correlated with receipt of public subsidies, an upward (or downward) bias in the estimated effect of public finance on the investment–cash flow sensitivity will follow. To address this problem, we add to the set of instruments of the GMM-SYS estimator three external instruments: the first two variables reflect the availability of public funds in the geographic area of the focal NTBF and in the industry in which it operates ($PUB\_FIN\_Area_i$ and $PUB\_FIN\_Sector_i$);[9] the third variable is the ratio between the yearly subsidies transferred to the private sector by the Italian Government and gross domestic product (GDP) (SUB_GDP). Good instruments need to be related to public finance variables, but should be independent of the error terms of the Euler equation. We expect that the likelihood of obtaining public finance is higher if the firm operates in a sector and geographical area with an abundance of public subsidies; it is also higher in years when more subsidies are available. However, the effect of public finance on investment rate and investment–cash flow sensitivity is expected to be independent of these variables and so they are a source of exogenous variation (see Sørensen, 2007; Bottazzi *et al.*, 2008; Chemmanur *et al.*, 2009; Ivanov and Xie, 2010).[10] Results of the Hansen statistic reassure us about the validity of the moment conditions used in all the estimations. Finally, to evaluate the relevance of all our econometric models, we implemented the Arellano and Bond test for first- and second-order serial autocorrelation of residuals [AR(1), AR(2)]. If ε_{it} is not serially correlated, the difference of residuals should be characterised by a negative first-order serial correlation and the absence of a second-order serial correlation. Our results confirm this.

Table 5. Descriptive statistics on regression variables

Variable	Number	Mean	Median	SD			Skewness	Kurtosis
				SD	Between	Within		
Not winsorised								
$I_{i,t}/K_{i,t-1}$	1498	1.292	0.445	7.364	4.774	6.234	21.290	505.771
$CF_{i,t}/K_{i,t-1}$	1498	1.017	0.479	3.664	2.488	2.965	12.229	229.518
$S_{i,t}/K_{i,t-1}$	1498	23.713	10.946	87.009	57.911	66.993	27.011	892.301
$(D_{i,t}/K_{i,t-1})^2$	1498	2427.442	24.772	69815.77	33020.50	61829.99	38.345	1479.17
Winsorised 2% each tail								
$I_{i,t}/K_{i,t-1}$	1498	0.932	0.444	1.537	0.897	1.343	3.691	18.390
$CF_{i,t}/K_{i,t-1}$	1498	0.873	0.479	1.515	1.239	1.098	2.916	14.429
$S_{i,t}/K_{i,t-1}$	1498	19.946	10.946	25.823	22.402	14.994	2.877	12.541
$(D_{i,t}/K_{i,t-1})^2$	1498	288.753	24.772	1002.6	848.954	659.26	5.403	32.884

Note: $I_{i,t}$ is the increase in a firm's book value of tangible and intangible assets net of depreciation between periods t–1 and t. $K_{i,t-1}$ is the beginning-of-period-t book value of tangible and intangible assets. $CF_{i,t}$ is firm i's cash flows after taxes and before dividends in period t. $S_{i,t}$ is firm i's sales in period t. $D_{i,t}$ is firm i's total current and long-term debt at the end of period t.

Table 6. Effect of public finance on firm investment rate and investment–cash flow sensitivity

