THE RIMINI CENTRE FOR ECONOMIC ANALYSIS

WP 10-09

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THE FINANCING MENU OF R&D AND TRADITIONAL INVESTMENTS

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1. Introduction

The aim of this study is to identify the different role of financial funds in traditional and R&D investments in Italian manufacturing firms using information from Capitalia's latest Survey of Italian Firms. R&D, defined as a creative activity implemented to improve know-how and its utilization in new applications, is quite distinct due its high rate of information opacity. Coherently with the asymmetric information theory, R&D thus implies greater difficulties to find external financial funding. The higher risk related to R&D projects could entail some form of financial constraints. However, signaling mechanisms such as self-financing could correct such a market imperfection.

The purpose of this work is twofold. First, we investigate which indicators (firm structural characteristics, information asymmetries and credit market structure) can define the pattern of the R&D financing scheme. Second, we investigate whether R&D investments face greater difficulties in gathering external financial resources compared to traditional investments.

The decision to fund an R&D investment through informed debt or self-financing is initially tested through a simple Logit and OLS analysis and, thereafter, through SUR models. The study includes both traditional and R&D investments, and the outcomes enable a comparative analysis of the particularity of R&D financing *versus* traditional investments. As highlighted by Himmelberg and Petersen (1994, p. 38) "this approach allows us to compare our findings to the existing literature on physical investment under capital market imperfections. Second, it is inappropriate to view the firm as having access to separate financing sources for R&D and physical investment. Finally, as argued by Schumpeter, new knowledge must be incorporated in the production process through investments in new plant and equipment. Hence, the financing of physical investment for R&D-intensive firms are more prone to moral hazard and adverse selection problems".

The remainder of the paper is organized as follows. Section 2 briefly looks into the main theoretical and empirical literature on SME financial preferences. Sections 3 and 4 describe the data set, while the econometric analysis and the main results follow in section 5. Section 6 contains the conclusions.

2. Theoretical background and empirical issues

Traditionally, firm market value and real decisions are considered independently from the financial structure and financing policies, given that in the theoretical context, based on Modigliani and Miller's model (1958), financial markets are perfect and characterized by fiscal neutrality, and thus, external funds and internal funds are considered perfectly substitutable. However, the absence of information asymmetry implies conclusions that cannot appropriately explain the different SME financial preferences involved in traditional investments, as compared to those in R&D. Due to high information opacity, firms involved in R&D investments have greater difficulties in obtaining external funds. As suggested by Myers-Majluf (1984), information asymmetries lead to a hierarchic preference for internal financial resources that justify higher R&D self-financing rates compared to traditional investment rates (Hall, 2002).[1]

According to the pecking order theory, the cost of funding increases to the increase of information asymmetries. The cost of information asymmetries, more reliable in the case of SMEs, implies that firms choose the less expensive form of financing in terms of information disclosure (Bhattacharya-Chiesa, 1995).[2] As a consequence, new investments are initially financed with internal capital and further by low-risk bank credit followed by bonds and, only as a last option, through share issues. Likewise, Berger-Udell (1998) reiterate that firm financial demands change with the transformation of their information capacities. Small, new and innovating firms primarily make use of internal capital and commercial loans. The development of such firms requires higher information transparency thus making it easier to obtain external equity. The

[1] For a review of the literature supporting the Myers-Majluf theory of hierarchic funding resources, see among others Harris-Raviv (1991), Myers (2003) and Frank-Goyal (2005).

[2] Even when possible from a legal point of view, SMEs show a limited interest in the *equity* market, given that it is more expensive when related to *information disclosure.* Generally, SMEs are apparently less prone to sharing control of the firm with third parties, fearing a loss of autonomy and flexibility in the management of their activity.

hierarchy of financial resources, partially oriented towards growth, is best adapted to SMEs investing in R&D.[3]

Atzeni-Piga (2007) provide a further interpretation, focusing on the role of self-financing as a way of addressing problems arising from information asymmetry and thus from the potential risk of credit rationing. However, a high rate of self-financing could cause the project to be extremely confidential and conversely create the undesired effect of limiting access to external financial resources. Furthermore, credit rationing depends on the R&D investment intensity rate. Firms strongly oriented towards R&D activities apparently do not experience credit constraint problems and vice versa.[4] This result is also confirmed by Herrera-Minetti (2007) who demonstrate that there is no clearly defined correlation between R&D investments and credit rationing: firms with low R&D investment intensity are actually inclined to ask for lower loans and, as such, appear to be rationed to a greater extent than those with high R&D intensity.[5] Moreover, the authors show that relationship lending has a positive effect on the probability that firms engage in innovation, even identifying measures of local financial development. This result is in line with the view that sound banking relationships can foster firm innovation. The authors find that strong relations benefit innovation not just by fostering R&D but also by channeling funds for the introduction and acquisition of new technologies.[6]

Another important argument linked to R&D investment refers to the lack of collateral, which could partially or entirely cover the project default risk. Bester (1985) argues that there is no rationing if banks compete amongst themselves by simultaneously establishing the collateral level and interest rate. The firm's choice of one contract over another is a self-selection mechanism. For instance, a firm with a low insolvency probability is ready to provide higher collateral in exchange for a lower interest rate as compared to those with higher risk.[7] As suggested by Ozkan (2002, p. 827) "one important distinction between R&D

[3] An exclusive relationship with a few banks would guarantee firms investing in R&D against the risk of losing their intellectual property in favor of competitors (cf. *infra* Bhattacharya-Chiesa, 1995).

[4] Similar findings were provided by Herrera-Minetti, 2007, on Italian SMEs and by Aghion *et al.* (2004) on UK quoted firms.

[5] The database used for this study is the VIII Survey of Italian Manufacturing Firms conducted by the SME Observatory run by the Medio Credito Centrale in 2001.

[6] This evidence suggests that banks are more prone to finance traditional investments occasioned by the introduction of new technologies instead of accompanying the firm in the R&D of new technology itself.

