Determinants of Financing Decisions in Innovative Firms: A Review on Theoretical Backgrounds and Empirical Evidence

Mihaela Diaconu
"Gheorghe Asachi" Technical University of Iasi, Romania
mhl_dcn@yahoo.fr

Abstract

We review some of the main aspects highlighted in the literature on financing innovation. The theoretical background related to the distinctive features of innovative firms impacting their financing decisions and the empirical evidence is reviewed. The growing literature on the financing of innovation shows that the theoretical and empirical work are not always constant across the various samples and situations faced by firms as a result of generating new findings. We highlight the interaction between financing choices for innovation and changing internal and external condition firms operate

Key words: capital market**,** cost of capital, firm, innovation, R&D.
J.E.L. classification: G2, O15, O31, O32.

1. Introduction

It is widely accepted that research and development (R&D) activities and innovation are difficult to finance on the capital markets. The support of this idea, in the form of various theoretical and empirical models, has begun with the classical studies such as Nelson (1959) and Arrow (1962). The main argument stands for the fact that (knowledge resulted from funding inventive activities) involves non-rivalry: its use by a firm does not prevent another firm to use it. To the extent that knowledge cannot be kept secret, firms cannot fully benefit from their investments and become reluctant in investing, generating underinvestment in R&D in the economy. The empirical support for the Arrow's argument regarding positive externalities generated from R&D are found mainly in the studies that attest that the social return from R&D is higher than the private return (Griliches, 1992; Hall, 1996 etc.).

Another argument related to underinvestment phenomenon in R&D and innovation that was subsequently addressed by researchers refers to the potential wedge existing between the private rate of return and the cost capital when the innovator (investor) and the financier are different persons. This paper focuses on the second type of market failure that characterise R&D activities; even the problems associated with incomplete receipts of income from R&D could be mitigated by protecting intellectual property rights, by subsidizing or providing tax incentives, difficulty of obtaining financial resources on the financial market or from other entrepreneurs can persist as a result of their cost. In other words, it is assumed that there is always a significant wedge between the entrepreneurs' required rate of return by investing their own funds and the external investors' required rate of return. Apart from the situation in which an inventor already has the needed funds, it is considered that certain innovations would not be able to be developed because of the higher costs of external financing, even when their rate of return exceeds the threshold rate of return or the funds would be available at a "normal" interest rate.

Starting from this assumption, many theoretical and empirical developments have been tried to identify the cost of R&D investments, testing the existence of such market failure (Hall and Lerner, 2010). In this respect, financing sources used by firms are analysed in the literature, depending on firms' size and sector, in order to be identified the financing wedge. The literature on financing innovation, even if it is less represented than other approaches, is constantly expanding, creating new records, and some are even inconsistent with the starting hypothesis, generating a real puzzle

to be solved.

In this paper, we review the main aspects regarding the role that financial markets play in impacting firms' innovation. In section 2, theoretical contributions regarding why financing R&D projects might be distinct from financing other types of projects and the modalities in which they can impact innovation are reviewed. Section 3 focuses on the empirical work of financing innovation in young ad mature firms.

2. Theoretical backgrounds regarding financing innovation

In a frictionless world, where all positive NPV projects are financed, one should not expect the sources of finance to impact innovation expenses conducted by firms. At least three features of the R&D process, however, introduce important frictions, which can lead to financing constraints in firms aiming to undertake R&D, as well as impact how the sources of capital have a bearing on the outcome of the innovation process.

Investing in projects that aim at developing new products or processes involves making expenditures. Their size and composition determine distinctive features which can impact financing of innovation. Viewed as an investment activity, innovation has distinctive characteristics from other investments in real assets.

First, a significant amount of funds (greater than 50%) is allocated to staff (scientists and engineers) salaries, and toward their efforts to increase knowledge and other intangible assets that are important source of future profits for companies. To the extent that knowledge is rather "tacit" than codified, they are embedded in human capital that may be lost when firm' specialists leave the organization. These facts have implications on R&D expenditures, and are of interest in explaining the tendency of firms in keeping them over time in order to avoid losses associated with human capital (Hall, 2009). Also, innovative firms have often less collateralised assets while increasing their intangible assets incorporated in human capital, determining that debt financing to be less appropriate particularly when R&D expenses are in significant percentage of total funds needed.