	(1)		(2)		(3)		(4)		(5)		(6)		(7)	
	Total		Small		Large		Young		Old		South		North	
$I_{i,t-1}/K_{i,t-2}$	–0.0195		0.0665		–0.0733		–0.1950		0.1903	*	0.0034		0.0081	
	(0.087)		(0.094)		(0.143)		(0.129)		(0.115)		(0.134)		(0.123)	
$(I_{i,t-1}/K_{i,t-2})^2$	0.0092		–0.0045		0.0182		0.0283	*	–0.0223	**	0.0127		0.0030	
	(0.012)		(0.018)		(0.018)		(0.017)		(0.011)		(0.019)		(0.016)	
$CF_{i,t}/K_{i,t-1}$	0.2381	**	0.4785	***	0.1437		0.2644	**	0.1397		0.4440	***	0.0921	
	(0.110)		(0.140)		(0.129)		(0.129)		(0.112)		(0.108)		(0.127)	
$PUB\_FIN_{i,t-1}$	0.1626		0.5499	*	0.0470		0.5460	*	–0.0403		0.3604		0.1441	
	(0.158)		(0.316)		(0.216)		(0.286)		(0.167)		(0.257)		(0.230)	
$PUB\_FIN_{i,t-1}\cdot(CF_{i,t}/K_{i,t-1})$	–0.2582	**	–0.7850	**	–0.1297		–0.5030		–0.1366		–0.4005	***	–0.2282	
	(0.132)		(0.325)		(0.156)		(0.307)		(0.137)		(0.107)		(0.213)	
$S_{i,t}/K_{i,t-1}$	0.0164	*	0.0263	***	0.0164	*	0.0105		0.0200	**	0.0236	***	0.0158	*
	(0.008)		(0.008)		(0.009)		(0.009)		(0.009)		(0.009)		(0.009)	
$(D_{i,t}/K_{i,t-1})^2$	–0.0000		–0.0003		0.0000		0.0003		–0.0002		–0.0006	**	0.0001	
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
Constant	0.2405		0.0249		0.2860		0.4419	**	0.3958		–0.1886		0.3528	
	(0.186)		(0.196)		(0.400)		(0.193)		(0.483)		(0.232)		(0.250)	
Investment–cash flow sensitivity of subsidised firms (Wald test)	–0.0201		–0.3065		0.1390		–0.2386		0.0031		0.0435		–0.1361	
	(0.107)		(0.307)		(0.108)		(0.287)		(0.110)		(0.084)		(0.192)	
Number of observations	1498		748		750		790		708		438		1060	
Hansen	138.67		135.68		147.03		157.98		124.69		68.68		142.93	
	[158]		[172]		[172]		[153]		[157]		[149]		[172]	
AR(1)	–3.9441	***	–2.6553	***	–3.5395	***	–2.5836	***	–3.6878	***	–2.0486	**	–3.4691	***
AR(2)	0.4284		1.2742		–1.2613		0.1744		–1.0542		0.9952		0.0217	

Notes: Standard errors in are shown parentheses; degrees of freedom are shown in square brackets.
***, **, * Indicate, respectively, significance levels of <1%, <5% and <10%.
All estimates include year and industry dummies (coefficients are omitted from the table). Estimates are derived from two-step system GMM with finite sample correction (Windmeijer, 2005). AR(1) and AR(2) are tests of the null hypothesis of, respectively, no first- and second-order serial correlation. Hansen is a test of the validity of the overidentifying restrictions. The linear test for cash flow shifts is defined in Section 4. *I* measures firm investments in fixed and intangible assets. *K* is the book value of tangible and intangible assets. *CF* is firm's cash flows after taxes and before dividends. *S* is firm sales. *D* is firm total current and long-term debt. PUB_FIN_{it-1} is a time-varying dummy variable equal to 1 if firm *i* received public finance in year *t-1* up to the end of the observation period. The dependent variable is the ratio between period *t* investments in fixed and intangible assets and the book value of total assets at the beginning of period *t*. External exogenous instruments are the availability of public finance in the geographical area and in the industry in which the firm operates (*PUB_FINArea, PUB_ FINSector*) and the ratio between the amount of yearly subsidies transferred to the private sector by the Italian government and GDP (*SUB_GDP*). All ratios are winsorised at the 2% threshold.

Econometric results

We illustrate in Table 6 the estimates of Equation (1). Column 1 refers to the total sample while, in the following columns, we report the estimates on the subsamples obtained according to our splitting criteria (size, age and geographical area). In all models, the null hypothesis of absence of a negative first-order serial correlation is rejected, while the null hypothesis of absence of a second-order serial correlation is not. The Hansen tests also indicate that the null hypothesis of equality to zero of the specified orthogonality conditions is not rejected.

Results referring to the total sample give some support to the view that NTBFs are financially constrained. The coefficient of the cash flow variable capturing the sensitivity of investments to cash flows for non-subsidised firms is positive and significant. Public finance does not significantly affect the investment rate, even though the coefficient of $PUB\_FIN_{i,t-1}$ (i.e. γ_6) is positive as expected. However, it helps relaxing financial constraints, since the investment–cash flow sensitivity of subsidised firms, looking at the Wald test on the linear combination of the parameters reported at the bottom of the table (i.e. $\gamma_3 + \gamma_7$) is not significant, suggesting that for subsidised NTBFs investments are not significantly related to cash flows.

We then split the sample into two subsamples, composed of small and old firms (columns 2 and 3). An observation falls in the large firms or small firms subsample if the firm has total assets above or below the overall median in that particular year. Estimated results for large firms suggest that these firms are not financially constrained, as the coefficient of the cash flow variable, although positive, is not significant. Moreover, public finance does not significantly affect either the investment rate or the investment–cash flow sensitivity.