[7] Contrary to the prevailing literature on collateral, Berger-Udell (1990) argue that collateral is frequently associated with risky debtors, risky loans and risky banks.

investment and investment in physical capital is that the result of R&D investment can not serve as collateral, as it may be impossible to put a lien on R&D capital". R&D investment generally has little rescue value: at the R&D stage, investments consist mostly of salaries and intangible assets; at the adoption stage, assets that embody new technology are specific to the firm. This implies that collateral has a limited role in mitigating incentives to add risk (cf. Herrera-Minetti, p. 227). Evidence suggests that collateral is more likely to be pledged in the presence of significant information asymmetries between borrowers and lenders. However, the theory cannot easily be verified in the case of R&D since intangible assets are difficult to collateralize (cf. Gonas *et al.* 2004).

Finally, another strand of literature shows that public subsidies on R&D alleviate debt and equity gaps for small firm innovation projects. Innovations are expected to generate positive external effects, but since firms can only appropriate private returns they will only launch privately profitable innovation projects. Thus, underinvestment in R&D entails the risk that socially useful projects are not privately implemented. The absence of collateral due to physical assets implies that banks and other debt-holders are reluctant to finance projects involving substantial R&D investments. These arguments therefore justify public market interventions for R&D. As suggested by Czarnitzki (2002, p.1) the positive external effects argument is usually considered in order to fund basic research, while the second argument on the wedge between internal and external cost of capital is used as a rationale for supporting SME activities.

R&D activities can be regarded as an investment in a firm's knowledge capital and thus, in several studies, estimations of R&D investment equations are compared with investment in physical assets. Investment in intangible assets, such as R&D, tends to be both riskier and more difficult to collateralize than investment in physical assets. The results of Hall's (2002) study, one of the first on this topic, can be summarized as follows: i) small and start-up firms in R&D industries face higher costs of capital than larger firms; ii) the financing gap for large firms is more difficult to establish, but it seems clear that these firms prefer internally generated funds for R&D investment; iii) the venture capital solution to the problem of R&D financing has some limitations - first because it tends to focus only on a few industries with a minimum size investment that is

too large for start-ups in some fields; iv) public subsidies are an important source of finance for R&D investments and need to be further investigated.

3. Data and sample analysis

Our study uses the SME Observatory[8] Survey of Italian Manufacturing Firms that is a key source of mainly questionnaire-based information. The survey is conducted on firms with 11 to 500 employees and as a full census for larger firms. The Bureau van Dijk databases complete the financial statement data for Italian firms targeted by the Survey (4,139) and provides a greater historic introspective. 1,357 firms declared expenditure both in R&D and other investments and these constitute our sample. To compare the determining factors of R&D expenditure and traditional investment self-financing[9] we build a homogeneous sample with respect to all the variables, except for the decision to spend on R&D and/or other investments.

The sample is strongly characterized by small firms[10] and companies in the first quantile are on average 5 years old.

We focus on the financing source survey sections[11] inquiring into the percentage breakdown of the use of different finance investment channels.

Our study focuses on the section of the questionnaire[12] dedicated to the different contributions of each financial source to investment, technological innovation and research and development for both R&D expenditure[13] and traditional investments (cf. Table 1). [14]

(insert Table 1 here)

[8] Capitalia Research Division.

[9] It was therefore necessary to identify a homogeneous sample group regarding all the structural variables characterizing firms that carry out both types of investments (R&D > 0 and Investment > 0). Some attention should be paid to the fact that the need to select firms engaged in both activities (investments and R&D) certainly reduces the sample size. Therefore, it excludes firms that are severely rationed to such an extent that it would hamper any form of investments or R&D expense, or firms that, for the given period, deliberately preferred to rule out any investment or R&D expense.

[10] 50% of firms have total assets of less than 12 million Euro and 68 employees; 50% (75%) of firms have total assets below 12 (31) million Euro and employ less than 68 (145) employees. Given the size of firms included in our sample, the use of equity is marginal related to the investment financing operations of the Italian SMEs considered.

[11] Section C – "Investment, Technological Innovation and Research and Development". In particular, Question C1.5: "How were the investments made during 2001-2003 financed?" (see Capitalia, 2005).

[12] It should be noted that as we are dealing with a questionnaire the data provided are affected by the compiler's convictions as to how the reported event should be defined.

[13] Questions C2.2.1: "In the three-year period 2001-2003, how much did the firm spend on R&D?" and C2.2.2: "How much did it spend?" (cf. Capitalia, 2005).

[14] Questions C1.1: "In the three-year period 2001-2003, did the firm invest in installations, machinery or equipment?" and C1.2: "How much did it spend?" (cf. Capitalia, 2005).

4. Descriptive analysis

Table 1 shows that self-financing is on average much more important in R&D expenditure than in traditional investments.[15]

In traditional investments, leasing and banking debt are the most significant alternatives to self-financing. In R&D instead, credit appears to be as important as public funding among external sources of financing.[16]

We investigate both the determinants of the choice of self-financing and the importance of internal financial sources where applicable. The aim of the empirical verification is twofold: i) to verify if financial constraints exist (external rationing) and force firms to self finance R&D above alternative traditional investments; ii) to define the determinants of self-financing (structural characteristics of the firm; informative asymmetries and loan market structure).

Table 2 shows that firms asking for more credit are more inclined towards self-financing in R&D (74.55%) than other investments (38.52%). There is an *ex ante* self-selection effect that suggests that if a firm decides to invest in R&D it probably already has enough internal resources to finance it.

While this result seems to suggest greater external rationing, in the case of R&D expenditure it shows that credit constraints are much less severe compared to traditional investments.

Empirical evidence suggests that the impact of credit rationing is different in traditional investments compared to R&D expenditure. We observed the following results where external rationing occurred,: i) self-financing of traditional investments is higher than in the absence of credit rationing (+14.31%); ii) this difference is marginal (+3.58%) in the R&D case; iii) the financial structure of the source of financing in R&D expenditure is quite similar both in credit rationing and in its absence; iv) the banking channel is marginal in R&D investments when credit rationing occurs and when it does not.

