How financial systems and firm strategy impact the choice of innovation funding

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Abstract

Purpose – The funding of innovation is explained by typical cost-based financial approaches. This paper breaks away from such tradition, and the purpose of this paper is to propose an alternative view where innovation funding decisions are strategic and concern interactions between actors – each with their own characteristics and strategic intentions – project features, and traits of the setting in which interactions take place.

Design/methodology/approach – This paper builds up an alternative framework to understand how innovation is financed by considering the interplay of innovation characteristics, the strategic reasons of project owners and funders, and the role of the matching environment and conditions. This proposal includes explanatory elements overlooked by extant theories. An illustrative case is presented to support the need for this proposal.

Findings – The framework proposed proves useful to better understand innovation funding cases where the traditional financial theory does not suffice.

Practical implications – Innovative companies may improve decision making about resource allocation to innovation; innovation funders may refine their decision-making criteria and implementation; and policy makers and practitioners need to devise better supporting strategies for innovative companies.

Originality/value – This proposal considers a continuum of funding options where supply/demand will match on the grounds of strategic decisions made during the interaction itself, under certain contextual conditions. Hence, it enriches the understanding of strategic decisions regarding firm capital structure and investment theory when it comes to funding innovation.

Keywords Innovative projects, Investment strategy, Capital structure, Strategic decision making, Fundamental uncertainty, Risk funding

Paper type Research paper

1. Introduction

Innovation and resource allocation are strategic activities to strengthen the competitive position of any company. Thus, innovation-related activities – funding included – involve strategic decision making on the side of company management and external funders.

Ideally, companies develop and use or sell new services and goods to gain a better position over competitors. Hence, additional profit can be either devolved to company owners or dedicated to boost new research and development (innovation) that will, in turn, generate newer services and goods (Scherer, 2001). Such a virtuous cycle seems a straightforward manner to put money and knowledge together (Perez, 2002, 2004).

In particular, finding and allocating resources to fund innovation is strategic because such decisions are linked to the creation and application of knowledge to boost up innovation and firm competitive performance. Actually, "[…] firms that invest in R&D at a much higher rate than their competitors are most likely **trying** to compete of the basis of innovativeness" (O'Brien, 2003, p. 419), so investment rates serve as signals to tell firms that compete on the basis of knowledge from firms that use a different strategy.

Actually, in many cases, company management need to fund projects through external investors. In fact, the main role of a financial system – usually composed by banks and financial markets (foreign exchange, fixed-income, equity markets, derivative markets) – is "to facilitate the transfer of resources from savers ('surplus units') to those who need funds

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('deficit units'). In a well-designed financial system, resources are efficiently allocated" (Boot and Thakor, 1997). However, financial systems' configurations and functioning differ across countries for a number of reasons and that will certainly affect external project funding in innovative companies. Moreover, lacking or malfunctioning external sources of funding do impact innovation funding in a number of ways.

In this paper, a developing economy case is presented to illustrate some current explanatory failures. On such a basis, common explanations about investment sources and mechanisms are reviewed concerning the funding of long-term investment projects and the capital structure of the companies where such projects are developed, particularly as capital structure is related to corporate governance.

Next, our main point is set by highlighting some neglected dimensions of strategic decision making on innovation funding; specifically, the characteristics of innovative projects and the main reasons for project owners and potential funding suppliers to consider relating to each other are brought forward. Later, there is a discussion on the matching possibilities and the relational dimension where specific conditions for interaction have to be taken into account if a comprehensive picture of the topic is to be drawn. Finally, some relevant implications and future research avenues are discussed.

2. An illustrative case: innovation financing in Colombia

A case, whose specificities cannot be explained by extant theories, will be used to analyse the failures of current explanations and the need for a fresh approach to such phenomena that are likely to affect developing and developed economies.

Colombia, the fourth biggest Latin American economy and latest OECD member, has a formal national science/technology/innovation (STI) system in place. However, manufacturing companies that bet on innovation are not numerous, are mostly big, belong to sparsely populated technology-intensive sectors, and do mostly incremental innovation. In fact, Colombia is the tail light by OECD standards (Pardo and Cotte, 2018).