Results for small NTBFs are more interesting. The investment rate of small non-subsidised NTBFs is found to be sensitive to cash flows, as documented by the positive and significant (at 99%) coefficient of the cash flow variable. Interestingly, the magnitude of this coefficient (0.4785) is significantly higher than that estimated for the total sample (0.2378), confirming the relevance of financial constraints for small, high-technology firms. This result is in line with the argument that these firms find it difficult to obtain external finance at fair terms and are forced to rely on internal capital to finance their investments. When small NTBFs receive public funds, they are able to remove the financial constraints that would otherwise inhibit investments. Accordingly, their investment rate increases and investments are no longer dependent on internal cash flows. In fact, the coefficient of $PUB\_FIN_{i,t-1}$ is positive and significant at the 90% confidence level. The coefficient of the cash flow variable in the years following the receipt of public finance is no longer significant, as documented by the value of the Wald test reported at the bottom of the table, indicating the removal of financial constraints.

Let us now consider the effects of public finance on the investments of young and old NTBFs, reported in columns 4 and 5. These estimates are qualitatively similar to those illustrated above. They confirm that non-subsidised young NTBFs rely on internal cash flows to finance their investments, while older firms are not financially constrained. However, the cash flow coefficient of young non-subsidised firms is lower in magnitude and less significant than the corresponding coefficient for small firms. Although the absence of both a track record and collaterisable assets represent a problem for NTBFs, the latter seems to be more important than the former, discouraging external investors. This might explain why the cash flow

sensitivity of small NTBFs is almost twice as large as that of young NTBFs. After receipt of a public subsidy, the investment rate again increases and the sensitivity of investments to cash flows vanishes.

Finally, let us turn our attention to the estimates that consider the geographical area in which the NTBFs are located as splitting criteria (see columns 6 and 7 for southern and northern NTBFs). The estimated cash flow coefficient for non-subsidised firms located in the south of Italy is positive and strongly significant, while NTBFs located in the more developed areas of the north of Italy are not financially constrained, whether or not they are subsidised. The effect of public finance is again beneficial for financially constrained southern firms. The Wald tests reported at the bottom of the table indicate that, for subsidised NTBFs located in the south of Italy, the null hypothesis of no positive dependence of investments on cash flow shocks cannot be rejected at conventional confidence levels (the coefficient is positive, but not significant). Thus, our results again suggest that receipt of a public subsidy leads to a relaxation of financial constraints. Nevertheless, it is worth noting that public finance has no effect on the investment rates of southern NTBFs, even if these firms are, on average, smaller and younger than firms in the north of the country. Therefore, one should expect results similar to those reported in columns 2 and 4. Instead, the coefficient of $PUB\_FIN_{i,t-1}$ is lower in magnitude and not significant. This result might be attributable to the lower investment opportunities that NTBFs face in depressed regions. It might also be relevant that, if financial markets are not well developed, as in the case of southern regions, firms may simply tend to substitute private loans and external equity with costless public financing. As a consequence, the final effect of public subsidies is merely to replace private sources of financing. Therefore, southern NTBFs are not financially constrained after receipt of the subsidy since they can use public funds directly. However, NTBFs do not significantly increase their investment rates since it is unlikely that they will be able to raise additional external capital from private investors. In other words, we observe only the direct effect of public finance and not the certification effect because of the underdevelopment of efficient capital markets (see Faini *et al.*, 1992; Guiso *et al.*, 2004). As a consequence, if private external capital is limited, the public finance effect turns into a simple substitution of financing, with little effect on overall investment rate.

Discussion and conclusions

This paper investigates whether public finance helps financially constrained NTBFs to relax the financial constraints that bind their investment activity. Moreover, we assess whether the effects of public finance differ by considering the size and age of the NTBF and its geographical localisation. For this purpose, we consider a unique hand-collected longitudinal dataset that includes 293 Italian NTBFs observed from 1994 to 2003. Out of these firms, 66 have obtained one or more public subsidies. The longitudinal dimension of the dataset and the availability of a rich set of variables allows us to estimate a modified version of the Euler equation using GMM-SYS estimation techniques with an enriched set of instruments, so as to take into account the endogenous nature of public finance.