(insert Table 2 here)

[15] The use of external equity appears extremely marginal in both cases.

[16] Public funds appear on average more important in financing R&D expenditure compared to other investments. Nevertheless, literature seems to suggest that public financing does not explain the greatest R&D expenditure. We observe a sort of *ex ante* self-selection of firms: only firms that really intend to undertake an innovative project ask for public funding (cf. Czarnitzki, 2006 and Gabriele-Zamarian-Zaninotto, 2006 and Meuleman-De Maeseneire, 2008).

The data demonstrates that credit rationed firms have fewer self-financing possibilities both in traditional and R&D investments. The difference is, however, less evident in the case of R&D self-financing.

4.1 Specification of independent variables

The independent variables are summarized in Table 3. First, with reference to the variables describing the financial and structural firm characteristics we defined a proxy of INTERNAL RATIONING comparing the cash flow at year t-1 (FDC_{t-1}) and expenditure in traditional and R&D investments at year t ($INV_t+R\&D_t$). If at the end of year t-1 there are enough funds to entirely finance traditional and R&D investments internally then no form of internal rationing was observed, i.e. $FDC_{t-1}>(INV_t+R\&D_t)$. In the opposite case, the following different degrees of internal rationing were defined:

- $FDC_{t-1}<(INV_t+R\&D_t)$ for only one year, indicates low internal rationing;
- $FDC_{t-1}<(INV_t+R\&D_t)$ for two years, indicates medium rationing;
- $FDC_{t-1}<(INV_t+R\&D_t)$ for three years, indicates high internal rationing[17].

Likewise, CURRENT RATIO represents both a way to calculate the potential internal liquidity sources in the short term, but is also one of the most widely used bank indicators in the loan application evaluation process (i.e. credit rating).[18]

As suggested by some previous empirical analyses[19], public funding is an important source of financing in sustaining R&D activities. In our study, the

[17] Given that our work inquires into what determines self-financing, identifying available liquid assets or those easily liquidated, becomes relevant. On one hand, direct use of the available cash flow may be preferred in the year the survey refers to, which in our case is 2003. However, since we are dealing with a three year survey, we constructed an INTERNAL RATIONING indicator defining the number of periods where the use of internal self-financing resources were difficult due to the reduced availability of cash flow in the previous period. Internal rationing, whose map is built via a categorical variable, takes on a higher value if, during the three years considered, a general insufficiency of cash flow to sustain investments and R&D was observed. The previously defined proxy shows an average value equal to one in our sample. This means that on average, the firms considered here had insufficient cash flow to cover the investments and R&D expenditure in one out of three years.

[18] In our sample this indicator, as could reasonably be expected, shows a negative correlation with the ratio between debt and total assets, i.e. LEVERAGE. These two explanatory variables simultaneously represent the main indicators used to calculate the financial risk. We expected greater firm risk and potential credit rationing as LEVERAGE increases. A first insight on this point comes from the correlation matrix, which displays an important positive statistical relationship between leverage and credit rationing (cf. Tab. 4).

[19] Cf. Hall, 2002, Czarnitzki, 2006 and Meuleman - De Maeseneire, 2008.

dichotomic variable is PUBLIC SUBSIDIES.[20] The question was addressed without distinction to all firms, regardless of the type of investment made, and public subsidies would appear more relevant in R&D than in traditional investments.

Amongst income variables, we first considered the TURNOVER that also measures the capacity to produce resources and, indirectly, self-financing. Similarly, the return on investment (ROI) measures the firm's capacity to generate resources; however, a high return variability measured by the STD ROI is generally linked to a greater difficulty in obtaining external financial sources.

We constructed the HIGH_R&D dichotomous variable (equal to one if the R&D expenditure over the total asset is greater than 4.5%).[21] Since R&D is heavily dependent on human capital, another proxy of the degree of R&D intensity, can be attributed to the rate of recruitment in the last year, HIRING.[22]

The degree of the lending/information asymmetry relationship between the bank and the firm can be summarized in the following set of variables: i) the number of banks from which the firm borrows, i.e. MULTIPLE BANKING; ii) the main bank's share of total banking debt, i.e. MAIN BANK; iii) the functional distance between the bank and the firm, i.e. LOCAL BANKING; iv) the duration of the relationship with the main bank in years, i.e. DURATION; v) CREDIT RATIONING, for credit constrained firms.[23]; vi) the degree of OPACITY proxied the ratio between intangibles over tangible.

Finally, the degree of banking competition was measured by the number of bank branches per region, BRANCHES, and by the loan regional-market concentration, HHI_LOANS, that could alter information gathering and loan economic profitability.

(insert Tables 3&4 here)

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[20] Section F3, Fiscal subsidies – Question F3.1: "Has the firm used financial and/or fiscal subsidies in the period 2001-2003?"

[21] Atzeni and Piga (2007) to test the degree of R&D and the self-financing decision, identified firms belonging to the last distribution decile of the ratio between expenditure in R&D and the total asset.

[22] This variable was obtained directly from the questionnaire section B. LABOUR FORCE. Question B. 2.1 Did the company recruit in the years 2001-2003? (see Capitalia, 2005). 90% of firms in our sample reported that they recruited during the period considered.

[23] Questionnaire Section F -– Question F1.5: "In 2003, would the firm have liked to have obtained more credit at the interest rate agreed with the bank?" (see Capitalia, 2005).

5. Methodology and results

The SELFFIN A, B, C, dependent variables[24] on the decision to self-finance are described in Table 3 and defined as follows:

- SELFFIN_A (presence of self-financing);
- SELFFIN_B (self-financing as the main source);
- SELFFIN_C (full self-financing).

Self-financing was also measured by the variable INV_SELFFIN_% and R&D_SELFFIN_% that express the firm's overall trend to self-finance. These were obtained as a relation between the amount of money used in self-financing for investment purposes (or for R&D) and the size of the firm. Both these variables were applied to analyze the potential existence of correlations between the decision to self-finance investments and those of R&D expenditure. Where such a correlation was negative, a crowding out effect was observed whereas a common feature of the use of self-financing was observed where the correlation was positive.