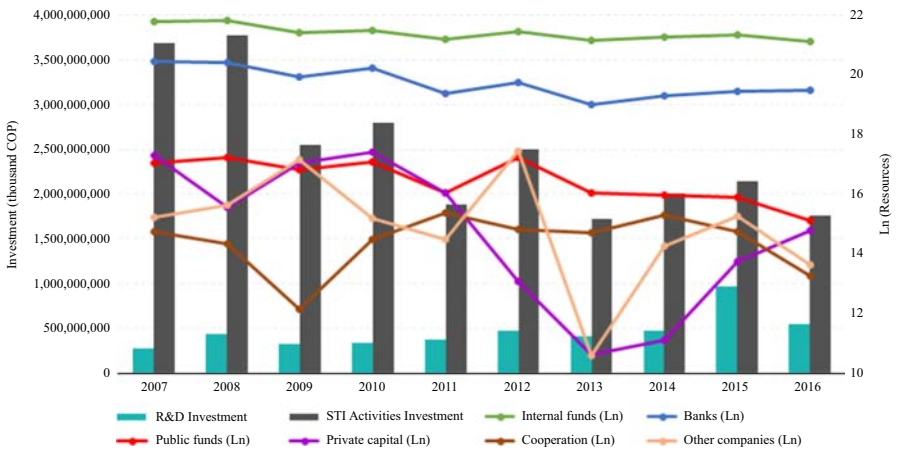
Colombia spends a meagre 0.25 per cent of GDP in STI, while the government contributes 30 per cent of STI activities funding, private funding reaches 70 per cent. Firms contribute 53 per cent, and HEIs, NGOs, research centres and government organisations account for the remaining 47 per cent, being *Colciencias* (the innovation system "hub"), the main national seed funder and regional governors' offices, the suppliers of oil royalties funding.

As for the Colombian financial system, only a few first- and second-tier banks may eventually fund STI projects. Venture capital is not abundant and faces a number of serious restrictions (Jiménez, 2008), and the stock market is small and underdeveloped.

Furthermore, most Colombian innovative companies resort to retained earnings, first. Only when internal funding is not feasible, they do attempt to get loans from commercial banks and, very marginally, from suppliers/customers (advanced/delayed payments) (Sierra *et al.*, 2009; Barona, Rivera and Aguilera, 2015; Barona, Rivera, Aguilera and Garizado, 2015). External funding seems more relevant for small/mid-sized companies (García *et al.*, 2013), maybe due to their low liquidity.

Hence, Colombian innovative firms exhibit a pecking-order funding preference consisting of internal liquidity (including funds from corporate group), commercial banks loans and public funding (there are about six sources available, but not more than two are typically used) (Figure 3). International bank leverage and bond funding are infrequent (Sierra *et al.*, 2009; Barona, Rivera and Aguilera, 2015). Unlike standard cases, Colombian innovative firms do not like very much resorting to fresh equity (ANIF, 2018) (Figure 1).

This depicts a paradox: companies invest very little in STI, but they prefer internal funding; also, low-liquidity companies prefer going to more costly local banks than using more convenient government subsidies or low-rate credits. Moreover, such companies rarely



Source: Author's elaboration based on Colombian Innovation Survey

Figure 1.
Innovation funding sources preferred by Colombian companies

seek fresh equity, except for some OTC sources (e.g. start-ups). This leads to wonder about how are decisions made and what the roles of firm CEO/CFO/CSO are in such regard[1].

This paradox leads to several questions. How well do project owners know the institutional financial layout? How often and why do they use external investors or not? Does the existing institutional financial layout meet the needs of innovative sectors and companies? What is the role of firms' innovation-related strategy?

Seemingly, Colombian innovative companies are financially constrained, but do not know nor trust the STI ecosystem – particularly its financial actors – well enough. Strangely, they are somehow not interested in taking advantage of available cheaper, relatively specialised funding sources/mechanisms (e.g. *Colciencias*) as they feel official agencies' red tape is excessive. However, they go to private banks (generalist funders) where collateral and cost set up a barrier given the information asymmetry (Tables I and II).