Second, R&D investments are expected to obtain higher revenues characterised by significant uncertainty or high standard deviation. Uncertainty leads to an "option value" of projects (Dixit and Pyndyck, 1994). From a financier's perspective, this makes it significantly harder to evaluate potential innovative projects that may require funding particularly since often the only way to learn about the potential of a particular approach is to invest in it. This raises significant possibilities of financing constraints arising in the funding of innovation. In addition, the payback period of projects and the firm's financial structure may impact on how projects are financed.

Generally, start-up firms confront themselves with highest uncertainty, making the application of traditional methods of project evaluation to be the most difficult. Also, investments are carried out in the long run during which new information that reduces uncertainty can be available, requiring an analysis over the entire lifetime of the projects. This may result in significant problems associated financial constraint.

Finally, although often times neither the innovator nor the financier knows the true potential of the project, the innovator may still know more about the project than the financier. It is often impossible to accurately measure inputs into the innovation process, and one cannot write complete, state-contingent contracts when one does not even know what the output might be. These conditions allow for agency costs to arise in the financing of innovation that can be significantly greater than those present in standard settings between financiers and entrepreneurs.

These particular attributes of R&D have an important bearing on how the financial sector impacts innovation that is undertaken by firms.

3. Financing innovation in firms

One implication of Modigliani-Miller theorems (MM 1958, 1963) is that firms that choose an optimal level of investment expenditure should be indifferent to how they are financed and bear the same cost for the last monetary unit of capital invested whether investing in real assets or conduct research and development investment. The latest monetary unit spent on each type of investment should generate the same rate of return (after adjusting for undiversified risk). Much of the

literature discusses the MM theorems, and one can admit that they can be used as starting points for various analyses.

The challenging issues of the MM theorems arising from the financial practice refers essentially to: uncertainty associated with the existence of incomplete markets, which make suitable R&D investment decision through real options; cost of capital can vary depending on sources of funding, due to the influence of fiscal or non-fiscal factors; cost of capital can be dependent on the type of investments in tangible or intangible assets. They may influence R&D expenditure conducted by firms by impacting the wedge between the cost pf funds internally generated by firms and the cost of funds on the financial markets due to: information asymmetry between entrepreneurs (inventors) and investors (capital providers); moral hazard problems existing at the inventor/entrepreneur level arising from the separation of ownership and management; the incidence of taxation.

3.1 Informational asymmetry and its impact on financing innovation

In the context of financing R&D, information asymmetry issues raised in the literature stems from the fact that the inventor has detailed information regarding the nature and likelihood of project success than potential investors. The use of resources on the financial market, in addition to funds internally generated, is conditioned by the dissemination of information designed to demonstrate the effectiveness of projects and the possibility of supporting the capital costs, but also by the capital providers' ability to interpret such information. When the firm considers that it is in its best interest not to disclose certain information to capital providers, associating that with jeopardising the chances of success by exploiting them by the competitors, the financing costs can increase significantly, leading to deterring innovation.

This problem implies that if at least one piece of information that characterises a particular project is not disclosed to financier, the latter cannot appreciate the profitability. As the result, the market of financing R&D can impose higher costs of funds incorporating risk premiums. Risk premiums may be higher for long-term projects and investments in real assets as well, when capital providers have difficulty in dissociating "good" and "bad" projects (Leland and Pyle, 1977). In the Leland and Pyle (1977) model, firms with growth opportunities can "separate" themselves from less attractive investment by using of R&D expenditures to signal their quality.

When the size of R&D expenditure is observable (used as signal), the risk premium can be reduced. At the other extreme version of the model, the market for R&D projects can disappear completely if problems associated with information asymmetry are significant. Countless records resulting from informal sources suggest that potential innovators consider the description above to be appropriate. Therefore, funding innovative companies from private equities is seen as a solution to the problem of "disappearance markets."