The general equation to be estimated can be written as follows:

(1) $$Y = f(K_j, Z_\gamma, B_\tau, W_q)$$

where the dependent variable **Y** is, alternatively, **SELFFIN A, B, C** or **SELFFIN_%** both for traditional investments and R&D expenses; **K** summarizes the firm's structural and financial characteristics; **Z** summarizes the information asymmetries and relationship lending characteristics; **B** summarizes the bank markets characteristics; **W** summarizes the "symmetric" effects (INV_SELFFIN_% and R&D_SELFFIN_%) that were computed by directly considering the answers given in the questionnaire relating to traditional and R&D investment funding choices (see Table 3).

We use three different models to address the following questions:

[24] The dependent variables used as a proxy for self-financing were obtained directly from the questionnaire.

1. First, we investigated the determinants of the self-financing decision related to traditional and R&D investments.[25] INV_SELFFIN A, B, C and R&D_SELFFIN A, B, C were estimated using Logit specifications:

$$(1) \qquad \Pr(SELFFIN_i = 1) = \frac{1}{(1+\exp(-X_{ij}\alpha))}$$

where $\mathbf{X_{ij}}$ contains the explanatory variables and **j=K,Z,B,W** denotes dependent variables while α is a set of coefficients to be estimated[26].

Table 5 presents the estimation of our LOGIT model with three relevant results. First, PUBLIC SUBSIDIES negatively impacts on all self-financing decisions. Public subsidies, *ceteris paribus*, may reduce internal funding or debt financing. Exclusive self-financing (SELFFIN_C) is also strongly conditioned by the presence of public incentives in traditional and R&D financing choices.[27] Second, the relationship lending variables (MULTIPLE BANKING, LOCAL BANK, MAIN BANK and DURATION) as well as CREDIT RATIONING, OPACITY, BRANCHES and HHI LOANS do not appear to affect R&D self-financing decisions. These results are only partly confirmed in self-financing of traditional investments. According to the theoretical predicted sign, the MULTIPLE BANKING and HHI_LOAN variables appear to be statistical significant. On one hand, investment self-financing decreases (i.e. banking debt increases) as the bank increases the number of banking relationships; on the other, as the banking market becomes more concentrated firms have greater opportunities to be externally funded and thus self-financing decreases. Finally, we found that "symmetric" variables (the R&D expenditure self-financing rate in the case of investments and, speculatively, the rate of self-financing in the case of R&D expenditure) are strongly and significant.

This result requires exploring a possible relation, and interaction, between internal funds used to finance R&D and/or traditional investments. We expected self-financing of investments to decrease as the self-financing for R&D

[25] This consists of a dichotomy classification of the three self-financing levels stated by firms in the questionnaire and described in the previous sections.
[26] Greene (2003).
[27] This result is stable and robust to all other tested models (OLS and SUR).

expenditure increases (crowding out effect), since both variables depend on the same availability of internal sources. However, with reference to the sample analyzed in this study, the evidence suggests quite the opposite (inertia effect). Firms with higher self-financing of investments are also those that self-finance R&D expenditure to a larger extent even if the relevance differs.

(insert Table 5 here)

2. Second, we investigated the relevance of self-financing to R&D expenditure and investments. The continuous dependent variables INV_SELFFIN_% and R&D_SELFFIN_% were estimated based on the following OLS specifications:[28]

(2) $$INV\_SELFFIN\_\% = F(K, Z, B, W)$$

(3) $$R\&D\_SELFFIN\_\% = F(K, Z, B, W)$$

Consistently with all previous specifications, the PUBLIC SUBSIDIES variable is statistical significant and its presence implies lower self-financing usage both in the traditional and in the R&D case (Table 6). Therefore, public incentives appear to be a useful "support" to those firms that have limited internal financial sources. The internal rationing variable has a negative and significant sign on investment self-financing while it is not relevant in the alternative R&D case. From a financing point of view, the presence of public subsidies is linked to a less binding internal constraint. In addition, public subsidy in R&D constitutes a necessary condition, whereas self-financing seems weakly related to the internal rationing state. This result can be interpreted from two perspectives. On the one hand, those firms taking advantage of public subsidies are engaged in intensive investment and R&D self-financing. However, the

[28] We checked the potential correlation among the group of variables usually associated to balance sheet data. OLS analysis is performed by adding blocks of variables to verify the stability of the results. The study based on OLS regressions proceeded by considering three steps where a sequence of variables was loaded to test the robustness of the specific model. As known, these components may display significant multicollinearity issues.

causality relation between the two variables cannot be tested here due to firms being engaged in both investments and R&D expenditure. In fact, we cannot ascertain whether it is the presence of the public subsidy that enabled the investments – due to a lower self-financing requirement - or the lack of public subsidy that caused this rationing and prevented the investment.[29]

We observed that the most important variables to explain self-financing, that is the return on investment (ROI), appear generally relevant with an expected positive impact.[30] Finally, as shown in the logit model, there is a significant positive relation between the self-financed investment and the self-financed R&D percentages. It was thus important to analyze if there was a potential correlation between OLS models on investment self-financing and OLS on R&D self-financing.[31]

(insert Table 6 here)

3. Third, to investigate the potential relation between the decision to self-finance investments and R&D we used a seemingly unrelated regression (SUR) specification, which considered a correlation in error terms in equations (2) and (3).[32] From the above Logit and OLS analyses some common factors (see for example LEVERAGE, ROI, PUBLIC SUBSIDIES, and TOTAL ASSETS) emerged that influence both investment and R&D self-financing. The analysis investigates these relations through a SUR that produces more efficient results.[33] For robustness reasons the SUR is proposed on two specifications.[34] The results are outlined in the Table 7 and some comments are offered hereafter.