A scarce record of accomplishment on both sides and knowledge asymmetries seem to further hinder trust creation, particularly in the case of SMEs and start-ups (Sierra *et al.*, 2009; Otalora *et al.*, 2009). Connectedly, the available funding sources/mechanisms (e.g. scarce venture capital) and the "rationality" of company management seem to favour cost/profitability-based matching over more strategic motives. Also, no studies about funding supply are available.

So the primary obstacles seem to regard rather poor matching environment and mechanisms and, subsequently, a very limited set of mostly generalist funders with rigid conditions (e.g. screening criteria) that make adaptive demand-supply matching difficult.

Finally, no studies on Colombian innovative firms' strategy are available, but the scant existing evidence suggests that short-termism and cost-related criteria are at the core of most decisions. Such a limited approach seems in line with the characteristics of the Colombian IFL and the STI ecosystem. This characterisation highlights the embryonic state of the STI system concerning one key variable: the development of appropriate innovation funding sources and mechanisms.

3. Literature review

3.1 Long-term real investment and capital structure

Given the main elements of the case briefly presented above, it is necessary to understand why and how such situations are accounted for in extant theories. Two theoretical views

Exogenous factors		
Funds demand	Project characteristics	Funds supply
Manufacturing companies, mostly small- and mid-sized belonging to low R&D intensity sectors and exhibiting low share of highly skilled labour; big enterprises are more innovative. Low spending on STI activities Scarce knowledge about markets, regulation (including IP protection), and technology Most companies are cost oriented and not quite aware of funding availability (even public sources) Strategy motives (first-mover advantage, financial slack, risk/cost/profit sharing preferences and business model) not clearly identified	Mostly low innovation/uncertainty/risk non-technological product and process projects, developed in-house for both, internal and external usage **Matching environment and mechanisms** Scarce and not easy to identify sources of info about potential partners Innovation public policy agencies: Colciencias, Bancoldex, Innpulsa Investors' associations: Angel investor's networks, private equity funds association Small, undeveloped stock market Few incubators/accelerators Potential partners relate to one another through individual efforts, public agencies' calls and, eventually, word-of-mouth references STI actors do not seem well articulated **Conditions for interaction** Interplay of strategies limited to cost and profit expectations Signals to potentially interested third parties are not usual nor easy to catch	Relatively specialised funders (seed stage on): Colciencias (National STI hub agency), oil royalties (regional funds), ministries (Agriculture, ICT…), Innpulsa, SENA, Ruta N Generalist funders (late stages): Bancoldex, Findeter (2nd T) and few commercial banks (1st T) A number of national and international private funds, not many support innovation - related risky projects. Most investments directed towards real estate, infrastructure… Bonds and stock not usually traded to raise funding for innovation Institutional investors (pension funds) do not usually put money in innovative companies Angel funding (seed stage on) scarce but available – Four networks: Capitalia Colombia (Medellín), Red Nacional de Ángeles Inversionistas (Bogotá), RaiCap (Medellín), TIC-HubBOG (Bogotá) (2010 operations reached USD 1m – 2015 operations got over USD 8m) OTC: Friends/Family/Founder/Fools No public info about corporate JV funds, particularly aimed at innovative projects
Investees' behaviour Cost-based selection criteria and short-term goals		**Investors' behaviour** Profit-led selection mostly
Systemic specificities of milieu Institutional weakness, weak dynamics and deficient coordination at different levels (national/regional/local) of STI		

Table I.
STI funding in Colombian ecosystem

Source: Author's own elaboration

Obstacles to innovation	Percentage
Shortage of internal resources	63.4
Uncertainty about demand for innovations	62.4
Uncertainty about success of project	57.9
Ease of imitation by third parties	55.8
Jave	54.4
Low profitability of innovation	
Lack of qualified personnel	49.3
Little information about markets	48.2
Little information about public support	47.1
Difficulties in accessing external financing	45.3
Little information about available technology	45.1
Few possibilities for cooperation to innovate	44.3
Difficulty to comply with regulations	41.1
Low institutional capacity to protect inventions	40.8
Low offer of testing services and certifications	39.2