Our results can be synthesised as follows. First, our estimates indicate that small and young NTBFs, and NTBFs located in depressed regions in the south of Italy, rely on internal funds to finance their investments. These firms exhibit positive and

significant investment–cash flow sensitivity. These findings are in the spirit of studies claiming that these firms are likely to be financially constrained (Carpenter and Petersen, 2002a,b; Hyytinen and Toivanen, 2005; Sarno, 2005; Guariglia, 2008; Czarnitzki, 2006; Colombo and Grilli, 2007; Bertoni *et al.*, 2010; Colombo *et al.*, 2010a). Conversely, no such relationship emerges for larger and older NTBFs and for NTBFs located in the north of Italy. Second, we show that receipt of public subsidies results in a reduction of the investment–cash flow sensitivity for small, young NTBFs located in the south of Italy. However, public finance leads to an increase of the investment rate, thus boosting the growth of subsidised young and small NTBFs – except those in the south of Italy.

Our work contributes to the literature arguing that public finance is extremely important for small and young, high-technology firms (e.g. Lerner, 1999; Lach, 2002; Colombo *et al*., 2009, 2010a,b). These studies suggest that public finance can alleviate the negative effects of capital market imperfections on innovation and the growth of firms (see also Hyytinen and Toivanen, 2005; Czarnitzki, 2006; Czarnitzki *et al*., 2009). Our findings show that public support does not have beneficial effects on large and old NTBFs, or on NTBFs located in highly developed regions. These firms are not financially constrained and, accordingly, public support does not affect their investment strategies. This evidence reinforces the view that public policy measures have to be targeted to small, young NTBFs, which really need public finance for innovation, growth and investment. In Italy, as in most European countries, this has rarely happened (Colombo and Grilli, 2006). Therefore, it is fair to acknowledge that, despite the potential beneficial effects of public support for NTBFs, governance failure, in distorting fund allocation, can prevent these benefits from materialising (see Schneider and Veugelers, 2010).

However, Italian policy measures emphasise the development of firms located in the south of the country. Although we have found that such measures have been effective in reducing the financial constraints of southern NTBFs, it is worth pointing out that no effect has been detected on firm investment rate.[11] This evidence suggests that these firms probably face few investment opportunities. Therefore, the Italian Government should complement the direct subsidisation of NTBFs with other indirect measures aimed at increasing the infrastructure of such regions in order to support the growth of these firms. This result might be driven by the underdevelopment and inefficiency of capital markets in Italian southern regions. Thus, the public finance effect turns into simple substitution of financing, with little effect on overall investment rate. An active VC market in these regions might complement the direct subsidisation of southern NTBFs. In this way, public finance might have a real certification effect for outside investors, as reported by Lerner (1999) when analysing the SBIR programme in the US.

In the light of these considerations, our work contributes to the current policy debate for the design of appropriate measures to support NTBFs. Indeed, it is worth pointing out that the European 2020 targets (SEC, 2010) identify access to finance as one of the main bottlenecks to the growth of small and medium-sized enterprises in Europe. The European Commission has highlighted how the member states of the euro area should reduce the large and persistent divergences in the economic and industrial conditions of different zones. In line with these initiatives, our work emphasises the importance of public initiatives to support the investments of small, young NTBFs, particularly those located in depressed Italian regions.

Much remains to be done in this field. There are four directions for future research that seem very promising. First, it should be determined whether the results we obtained for Italian NTBFs can be extended to other countries. A cross-country dataset, similar to the one used in this work, would be a fundamental step forward in providing a micro-econometric assessment of the effects of public policy measures. Second, we focus attention here on subsidies provided by the Italian Government. However, both local and supranational public institutions are increasingly important sources of public support to NTBFs. Thus, it could be interesting to analyse whether different sources of public financing produce different effects. Third, our results suggest that public finance is effective in alleviating the negative effects of capital market imperfections faced by NTBFs. However, they do not reveal the reason behind this positive effect. Indeed, the positive impact of public finance on the investment rate and on the sensitivity to cash flow of small and young NTBFs may be explained by different reasons. These firms may use public funds in order to increase the level of fixed assets, which can then be used as collateral. Moreover, if the subsidy is granted through a selective scheme, a certification effect may apply. However, because our dataset lacks enough firm-year observations relating to subsidised NTBFs, we are not able to discriminate between selective and automatic schemes, and so we are not able to distinguish between these effects. Finally, we have considered the three splitting criteria independently. However, it would be interesting to evaluate the presence of financial constraints and the impact of public finance by combining these criteria. For instance, one could investigate if financial constraints are binding for old and large NTBFs, but located in the south of Italy, or for young and small NTBFs, but located in the north. A better understanding of such issues would provide useful insights for the design of effective policy measures, in order to relax the financial constraints that bind the investment activity of NTBFs.