[29] In this case, the firm is not present in our sample.
[30] Only in the more complete model does ROI appear as not significant when compared to the Hiring variable.
[31] If this proves to be the case, it would be necessary to perform an eventual SUR evaluation of investments and R&D and test the potential presence of a correlation in the errors of the two separate OLS regressions.
[32] Zellner (1962).
[33] The gain in efficiency from using the SUR estimator increases with the correlation between equation errors and decreases with the correlation between equation regressors. The outcomes of the SUR analysis are considered appropriate, referring to how they are explained by the test coefficients in Table 7.
[34] The first specification is based on a set of statistically significant regressors drawn from the previous OLS regressions. This exercise was aimed at testing whether – given the existence of a "common effect" between investment and R&D self-financing – the previous OLS results could have been erratic. The second specification is based on a larger number of regressors, which were closer to the statistical significance in the previous OLS regressions and could become strongly significant.

First, both investment and R&D self-financing depend on ROI, PUBLIC SUBSIDIES and HHI_LOANS. These results are robust to both SUR specifications (Model 1 and 2). Heterogeneous results emerged with reference to INTERNAL RATIONING, TOTAL ASSETS, HIGH_R&D, MULTIPLE BANKING and OPACITY, which are relevant only in traditional investment self-financing. As suggested by the previous OLS analysis, the R&D project is independent of both OPACITY and MULTIPLE BANKING variables. Moreover, contrary to previous studies, CREDIT RATIONING does not appear significant in either investment or self-financing R&D.[35]

In summary, R&D self-financing appears to be driven by three elements: i) public subsidies; ii) firm performance, i.e. ROI; iii) leverage and the degree of banking market concentration. The SUR analysis confirms the previous OLS results, i.e. R&D self-financing follows a logic that is less related to firm and banking variables than to public incentives and internal high returns. These results imply that traditional and R&D investment financing decisions appear, at least partially, different.

(insert Table 7 here)

6. Conclusions

The study analyzed the main distinctions between the financing logic of investments and R&D expenditure on a sample of firms engaged in both activities. Descriptive analyses confirmed that R&D expenditure is strongly based on internal financial funding. The econometric analysis focused first on the analysis of the decision to self-finance the investment and secondly on the financial funding mix; once the firm has decided to self-finance its activity, it has to decide how much self-selection to use among all other financial funds.

The empirical evidence demonstrates that firms with a high self-financing investment rate bear out the same behavior as R&D expenditure. Both types of self-financing – investment and R&D self-financing – are strongly related from a statistical point of view to the availability of public subsidies and to firms' high returns.

[35] The choice to finance an investment project is a rational choice made by the firm from a pecking order theory perspective rather than the result of credit rationing.

Public subsidies can be interpreted as signals used by firms to increase external financial funds both in traditional and R&D investments. On having have passed the "public screening" firms can benefit by decreasing both traditional and R&D self-financing investments and increase the firm's capability to attract external funds.

The empirical evidence shows that internal rationing is crucial to investment self-financing while external or credit rationing has a quite irrelevant effect.[36]

Proxies of relationship lending are only partially significant in traditional investments. Firms deciding to engage in R&D self-financing do not exhibit any strong external banking relationship evidence. We can consequently affirm that public subsidy acts as a stimulus of investments and R&D expenditure and decreases the self-financing component in the financing decisions of profitable firms. Lack of guarantees or collateral, described herein by R&D opacity, finds solution in public subsidy, which also helps the firm to engage in self-financing.

The sample considered, ideal to a *ceteris paribus* comparison of R&D and investment self-financing, rules out by its own definition, those firms that have not undertaken entrepreneurial activities, either due to credit rationing or own decision-making. Subsidies, obviously, do not only sustain R&D activities, but also simultaneously decrease the general self-financing quota of firm financing and reinforce external financing.

At the same time, investments follow a more traditional financing scheme: in smaller firms these are generally self-financed, with lower leverage and a higher ROI. Self-financing is strongly dependent on information opacity. Investment and R&D self-financing increases as information opacity increases.

Traditional investments, less supported by internal capital, have a higher dependency on the "information" environment, as indicated by the banking variables. R&D expenditure is present only in the case of high returns and in the presence of public subsidies to support internal resources.

[36] This result may be related to the fact that our sample includes only firms engaged in both investments and R&D that were probably not financially constrained.

Appendix

Table 1 – The sources of finance: Investments vs. R&D

	Sample: I > 0 and R&D > 0 (n = 1357)	
Variable	Traditional investments	R&D expenses
Private equity	1.32	0.81
Internal funds	**50.87**	**79.70**
Short Term Loans	6.38	-
Long Term Loans	11.68	5.85
Leasing	14.21	-
Subsidized interest loans	6.67	3.50
National and european public funds	3.25	-
Tax incentives	-	6.00
Subsidized loans	3.67	2.84
Intergroup loans	1.63	-
Other firms loans	0,10	-
Other	0.21	1.29
Total	**100**	**100**

Source: our computation based on Capitalia's data set

Table 2 – Rationing and sources of finance: Investments vs. R&D

In 2003, would the firm have liked to have obtained more credit at the interest rate agreed with the bank?

	Traditional investments		R&D	
Variable	Yes	No	Yes	No
Private equity	3.60	0.92	1.85	0.61
Internal funds	**38.52**	**52.83**	**74.55**	**78.13**
Short Term Loans	9.57	5.87		
Long Term Loans	15.89	11.08	9.27	5.23
Subsidized interest loans	5.87	6.85	2.78	3.48
Full subsidized loans	3.55	3.17	-	-
National and european public funds	-	-	6.47	5.94
Tax incentives	3.82	3.70	1.80	3.10
Leasing	16.57	13.71	-	-
Intergroup loans	1.97	1.60	-	-
Other enterprise loans	0.09	0.10	-	-
Other	0.54	0.16	3.28	3.51
Total	**100**	**100**	**100**	**100**