Table II.
Ranking of problems identified by Colombian innovative companies

Source: Author's elaboration based on Colombian Innovation Survey

predominate in the finance literature regarding the capital structure of companies that want to finance long-term real investment, a category where innovation activities fit in. Both views are essentially based on the cost of funds: long-term corporate capital structure has been explained by a given (optimal) combination of internal liquidity and debt (trade-off theory – TOT) and, alternatively, by a preferential ranking of funding sources based on the cost of funds (pecking order theory – POT) (Myers, 2001; O'Brien, 2003).

The TOT states that a firm will incur debt to a point in which the marginal value of tax shields on additional debt is offset by the increase in the present value of financial distress costs. The theory predicts that firms have an optimal capital structure and adjust their leverage toward the optimum over time. This optimal combination of internal liquidity and debt brings forth benefits such as the tax shield itself, lesser free cash flow problems and also less other conflicts between managers and shareholders; simultaneously, expected costs arise on account of financial distress, underinvestment and asset substitution problems (Jensen and Meckling, 1976; Myers, 1977; DeAngelo and Masulis, 1980; Jensen, 1986; Stulz, 1990).

However, Myers and Majluf (1984) beget an alternative explanation (POT) proposing that companies, based on asymmetries and costs, exhibit a hierarchical preference for investment funding originated from: internal funds, debt funds (bonds) and new equity (fresh stock). They, however, make it clear that POT does not pretend to be a universal explanation since their conclusions are dependent on the assumptions specifically created for their model and such is just "[…] one of many possible stories about corporate finance. A full description of corporate financing and investment behavior will no doubt require telling several stories at once" (Myers and Majluf, 1984, p. 220).

Further POT works have incorporated other types of debt (bank debt is primarily used by low risk businesses, while external equity is used by high-risk businesses) and have elaborated on the relationship between investment characteristics and funding sources (Baeyens and Manigart 2005; Vanacker and Manigart, 2010). External equity seems to be particularly important for unprofitable companies, firms that invest heavily in intangible assets, companies with high debt levels and limited cash flows or businesses subject to high failure risk. External equity is crucial as it allows some high-growth businesses to undertake investment and grow beyond their debt capacity.

Evidence on the validity of each explanation is mixed. Some authors feel that there is no solid ground to accept the superiority of one model over the other. Others have found evidence that may even reconcile both explanations (Cotei and Farhat, 2009).

These ideas are relevant for the funding of innovation insofar as innovative projects can be funded with an enterprise's own funds, by gathering funds elsewhere or through a combination of internal and external funds, if possible. However, it must be highlighted that the characteristics of innovative projects make it difficult to establish what the best combination of resources is.

3.2 Capital structure, corporate governance and innovation financing

Few studies deal with innovation funding (Freeman and Soete, 1997; Fransman, 2004; Pisano, 2006; O'Sullivan, 2007; Casson *et al.*, 2008; Lazonick and Tulum, 2011; Demirel and Mazzucato, 2010; Brancati, 2015; Mazzucato and Semieniuk, 2017). Yet, decisions about it are strategic since "[t]he R&D intensity of a firm, relative to its industry rivals, indicates the strategic importance of innovation to a firm" (O'Brien, 2003, p 419).