Empirical support of these phenomena exists, especially in the form of studying events, by measuring the market response to the announcements of firms to sell new shares or bonds. Both Alam and Walton (1995) and Zantout (1997) identify overly high rates of return obtained by buying shared issued by R&D intensive firms. The motivation may be that attracting new funding resources is considered "good news" when a company encounters problems of asymmetric information as a result of its R&D strategy. Similarly, it is shown (Szewczyk et al., 1996) that investment opportunities can explain obtaining abnormal yields from R&D activities and that the yields concerned are higher when the company is highly leveraged, implying a higher required rate of return for debt finance at equilibrium.

Reducing asymmetric information by providing detailed information to financiers is of limited effectiveness. Firms are reluctant to reveal innovative ideas into the market space, and the fact that that significant costs associated with disclosure of information to potential competitors can register reduces signal quality generated about investment projects (Bhattacharya and Ritter, 1983).

3.2 Moral hazard problems

Moral hazard problems in R&D investing arise from separation of ownership and management. This leads to a principal-agent problem when the goals of the two conflict, which can result in investment strategies that are not share value maximizing. Two possible scenarios may co-exist:

one is the usual tendency of managers to spend on activities that benefit them (growing the firm beyond efficient scale, nicer offices etc.) and the second is a reluctance of risk averse managers to invest in uncertain R&D projects (a detailed review on moral hazard problems can be found in Hall and Lerner, 2010).

Although the studies to date indicate clearly that the existence of managerial incentives in the long run can encourage R&D activities, and the concentration of ownership not necessarily discourage them, the intensity of these effects is not yet fully known nor if particularities in company governance can influence (eliminate) the agent cost so as to reduce the wedge between cost of capital and rate of return on R&D activities.

3.3 Capital structure and R&D

In principle, firms can use internally generated financial resources or external funds from bank loans or obtained from various individuals by issuing shares, opting for a financial structure that corresponds to the lesser cost of capital. One way of reflecting the financial resources used by firms is to examine the financial structure as a result of financial decisions.

Most studies, especially early ones, highlight that the increase in R&D spending is accompanied by loans reduction in the financial structure of firms. For example, Blass and Yoshie (2001) find that R&D intensive firms listed on stock exchanges in the US were less indebted (using mainly equity), while firms located in Israel opted more for bank loans and used government financial resources. The first ones proved to be more profitable and with faster growth, suggesting that choosing the place of shares listing and the decision to issue new shares depend on R&D expected rate of return. In other words, capital providers require a rate of return for the risk assumed.

Although bank loans can reduce firms' agent costs, this mechanism can be less useful for R&D intensive firms. These firms generate intangible assets that are mostly embedded in highly specialised human capital in certain activities, and this fact is often used in explaining a financing structure focused on less debt than is found in other firms. In turn, banks and other lenders usually prefer guarantees consisting of physical assets and usually avoid crediting of projects with significant proportions of research expenditure involving higher sunk costs than investments in real assets. Assets that have alternative values of use as high as the current ones are more appropriate for the governance structures associated with loans. Empirical support of these ideas results from Alderson and Betker (1996), which identifies that the size of liquidation costs and R&D expenses are correlated. The implication is that sunk costs associated with R&D expenditures can be registered, and can be higher than costs associated to other types of investments.

Also, debt service requires, in principle, stability of cash flows, and that makes financing by loans to be difficult. This fact and the existence of sunk costs can determine the difficulty of innovative firms to access loans and, at the same time, to not prefer them in financing of research programs, given the difficulty of loan repayment or increasing the cost of capital.

A part of the latest literature shows that, on the contrary, loans can be viewed as an valid option in mature innovative firm's financing that conduct significant R&D expenditures. Moreover, financing resources availability or cost of loans variability proved to have an impact on the rate and typology of innovations developed by firms. In the same framework, it is identified that agent costs of equity markets can have negative impact on innovation.