Source: our computation based on the Capitalia's data set

Table 3 – Description of variables

	Dependent variables	Source	Year	Observations	Mean	Std. Dev.	P25	Median	P75
INV_SELFFIN_A	Dummy variable; = 1 if self-financed investments > 0.	Capitalia	2003	1,357	0.78	0.42	1.00	1.00	1.00
INV_SELFFIN_B	Dummy variable; = 1 if self-financed investments > 50%.	Capitalia	2003	1,357	0.53	0.50	0.00	1.00	1.00
INV_SELFFIN_C	Dummy variable; = 1 if investments are fully self-financed.	Capitalia	2003	1,357	0.25	0.43	0.00	0.00	1.00
R&D_SELFFIN_A	Dummy variable; = 1 if self-financed R&D > 0.	Capitalia	2003	1,357	0.87	0.34	1.00	1.00	1.00
R&D_SELFFIN_B	Dummy variable; = 1 if self-financed R&D > 50%.	Capitalia	2003	1,357	0.76	0.43	1.00	1.00	1.00
R&D_SELFFIN_C	Dummy variable; = 1 if R&D is fully self-financed.	Capitalia	2003	1,357	0.58	0.49	0.00	1.00	1.00
INV_SELFFIN_%	Proportion of investment covered by self-financing.	Capitalia	2003	1,357	0.51	0.40	0.10	0.50	1.00
R&D_SELFFIN_%	Proportion of R&D covered by self-financing.	Capitalia	2003	1,357	0.77	0.36	0.60	1.00	1.00
	Explanatory variables								
	Firm's financial and structural characteristics								
INTERNAL RATIONING	Categorical variable: = 0 if Cash flowt-1 > (Investmentst + R&Dt) for three years; = 1 if Cash flowt-1 > (Investmentst + R&Dt) for two years; = 2 if Cash flowt-1 > (Investmentst + R&Dt) for one year; = 3 if never verified.	Capitalia	2003	1,100	1.17	1.14	0.00	1.00	2.00
CURRENT RATIO	Current assets / Current liabilities.	Aida	2001-03	1,278	1.53	1.06	1.05	1.24	1.68
LEVERAGE	Debt / Total assets.	Aida	2001-03	1,267	0.71	0.18	0.59	0.75	0.86
PUBLIC SUBSIDIES	Dummy variable = 1 if the firm received fiscal or public subsidies.	Capitalia	2003	1,357	0.64	0.48	0.00	1.00	1.00
TURNOVER	% turnover variation in 2002-2003.	Aida	2002-03	1,267	3.51	83.61	-0.11	0.00	0.08
ROI	Return on investment.	Aida	2001-03	1,052	5.37	5.01	2.61	4.80	7.41
ROI_SD	ROI standard deviation 1996-2003.	Aida	1996-03	1,249	2.83	2.62	0.96	2.02	3.75
TOTAL ASSETS	Ln of total assets.	Capitalia	2003	1,357	9.54	1.30	8.71	9.40	10.33
AGE	Ln of the years of the firm.	Capitalia	2003	1,330	3.37	0.56	3.00	3.37	3.76
GROUP	Dummy variable; = 1 if the firm belongs to a group.	Capitalia	2003	1,355	0.41	0.49	0.00	0.00	1.00
HI-TECH	Dummy variable; = 1 if the firm belongs to Hi-Tech industry.	Capitalia	2003	1,357	0.07	0.25	0.00	0.00	0.00
HIGH_R&D	Dummy variable = 1 if R&D / Total asset > 4,5%.	Capitalia	2003	1,354	0.10	0.28	0.00	0.00	0.00
HIRING	Dummy variable = 1 if the firm hired people in 2001-2003.	Capitalia	2003	1,357	0.91	0.28	1.00	1.00	1.00
	Relationship lending and information asymmetries								
MULTIPLE BANKING	Number of bank relationships.	Capitalia	2003	1,344	6.66	3.88	4.00	6.00	9.00
LOCAL BANK	Dummy variable = 1 if local bank has registered office in the same province as firm.	Capitalia	2003	1,357	0.52	0.50	0.00	1.00	1.00
MAIN BANK	Proportion of debt with the main bank.	Capitalia	2003	1,260	31.01	24.50	15.00	30.00	44.50
DURATION	Age of relationship with the main bank.	Capitalia	2003	1,306	17.00	12.30	8.00	15.00	24.00
CREDIT RATIONING	Dummy variable = 1 if the firm would desire more credit.	Capitalia	2003	1,357	0.15	0.35	0.00	0.00	0.00
OPACITY	Intangible assets / Tangible assets.	Aida	2001-03	1,278	0.47	0.16	0.36	0.47	0.58
	Banking market characteristics								
BRANCHES	Number of branches by region.	Bank of Italy	2003	1,357	3,260	1,787	2,218	3,148	5,841
HHI_LOANS	Loans Herfindal index by region.	Bank of Italy	2003	1,357	0.07	0.02	0.07	0.07	0.08

Table 4 – Correlations

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	INTERNAL RATIONING	1																						
2	CURRENT RATIO	-0.275*	1																					
3	LEVERAGE	0.258*	-0.320*	1																				
4	PUBLIC SUBSIDIES	0.079	-0.088		1																			
5	TURNOVER		-0.127*			1																		
6	ROI	-0.300*	0.196*	-0.296*	-0.081	0.088	1																	
7	ROI SD	-0.073	0.182*	-0.138*		-0.159*	0.117*	1																
8	TOTAL ASSETS	-0.125*		-0.088		0.084	-0.147*	-0.106*	1															
9	AGE		0.141*	-0.080		-0.063		-0.060	0.127*	1														
10	GROUP			-0.068		0.070	-0.124*		0.234*	-0.067	1													
11	HI-TECH	0.078	0.061						0.060		0.099*	1												
12	HIGH R&D	0.291*			0.092*				-0.106*			0.200*	1											
13	HIRING						0.073	-0.077	0.156*		0.078		0.077	1										
14	MULTIPLE BANKING		-0.245*	0.246*	0.083			-0.181*	0.295*	0.103*	0.142*		-0.064	0.134*	1									
15	LOCAL BANK		0.061							0.079	-0.071		-0.078			1								
16	MAIN BANK		-0.086	0.141*			-0.129*		-0.107*						-0.137*	-0.059	1							
17	DURATION		0.126*	-0.086				-0.093*		0.299*	-0.147*					0.196*		1						
18	CREDIT RATIONING	0.171*	-0.209*	0.238*		-0.069	-0.150*		-0.095*								0.084		1					
19	OPACITY	0.060	-0.176*		0.132*		-0.177*	-0.112*	0.162*	-0.058	0.078	-0.062	-0.059		0.127*		0.074			1				
20	BRANCHES				-0.060					0.100*											1			
21	HHI_LOANS																0.059			0.084	-0.293*	1		
22	INV_SELFFIN_%	0.085	0.168*	-0.293*	-0.063	0.106*	0.171*		0.116*	0.096*			0.059		-0.068		-0.105*	0.095*	-0.150*				1	
23	R&D_SELFFIN_%	0.256*	0.088				0.113*	0.077	-0.144*			0.144*	0.289*	0.065	-0.095*						0.094*	-0.068	0.235*	1