Several authors have found evidence on the validity of POT when financing innovation (Saltari and Travaglini, 2001; Hogan and Hutson, 2005; Casson *et al.*, 2008; Atherton, 2009; Ullah *et al.*, 2009). Furthermore, a "new pecking order" for innovative firms has been proposed in relation to the size of firms and their stages of development in correspondence with "different degrees of information opacity and financial requirement" of project-based

firms that move from start-ups to established companies (where project and company capital structure are virtually the same). Such proposal includes: insider capital, informal private equity (founders, friends, family) and easy-term public financing (seed stage); venture capital financing (Business Angels included) (start-up stage); self-financing, bank and/or business credit (early growth stage); and non-financial companies, commercial banks, direct issue of bonds and public equity (sustained growth stage) (e.g. Van Osnabrugge and Robinson, 2000). This entails a transition regarding firm control that goes "from personal to business angel to venture capital to stock market finance [and] involves a gradual broadening of the investor base" (Mayer, 2002, p. 318).

Studies do recognise, though, some cases in which the proposed hierarchical order of the usable sources can be reversed due to factors such as differing expectations on future liquidity constraints, the characteristics of stockholders/managers or the appearance of new funding sources. Anyway, the POT, for funding innovation, remains essentially based on the cost of funds as related to the existence of project asymmetric information between owners and potential external financiers. Moreover, the basic reasoning behind the ordering of funding sources has to do with the convenience and the preferences of the company owners/managers (the demand side). Hence, the lower the cost and the higher the availability of internal funds, the lesser the probability of seeking external funding.

In short, capital structure affects ownership and control structure (governance), particularly in what regards the making of strategic decisions in the presence of diverse stakeholders. Setting up a particular capital structure is a strategic decision in itself. It all becomes more complex when such a choice is affected by the intertwining of other strategic decisions about knowledge, chiefly when they refer to projects in which intangible, highly specific assets and capabilities with high sunk costs and fundamental uncertainty are involved.

Bagella and Becchetti (1997) and Carr and Tomkins (1998) propose the existence of prototypal styles regarding strategic decision making where the finance function is influenced by context and culture variables and identify four basic patterns of corporate governance and industrial structure correspondence (Anglo-Saxon, German, Italian, Japanese). Such models essentially cover the spectrum of options comprised between a bank-oriented system (characterised by a weak separation between ownership and control, high ownership concentration, low independence of management, high role of financial intermediaries, low role of financial markets in corporate monitoring and very weak constraints on bank ownership of firm equity) and a market-oriented system (characterised by a strong separation between ownership and control, low ownership concentration, high independence of management, low role of financial intermediaries and high role of financial markets) (Becchetti and Sierra, 2002). Unsurprisingly, those two poles readily correspond to the two alternatives to internal liquidity funding mentioned by the POT, namely, debt and equity funding.

Later, Tylecote and Visintin (2008) propose four stereotypical models, and some variations, of corporate governance and finance systems (SCGFs) in which different approaches to innovation are characterised. Essentially, they find a match of SCGFs' characteristics –where corporate governance is broadly understood as "who controls and influences firms, and how" – with sector specific requirements (based on Nelson and Winter's technological regimes or "the learning and knowledge environment faced at a given time by firms in a particular sector or subsector" (p 11))in terms of opportunity for innovation (implying high spending demands availability and acceptability of risk capital, and management autonomy), need for reconfiguration (availability of expert finance for new firms and pressure for high value-added in areas affected by radical innovation), visibility of innovation (shareholder/financier engagement) and innovation stakeholder spill-overs (stakeholder inclusion) (Table III).

Interestingly, no specific capital structure is associated to any stereotypical SCGF in this approach. Rather, a variety of funding sources are allocated to each type on the grounds of

	Shareholder	Stakeholder	State-led	Family/state
Type of coordination	Outsider	Insider	Insider	Insider
Directness of control and degree of managerial autonomy	Indirect	Direct	Varying	Direct
Poles of control	Unipolar	Multiple	Bipolar	Unipolar
Funding sources	Retained profits, Corporate bonds, Private equity (VC and LBOs), IPOs	Bank debt (relational), Transient private equity, VC from banks	Bank debt (banks agents for/owned by government) … Large banks-to-large firms	Subsidies and others (State-owned firms), Bank debt (transactional), VC
Typical example	USA, UK	Germany, Japan, Nordic countries	France, Korea	Italy, Spain, Greece, Portugal

Source: Author's elaboration based on Tylecote and Visintin (2008)

Table III.
Major stereotypical systems of corporate governance and finance

the suitability to the predominant coordination type and the directness of control and degree of managerial autonomy. Furthermore, bonds and IPOs are said to be used predominantly in the shareholder-based type where bank debt is not used, while subsidies are present only in the family/state-led category, profits are retained for reinvestment only in the shareholder type, and venture capital is absent in the state-led class. This posture clearly contradicts the cost-based financial approach.