Looking first at bank financing, Mann (2014) shows that it is not only common for innovating firms, but that furthermore, patents are often used as collateral in such instances. He notes that 16% of the aggregate stock of patents at the US Patent and Trademark Office (USPTO) has been pledged as collateral at some point, and that companies with patent-backed debt have performed over 40% of USPTO patenting since 2003. He documents that the amount of credit is economically large and seems to directly finance research. He also documents that lenders are frequently banks, but may also be venture debt or other non-bank lenders. Similarly Hochberg, Serrano and Ziedonis (2014) find that patents are used as collateral for venture debt, and Chava, Chong and Nanda (2012) find that firms with significant patent activity and higher-quality patents receive cheaper bank loans than peers.

Robb and Robinson (2014) show that external bank finance is an important source of start-up capital, even for high-potential start-ups that might be engaged in innovation and who don’t have

any collateral (tangible or intangible) to pledge. Consistent with this, Cornaggia et al. (2013) find that innovation by small private firms, who depend more on bank finance for capital than publicly-traded firms, increased following the inter-state deregulations, while innovation fell among publicly-traded firms. Cornaggia et al. (2013) argue that this latter effect is driven by an increased negotiating ability of innovative targets, which are less likely to be acquired and instead continue on as standalone firms due to the greater ability to access external finance. These papers suggest that an important and still insufficiently explored area concerns the way in which banks can lend and monitor the funding of innovative firms. This is not only an important area of investigation, but it has profound implications for the development of the literature, suggesting that the link should be very different from one firm to another.

Small businesses are more likely to setting up a financial structure with a smaller proportion of loans. Creditor's option to provide funds at a cost that determines that a part of credit applications to not be resolved can be achieved, in principle, regardless of firm's size. Rationalization of bank loans (by not providing the entire amount requested, even when the borrower is willing to bear the interest rate) is a phenomenon found mainly in SMEs, taking place when, among related applications, some enterprises get loans, while others are rejected or, when there are identifiable groups of firms that cannot get loans regardless of their cost (Stiglitz and Weiss, 1981). The SME sector is generally most affected by credit rationing, orienting towards the use informal financial resources in completing internally generated funds, in order to avoid (formal) loans from banks, contracted at an interest rate higher than the average rate on the financial market, and eventually higher than that supported by large enterprises.

Various empirical studies show also that only a small proportion of fast-growing innovative firms use external financing from equity, which is looked to outline predominantly a deliberative decision and not a result of lack of access to other funds (OECD, 2010). That could mean that entrepreneurs pursue including minimizing external control and ownership dilution by using predominantly internal financial resources. In this framework, the financial structure adopted can reflect not only the existence of financial market imperfections, but also entrepreneurs' preferences.

4. Conclusion

The literature on financing decisions of innovative firms is filled with new themes. First, bank financing has appeared to be of relevance to innovative firms in some studies, but is likely to be more appropriate for large and mature firms, where investments are less risky for banks as a result of cash flow generated from existing activities and collateral held in real or intangible assets. Secondly, while equity investors are more willing to finance risky investments, capital market can impose significant agent costs on managers, with possible implications on the rate and type of innovation. Finally, the costs and benefits at the level of listed firms versus non-listed companies are heterogeneous, and understanding the mechanisms of compensation can be a promising field for future research. For example, Ferreira et al. (2014) argues that listed firms can be better positioned to benefit from the commercialization of new goods than to have liquidity through the capital market and, on the other hand, unlisted firms may be better placed by the novelty of manufactured goods.

In economies which continue to be characterised by bank-based financial systems, with only shallow public and private equity markets questions of whether access to bank credit can help firms to innovate in the absence of a meaningful supply of risk capital remain. Also, we think that more data is needed at the firms-level related to the type of projects they develop. Many firms develop more than just R&D involving the adoption of existing products and processes that are new to a particular firm or market, but not to the wider world. Such imitative innovation is arguably less risky and more in line with the risk appetites of most banks. This is particularly true of banks that have funded specific technologies in the past in partnership with other borrowers. In this case, banks may even act as conduits, facilitating the spread of technology across their borrower base. Lastly, even without financing innovative projects directly or explicitly, banks can still stimulate firm-level innovation. When banks provide firms with straightforward working capital or short-term loans, this can free up internal resources, which firms can then use to finance innovation.