For significance levels: * p<0.01; print < 0.10
Observations, n = 832

Note: The magnitude of the correlation coefficients is moderate and the analysis of the tolerance values and VIF indicate that multicollinearity does not seem to be a problem.

Table 5 – Investments versus R&D: LOGIT model

	INV_SELFFIN Logit			R&D_SELFFIN Logit		
	INV_SELFFIN_A	**INV_SELFFIN_B**	**INV_SELFFIN_C**	**R&D_SELFFIN_A**	**R&D_SELFFIN_B**	**R&D_SELFFIN_C**
Independent variable						
INTERNAL RATIONING	-0.066	-0.179*	-0.316**	-0.147	-0.171	-0.125
	-0.71	-2.22	-3.00	-1.30	-1.83	-1.42
CURRENT RATIO	-0.340*	-0.249*	0.009	0.179	0.033	-0.108
	-2.45	-2.00	0.07	0.75	0.20	-0.83
LEVERAGE	-3.151***	-2.520***	-0.195	0.609	-0.117	-0.865
	-3.94	-3.81	-0.25	0.61	-0.15	-1.23
PUBLIC SUBSIDIES	-0.416*	-0.695***	-1.908***	-0.738**	-1.206***	-2.138***
	-2.05	-4.11	-9.71	-2.71	-5.25	-10.19
TURNOVER	0.208	-0.455	-0.413	-0.356	-0.43	-0.203
	0.43	-1.08	-0.85	-0.62	-0.90	-0.45
ROI	0.056*	0.052**	0.006	0.049	0.031	-0.002
	2.32	2.66	0.3	1.63	1.33	-0.1
ROI SD	-0.032	0.012	0.033	0.03	0.003	0.023
	-0.92	0.37	0.91	0.67	0.08	0.71
TOTAL ASSETS	0.294**	0.318***	0.127	-0.1	-0.108	-0.158
	2.81	3.74	1.33	-0.81	-1.12	-1.76
AGE	0.227	-0.038	-0.258	-0.198	-0.337	-0.302
	1.13	-0.22	-1.19	-0.84	-1.76	-1.69
GROUP	0.108	-0.016	0.029	0.304	-0.001	0.114
	0.50	-0.09	0.13	1.14	0.00	0.58
HI-TECH	1.601*	0.446	0.404	0.355	0.028	-0.133
	2.49	1.23	1.06	0.68	0.07	-0.37
HIGH R&D	-0.747	-0.615	0.81	0.435	0.228	-0.877**
	-1.47	-1.39	1.68	0.90	0.65	-2.71
HIRING	-0.053	-0.238	-0.21	0.970**	0.327	-0.046
	-0.16	-0.85	-0.62	2.96	1.06	-0.15
MULTIPLE BANKING	-0.031	-0.062*	-0.086**	-0.044	-0.042	-0.009
	-1.04	-2.39	-2.6	-1.23	-1.47	-0.33
LOCAL BANK	0.048	0.121	-0.132	-0.129	0.123	0.006
	0.26	0.76	-0.68	-0.57	0.67	0.04
MAIN BANK	-0.004	-0.006	-0.006	-0.007	0.000	-0.006
	-1.08	-1.8	-1.53	-1.55	0.10	-1.67
DURATION	0.011	0.007	0.009	0.007	0.005	0.001
	1.15	0.84	0.89	0.68	0.59	0.1
CREDIT RATIONING	-0.325	-0.31	-0.474	0.11	0.161	0.235
	-1.31	-1.29	-1.45	0.34	0.61	0.94
OPACITY	0.802	1.646**	1.800**	0.055	0.654	0.722
	1.24	2.93	2.72	0.07	1.02	1.22
BRANCHES (X 1000)	-0.061	0,019	0,034	-0.011	0.000	-0.066
	-1.13	0.41	0.63	-0.17	0.00	-1.36
HHI LOANS	-4.75	-2.217	-15.31*	-5.504	-5.98	-4.131
	-1.23	-0.63	-2.48	-1.32	-1.60	-1.14
R&D_SELFFIN_%	30.580***	18.75**	5.279			
	3.41	3.14	1.11			
INV_SELFFIN_%				23.560**	23.220***	14.81***
				3.07	4.08	3.68
CONSTANT	1.562	1.075	2.339	2.828	4.545**	6.174***
	1.05	0.88	1.59	1.58	3.18	4.74
chi2 (DF_M)	103.8 (22)	152.5 (22)	188.8 (22)	57.39 (22)	95.54 (22)	208.8 (22)
r2_P	0.118	0.132	0.209	0.09	0.106	0.185
Observations	832	832	832	832	832	832