Moreover, an interesting suggestion deducible from this taxonomy points to the fact that different coordination and control structures will lead to different financial strategies and will have also an impact on the type of activities (e.g. innovation) developed by different kinds of companies (Colombia, our case star, would nearly fit the family/state SCGF).

Furthermore, R&D investments characterised by high specificity or opaqueness are found to be associated with lower ratios of leverage (Long and Malitz, 1985; Jordan *et al.*, 1998; Vincente-Lorente, 2001). Also, being innovation a strategic competitive choice, a low leverage ratio (i.e. high financial slack due to low levels of borrowing) is a strategic imperative to secure the continuity of the competitive strategy as long as the slack provides a source of funds for innovation that would not be available in the case of scarcity. This is a further reason for pecking order variation.

These approaches to innovation financing, however, do not account for a number of factors. First, all innovative companies' decision-makers seem to reason along the same line irrespective of company size, age (experience) and sector differences, of varying criteria and reasons for seeking external funding (only costs considered), and of the existence of other factors that might influence any innovation funding strategy. Second, it ignores the supply side; no role is recognised for potential financiers, no differences among them are documented and no divergence among funding possibilities are acknowledged. Third, it ignores the relational dimension in which project owners and fund owners interact to the end of matching projects and money, it overlooks the role of other actors (e.g. government), the importance of institutions, and the role of time (e.g. history). Fourth, it does not pay attention to the differing characteristics of projects, making R&D a sort of standard container for innovation.

4. An alternative approach to innovation funding

4.1 Dimensions of decision making when financing innovation

The scenario in which innovation financing is decided is complex. The POT seems to hold well in the case of SME's as long as the information asymmetry between firms and external financiers enhances the role of internal funding over the other options (Berger and Udell, 1998;

Bergemann and Hege, 1998; Gompers and Lerner, 1998; Kortum and Lerner, 2000; Becchetti and Sierra, 2002), particularly in the case of knowledge-based companies (Giudici and Paleari, 2000; Paul *et al.*, 2007; Casson *et al.*, 2008; Ullah *et al.*, 2009; Vanacker and Manigart, 2010). It seems to be true even in developing economies (Sierra *et al.*, 2009; Barona, Rivera and Aguilera, 2015). This is relevant since many innovative firms are small- or medium-sized and face strong financial constraints for a number of reasons (e.g. Himmelberg and Petersen, 1994; Westhead and Storey, 1997; Hubbard, 1998; Giudici and Paleari, 2000), although some authors contend the existence of a "finance gap" (Mina *et al.*, 2013).

Moreover, the differences between start-ups and established firms and their implications concerning the variation of the ranking of preferences for funding sources hold. The basic framework of the problem is based on and delimited by two propositions about innovative companies:

P1. They may be either project-based (e.g. a typical spinout in start-up phase) or portfolio-based (e.g. a typical established firm with a multi-asset pipeline).

P2. They may use either internal funds only, external funds exclusively or a combination of both.

Now, external funds can be raised for a specific project or for a project portfolio, which means that funding allocation in the latter instance is decided internally just like when internal liquidity prevails. This issue is relevant since financial constraints (e.g. no access to credit markets) seem to be related to firm experience and reputation, particularly when funding is channelled to high-risk projects (Stiglitz and Weiss, 1981; Myers and Majluf, 1984; Himmelberg and Petersen, 1994; Schiantarelli, 1996; Westhead and Storey, 1997; Hubbard, 1998; Giudici and Paleari, 2000; Casson *et al.*, 2008; Ullah *et al.*, 2009).