5. References

1. Alam, P. and Walton, K.S., 1995, Information asymmetry and valuation effects of debt financing. *Financial Review* 30 (2), pp. 289–311.
2. Alderson, M.J. and Betker, B.L., 1996, Liquidation costs and accounting data. *Financial Management*, 25 (2), pp. 25–36.
3. Arrow, K. J., 1962, Economic welfare and the allocation of resources for invention. In: R. Nelson, ed., *The Rate and Direction of Inventive Activity*. Princeton, NJ: Princeton University Press, pp. 609-625.
4. Bhattacharya S. and Ritter, J.R., 1983, Innovation and communication: Signaling with partial disclosure. *Review of Economic Studies*, 50, pp. 331–346.
5. Blass, A. A. and Yosha, O., 2003, Financing R&D in Mature Companies: An Empirical Analysis. *Economics of Innovation and New Technology*, *12* (5), pp. 425-447.
6. Chava, S., Chong, X. and Nanda, V., 2012, Funding innovation: The role of lender expertise and control rights. *Georgia Institute of Technology* Working Paper.
7. Cornaggia, J. et al., 2015. Does banking competition affect innovation?. *Journal of Financial Economics*, 115(1), pp. 189-209.
8. Dixit, A. and Pindyck, R.S., 1994, *Investment under uncertainty*. Princeton: Princeton University Press.
9. Griliches, Z., 1992, The search for R&D spillovers. *The Scandinavian Journal of Economics*, 94, pp. 29-47.
10. Ferreira, D., Manso, G., and Silva, A.C., 2014, Incentives to innovate and the decision to go public or private. *Review of Financial Studies*, 27, pp. 256-300.
11. Hall, B. and Lerner, J., 2010, The financing of R&D and innovation. In: B. Hall, N. Rosenberg, eds., *Handbook of the Economics of Innovation*, Elsevier, pp. 609-639.
12. Hall, B., 2009, The Financing of R&D and Innovation. *NBER* Working Paper 15325, Cambridge MA.: NBER.
13. Hall, B. and Van Reenen, J., 2000, How Effective are Fiscal Incentives for R&D? A Review of the Evidence. *Research Policy*, 29, pp. 449-469.
14. Hall, B., 1992, Investment and Research and Development at the Firm Level: Does the Source of Financing Matter? *NBER* Working Paper 4096, Cambridge MA.: NBER.
15. Hochberg, Y., Serrano, C., and Ziedonis, R., 2014, Patent collateral, investor commitment, and the market for venture lending. NBER Working Paper 20587, Cambridge MA.: NBER
16. Leland, H. E. and Pyle, D. H., 1977, Informational asymmetries, financial structure, and financial intermediation. *Journal of Finance*, 32, pp. 371–387.
17. Mann, W., 2015. Creditor rights and innovation: Evidence from patent collateral. *Anderson School of Management* Working paper. <//business.illinois.edu/finance/wp-content/uploads/sites/46/2015/03/Mann-Paper-March-2015.pdf>.
18. Modigliani, F. and Miller, M. H., 1958, The Cost of Capital, Corporation Finance and the Theory of Investment. *The American Economic Review*, 48 (3), pp. 261-297.
19. Nelson, R. and Winter, S., 1982, *An Evolutionary Theory of Economic Change*. Harvard: Harvard University Press.
20. OECD, 2010, *High-Growth Enterprises What Governments Can Do to Make a Difference*. Paris: OCDE.
21. Robb, A.M. and Robinson, D.T., 2010, The capital structure decisions of new firms. *NBER* Working Paper 16272, Cambridge MA.: NBER.
22. Stiglitz, J. and Weiss, A., 1981, Credit Rationing in Markets with Incomplete Information. *American Economic Review*, 71, pp. 393-409.
23. Szewczyk, S. H., Tsetsekos, G.P. and Zantout, Z.Z., 1996, The valuation of corporate R&D expenditures: Evidence from investment opportunities and free cash flow. *Financial Management*, 25 (1), pp. 105–110.
24. Zantout, Z.Z., 1997, A test of the debt monitoring hypothesis: The case of corporate R&D expenditures. *Financial Review*, 32 (1), pp. 21–48.