z statistics reported
* p<0.05, ** p<0.01, *** p<0.001

Table 6 – Investments versus R&D: OLS model

	INV_SELFFIN_%			R&D_SELFFIN_%		
Independent Variables	Model 1 OLS	Model 2 OLS	Model 3 OLS	Model 4 OLS	Model 5 OLS	Model 6 OLS
INTERNAL RATIONING		-0.031**	-0.028*		0.008	0.000
		-2.60	-2.20		0.74	-0.02
CURRENT RATIO		0.001	-0.028		0.006	0.003
		0.06	-1.49		0.40	0.15
LEVERAGE	-0.451***	-0.302**	-0.364***	-0.130*	-0.062	-0.051
	-7.57	-3.25	-3.53	-2.27	-0.70	-0.51
PUBLIC SUBSIDIES		-0.155***	-0.125***		-0.128***	-0.133***
		-6.04	-4.62		-5.25	-5.11
TURNOVER	0.000	0.001	-0.056	0.000	0.000	-0.047
	1.04	1.08	-0.85	0.28	0.14	-0.73
ROI		0.007*	0.006*		0.006*	0.004
		2.45	2.17		2.34	1.40
ROI SD		0.002	0.001		0.004	0.003
		0.39	0.21		1.01	0.63
TOTAL ASSETS	0.019	0.033**	0.051***	-0.021*	-0.021	-0.026*
	1.94	2.82	3.9	-2.23	-1.9	-2.05
AGE	0.020	0.010	0.000	-0.019	-0.039	-0.043
	1.03	0.44	-0.01	-1.00	-1.83	-1.65
GROUP	0.021	0.001	-0.007	-0.028	-0.010	0.017
	0.82	0.04	-0.24	-1.17	-0.37	0.61
HI-TECH	0.137**	0.114*	0.099	-0.027	-0.001	-0.020
	2.94	2.22	1.85	-0.62	-0.02	-0.38
HIGH R&D		0.114*	0.099*		-0.039	-0.027
		2.47	2.09		-0.90	-0.59
HIRING		-0.0409	-0.0467		0.0672	0.0885*
		-0.96	-1.04		1.67	2.05
MULTIPLE BANKING			-0.012**			-0.001
			-2.85			-0.22
LOCAL BANK			-0.003			-0.006
			-0.11			-0.26
MAIN BANK			-0.001			0.000
			-1.59			-0.30
DURATION			0.0012			0.0006
			0.99			0.53
CREDIT RATIONING			-0.068			0.014
			-1.82			0.38
OPACITY			0.236**			0.001
			2.71			0.01
BRANCHES (X1000)			0.003			7E-04
			0.38			0.10
HHI LOANS			-0.879			-0.788
			-1.56			-1.45
R&D_SELFFIN_%	0.304***	0.246***	0.247***			
	10.14	7.25	6.98			
INV_SELFFIN_%				0.268***	0.221***	0.230***
				10.14	7.25	6.98
CONSTANT	0.333**	0.305	0.496*	0.997***	1.001***	1.114***
	2.74	1.81	2.51	9.02	6.39	5.96
Observations	1165	928	832	1165	928	832
Adjusted R-squared	0.147	0.187	0.215	0.098	0.129	0.129
r2	0.152	0.199	0.236	0.104	0.142	0.152
aic	977.9	731.3	625.7	828.4	629.9	565.3
bic	1018.4	803.8	734.3	868.9	702.3	673.9
F	29.66	16.24	11.34	19.11	10.77	6.591
df_m	7	14	22	7	14	22
df_r	1157	913	809	1157	913	809

t statistics reported
* p<0.05, ** p<0.01,*** p<0.001

Table 7 – Investments versus R&D: SUR model

	Model 1 SUR		Model 2 SUR	
Dependent Variable	**INV_SELFFIN_%**	**R&D_SELFFIN_%**	**INV_SELFFIN_%**	**R&D_SELFFIN_%**
INTERNAL RATIONING	-0.028*		-0.030*	-0.007
	-2.29		-2.32	-0.57
CURRENT RATIO	-0.028		-0.029	-0.004
	-1.5		-1.53	-0.22
LEVERAGE	-0.403***	-0.166*	-0.399***	-0.143
	-3.95	-2.35	-3.83	-1.42
PUBLIC SUBSIDIES	-0.168***	-0.176***	-0.168***	-0.172***
	-6.34	-6.99	-6.26	-6.64
TURNOVER	-0.073	-0.061	-0.074	-0.064
	-1.09	-0.95	-1.1	-0.98
ROI	0.008**	0.006*	0.008**	0.006*
	2.69	2.33	2.63	2.01
ROI SD		0.004		0.003
		0.82		0.64
TOTAL ASSETS	0.046***	-0.016	0.047***	-0.015
	3.84	-1.51	3.54	-1.2
AGE		-0.037		-0.043
		-1.66		-1.67
GROUP			-0.001	0.017
			-0.03	0.60
HI-TECH	0.098		0.100	0.003
	1.88		1.83	0.06
HIGH R&D	0.101*		0.099*	-0.004
	2.16		2.05	-0.09
HIRING	-0.028	0.080	-0.028	0.082
	-0.62	1.85	-0.61	1.87
MULTIPLE BANKING	-0.012**		-0.013**	-0.004
	-3.02		-3.13	-0.96
LOCAL BANK			-0.004	-0.007
			-0.17	-0.3
MAIN BANK	-0.001		-0.001	0.000
	-1.65		-1.78	-0.71
DURATION	0.001		0.001	0.001
	0.97		1.07	0.75
CREDIT RATIONING	-0.067		0.068	0.002
	-1.82		-1.79	-0.05
OPACITY	0.238**		0.251**	0.057
	2.78		2.84	0.67
BRANCHES			0.003	0.001
			0.4	0.19
HHI LOANS	-1.213*	-1.139*	-1.145*	-1.051
	-2.25	-2.2	-2.01	-1.91
CONSTANT	0.803***	1.247***	0.798***	1.298***
	4.8	8.21	4.56	6.95
Obs	834	834	832	832
Parms	16	9	19	21
RMSE	0.353	0.341	0.353	0.340
"R-sq"	0.191	0.098	0.189	0.101
chi2	195.350	90.770	194.430	93.100
P	0.000	0.000	0.000	0.000
Correlation of residuals	0.238		0.238	
Breusch-Pagan test of independence: chi2(1) =	47.192 Pr = 0.000		47.255 Pr = 0.000	
t statistics reported * p<0.05, ** p<0.01, *** p<0.001				

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