Additional relevant issues concern intra and inter-sectoral differences in the access to debt and new equity funding (Atherton, 2009) or the settings in which innovative projects are undertaken (e.g. developed vs developing economies) (Takalo and Tanayama, 2010; Hall and Lerner, 2010). Furthermore, other issues regard prospective external financiers' skills to screen projects, the management of information asymmetry, financiers' characteristics and preferences, and their monitoring of funded projects.

Additionally, a number of public agencies are nowadays responsible for issues that impact innovative companies and sectors: allocating funds, screening projects, creating and implementing policy, and setting up incentives for firms and financiers (Mazzucato and Semieniuk, 2017).

These issues co-exist in real-life cases where strategic decisions on financing innovation are to be made. This is all incorporated in our explanation to offer greater insight on the conjunction of money and knowledge.

4.1.1 Characteristics of innovative projects. The main characteristics of an innovative project refer to: degree of innovation, degree of uncertainty and risk, development placement (in-house *vs* outsourced), usage setting (internal use *vs* external commercialisation), type of end result (process vs product). Such characteristics make assessment, selection and management difficult, and have implications on the way in which the actors look at them.

Moreover, issues regarding different stages (from project assessment and screening to benefit distribution) are strongly linked and have manifold connections and potential impacts on firms' strategy and project financing issues that beg for explanation. The very nature of innovative projects has an effect on the way in which such projects are assessed and selected for funding, their placement for development, their commercialisation and the way returns are appropriated and distributed.

The assessment and selection processes for funding decisions and return appropriation and distribution should be thought of from a double perspective: that of project owners/

developers and that of financiers. To begin with, the viewpoint of firms as project owners/developers implies considerations in terms of assessing and selecting projects (e.g. the risk of accepting bad projects/rejecting good projects) and managing them (e.g. development, assessment and feedback, commercialisation) (Lerner, 2007; Takalo and Tanayama, 2010). Moreover, studies confirm that early-stage venture capital differs from the late-stage one, which is also a key to understand the importance of investment timing and circumstances.

Also, investors' criteria to make selection decisions differ. VC funds may prefer: the human capital of the entrepreneur and the entrepreneurial team; the market environment; the characteristics of the product or service; and the financial criteria and exit opportunities (Knockaert, Clarysse and Wright, 2010). So, even if the economic/financial screening process by which innovative projects are selected is concerned with making decisions about uncertainty, risk, costs and expected returns of projects, other key topics such as the handling of knowledge spill-overs and the effects regarding long-term firm strategy and results have to be considered.

The biggest initial problem regards risk and uncertainty, particularly when the innovation degree is such that no benchmark is found to set any guidelines. Freeman and Soete (1997) relate the potential failure of monopolistic or social systems of innovation to three reasons: technical uncertainty, market uncertainty and general political and economic uncertainty[2]. Yet, uncertainty is begotten by other sources such as knowledge or ethics (Samaniego, 2010). In short, the higher the degree of innovation, the higher the degree of fundamental or true uncertainty (Knight, 1965; Shackle, 1955, 1961; O'Sullivan, 2005). Therefore, calculating risk, costs and returns for innovative projects becomes tougher than usual (Freeman and Soete, 1997; Pisano, 2006).

Ownership/control separation is also an issue (O'Sullivan, 1998; Lerner, 2007; Arora *et al.*, 2007). Once a decision regarding project selection is reached, the problem turns to the project management, particularly when external financiers are involved and close monitoring is needed to minimize agency problems and opportunism.

In such a regard, O'Sullivan (1998) brings forth Schumpeter's claim that innovation is a creative response to external conditions and remarks that "[…] there are no objective guidelines for making strategic decisions about the extent, direction and structure of the learning process nor for resolving disputes about the strategy for learning. Strategists thus require control of resources if they are to commit them to a developmental process in accordance with their evaluation of the problems and possibilities of alternative learning strategies" (p. 185).