Notes

1. Some studies assessing the effects of financial constraints on R&D and innovation have relied on direct survey-based measures of the existence of financial constraints (e.g. Savignac, (2008) and Tiwari *et al*., (2007). These studies show that financial constraints do indeed hamper innovation.
2. An automatic scheme gives financial assistance to all applicants fulfilling all the requirements specified in the law. In contrast, a selective scheme provides financial support to selected applicants; applicants compete for financial subsidies and their projects are judged by committees of experts appointed by the national authority.
3. Nonetheless, the finding that SBIR grants foster growth was not replicated by Wallsten (2000). After controlling for endogeneity of public support in a multi-equations framework, it was found that SBIR grants did not positively influence firms' employment growth, while crowding out firms' private R&D expenses.
4. In the north category, we include the following Italian regions: Valle d'Aosta; Piemonte; Lombardia; Liguria; Emilia Romagna; Friuli-Venezia Giulia; Trentino-Alto Adige; Veneto. In the South category we include: Lazio; Marche; Toscana; Umbria; Abruzzo; Basilicata; Calabria; Campania; Molise; Puglia; Sardegna; Sicilia.
5. The descriptive statistics presented here are consistent with the official statistics for the Italian industrial system, provided by Istituto Nazionale di Statistica (ISTAT, 2009).
6. Measures in support of the south date back to the early 1950s, when the Italian Government created the Cassa del Mezzogiorno (Fund for the South), a public agency devoted to financing industrial development and public infrastructure in the region. For a discussion of Italian policy measures targeted to NTBFs, see Appendix 1.

7. We measure investments by the increase in the book value of tangible and intangible assets net of depreciation.
8. Other authors have used ex-dividend cash flows (e.g. Manigart *et al*., 2003). We opted for cash flows before dividends because our sample is composed of unlisted firms. Managers of listed firms are more constrained than those of private firms because of the dividend paid to shareholders, as any reduction may be perceived as a negative signal by investors. Conversely, in private firms, dividends have no signalling role and all cash flows can be reinvested if profitable investment opportunity arises.
9. These indicators represent the share of RITA NTBFs that obtained public funds out of the total number of RITA NTBFs located in the same geographical area and operating in the same industry as firm *i*.
10. Note that we make the assumption that the clustering of public funds in specific industry or geographic markets is exogenous – that is, it is not driven by investment opportunities unobserved by third parties faced by the NTBFs that are in those markets and are potential candidates for receiving public funds. Therefore, it is uncorrelated with the error term of the Euler equation.
11. The evidence presented here is limited to the effect of public finance on investments in tangible and intangible assets. However, a positive effect of public intervention can materialise in different forms for firms in the south of Italy (e.g. productivity or R&D investments).
12. In Italy, several governmental institutions were responsible for the administration of public subsidies. They include the Ministry of Economics and Finance, the Ministry of Industry, the Ministry of University and Research, the Ministry of Labour and Welfare, the Ministry of Agricultural Food and Forest Policies, the Ministry of International Trade, and the Institute for Foreign Trade (ICE). In Italy, unlike in other European countries, there is no public agency in charge of innovation policy measures.
13. Law 808/1985 accounted for another 25%, but mainly benefited large established firms. The remaining 25% was dispersed among a plethora of schemes.
14. According to Italian fiscal law, firms may decide whether to treat R&D expenses as investments or to expense them when they are incurred. This latter option is more favourable for firms with positive net income.

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Appendix 1: Public subsidies to NTBFs in Italy

During the observation period, there was no large-scale national public support scheme in Italy expressly targeted to NTBFs (like the SBIR programme in the US or the Jeunes Entreprises Innovantes scheme in France). The only partial exception is Law 297/1999, favouring the creation of academic start-ups. Indeed, the industrial policy of the Italian Government relied on horizontal measures directed at all firms, or aimed at supporting specific sectors (e.g. Law 808/1985 in support of the aerospace sector, dominated by large enterprises such as Finmeccanica), or focusing attention on young or small enterprises independently of their sector of operations, with most beneficiaries being the small low technology firms that abound in Italy. As a result, in the period under observation here, sample NTBFs obtained financial support from 22 national policy schemes.

The policy measures implemented by the Italian Government to support private firms differ in objective, evaluation method for applications and financial instrument through which subsidies are obtained by beneficiary firms.[12] Some measures relied on automatic schemes and others on selective ones. Financial instruments included tax credits, non-repayable grants and subsidised loans (repayable loans priced below market interest rates). Support for firms located in the depressed areas of the south has traditionally been the most prominent. Data provided by the Ministry of Industry for the period 2000–2003 clearly document the importance of

this objective. In this period, policy measures inspired by this objective accounted for about 46% of total subsidies to private firms. The main schemes in this category, such as Law 64/1986 (Intervento Straordinario nel Mezzogiorno, Extraordinary Intervention for the South of Italy) and Law 488/1992, provide firms located in this geographic area with grants and other forms of public finance to support their investments.

Support for R&D and innovation was the second most important objective of Italian industrial policy, with a 22% share of the subsidies awarded to private firms in the 2000–2003 period. Most of the support was channelled through three instruments: the FAR fund (Fondo Rotativo per le Agevolazioni alla Ricerca, Fund for Research Facilitations) and the FIT fund (Fondo Rotativo per l'Innovazione Tecnologica, Fund for Technological Innovation), which were introduced by Law 46/1982, and Law 808/1985, targeting the aerospace industry. FAR supported pre-competitive R&D, while FIT had broader scope and financed any type of innovation activity, including the purchase of innovative machinery. FAR and FIT accounted for roughly half of total R&D and innovation subsidies granted to Italian private firms in the 2000–2003 period and were widely used by NTBFs.[13] The third most important objective (9% of subsidies in 2000–2003) was the support of investments in fixed assets. The remaining subsidies were channelled through schemes aimed at diverse objectives, including the promotion of entrepreneurship and of the internationalisation of firms.

In spite of the variety of the policy measures implemented by the Italian Government, it can be presumed that if NTBFs were financially constrained, the receipt of a subsidy should have helped them to relax these constraints, thereby positively influencing their investments. In fact, most policy measures utilised by Italian NTBFs support investments in tangible or intangible assets (i.e. R&D and innovation expenditures).[14] When this was not the case, the positive effect on investments may have been indirect. On the one hand, beneficiary NTBFs may have been able to finance investments through internal financial resources that would have been used for other purposes in the absence of the subsidy. On the other hand, receipt of a selective subsidy may have made it easier to obtain external finance from other sources because of the quality certification effect. For these reasons, in assessing the treatment effect of public finance on the investment activity of Italian NTBFs, we consider all national policy schemes from which NTBFs obtained support. Table A reports the policy measures that have been utilised by the NTBFs of our sample.

Table A. Description of policy measures implemented by the Italian Government for the NTBFs in the sample

Law	Short description	Number
L. 1329/65	Grants for investments in fixed assets by small medium enterprises	1
L. 1089/68	Grants for R&D investments	2
L. 902/76	Subsidised loans to promote firm's internationalisation	1
L. 46/82	Subsidised loans and grants for R&D investments by small medium enterprises	14
L. 696/83	Grants for investments in fixed assets by small medium enterprises	1
L. 26/86	Subsidised loans and grants for investments in fixed assets by small medium enterprises located in the regions of Trieste and Gorizia	1
L. 44/86	Grants and subsidised loans for investments in fixed and current assets in order to promote young entrepreneurship in the South of Italy (Mezzogiorno)	2
L. 64/86	Grants for firms located in the south of Italy (Mezzogiorno)	5
L. 317/91	Tax credits for R&D and innovation investments	3
L. 215/92	Grants in order to promote feminine entrepreneurship	2
L. 488/92	Grants for firms located in depressed areas	15
L. 236/93	Grants for R&D investments by young firms operating in service industries located in depressed areas	6
L. 451/94	Tax credits for employment	1
L. 341/95	Tax credits for investments in tangible and intangible assets (e.g. software) by firms located in depressed areas	2
L. 95/95	Subsidised loans and grants for investments in fixed and current assets in order to promote young entrepreneurship	2
L. 140/97	Tax credits for R&D investments	26
L. 196/97	Grants in order to promote employment and young entrepreneurship in the south of Italy (Mezzogiorno)	2
L. 266/97	Tax credits for investments in software and for ICT consultancy services for small medium enterprises	4
L. 449/97	Tax credits in order to promote employment	3
L. 297/99	Grants for R&D investments and tax credits for employment in order to promote high technology entrepreneurship	7
L. 388/00	Tax credits for general purpose and R&D investments and employment for firms located in depressed areas	5
L. 383/01	Tax credits for personnel training	5

Note: column 3 reports the number of sample firms that obtained the subsidy described in columns 1 and 2.