Successful innovative projects help enterprises become more competitive and entitle them to profits that can be appropriated (O'Brien, 2003). Such a result is vital to secure reinvestment in innovation projects for, without continued investment, the skills and knowledge will depreciate or obsolesce in front of strategic competitors. Yet, conventional analyses of the financial profitability of projects and the conditions to grant the appropriability of returns ignore issues, such as the impact of knowledge spill-overs, imitation, eventual financial under/over-investment, and other phenomena linked to innovation beyond the organisation and the sector level[3].

A key point regards how to define failure and success in the case of innovation. First, failure is not only related to specific project risk and uncertainty; competing innovative projects (parallel or competitive attempts) inevitably imply also some rate of failure. Second, projects may fail at different stages; some may not even survive the screening stage where funding is decided upon, some others may fail along the R&D stage, and others may even not make the grade during the use or commercialisation phase. Hence, reducing failure through "better" management or project selection and control techniques may prove difficult, except in the case of adaptive/imitative projects (Freeman and Soete, 1997).

Hence, placement for development and usage setting are important aspects of decision making on innovative projects. In-house or outsourced development and the potential demand for the innovation product are key issues. For instance, if it is a process/product developed in-house for internal use, market uncertainty is not an issue, neither it is when a project is done through outsourcing (commissioned by a customer) or when there is a clearly defined potential demand (e.g. a group of people affected by a disease).

Other relevant issues concern returns. For example, the distribution of the financial benefits of projects rests on the estimation of the future cash flows that take into account the successful use or commercialisation of the innovative project outcome. However, caution must be exercised as long as the probabilities of market success are difficult to estimate, at least accurately, because of different reasons (Freeman and Soete, 1997) including: time to market and time for market development (in some cases, more than twenty years); impossibility to predict competitors' future reactions (especially in oligopolistic sectors) or consumers' trends; difficulty to forecast future sales revenue and profit (especially in the case of previously inexistent products); and obsolescence that may kill a product or process even as it is launched.

Also, differences in terms of risk and uncertainty may be a matter of degrees. Uncertainty/risk associated to radically innovative projects is hardly ever measurable and insurable (Freeman and Soete, 1997). Uncertainty and risk affect costs, but particularly affect the management of projects because decision making becomes extremely difficult and necessarily tied to learning "on the spot", that is learning how to react to and manage unforeseen events and circumstances in the middle of those themselves.

Moreover, innovation type (product *vs* project) involve differences that regard also intellectual property protection (hence, return appropriability) and tangible collateral availability (hence, leverage), which influence project owners' and potential investors' preferences/decisions.

These decisions affect the way in which innovation occurs in an organisation as long as they affect the protagonists, the processes and the mechanisms of knowledge production and utilisation in whose regard no objective guidelines exist to make "good" strategic decisions on the learning process/strategy[4]. This takes us closer to the view sustained by Keynes (1936), supported by Freeman and Soete (1997) and endorsed here, that "animal spirits" underlie subjective estimations of expected results and value in highly innovative projects.

A final issue regards the difference about developing single projects or project portfolios. This is relevant as long as there are project-based firms, namely, start-ups such as university spin-offs that are conformed because of and around the development of a project and, on the other side, there are established firms that own a variety of innovative projects that are to be seen, at least in budgeting terms, as a portfolio (Freeman and Soete, 1997). These differences impact strategy as shall be seen later.

4.1.2 The dilemma of the demand-for-funds side. How is innovation funding decided by owners/managers? Do they consider internal and external financing sources simultaneously? To answer questions like these, one should start by thinking of the reasons to prioritise the recourse to either type of funds.

There are three orders of reasons that might favour the use of internal funds by project owners. To begin with, the relative abundance of liquidity could be a first motive if that involves low risk aversion and no competing lower risk (less innovative) projects in the company portfolio (Freeman and Soete, 1997). A second reason, not entirely independent of the prior one, is the scarcity of external funding or its availability at high costs due to high risk aversion or the presence of more attractive, competing, lower risk projects.

The third rationale to use internal funds has to do with strategic reasons rooted in competitive dynamics, which can be referred to in terms of not losing or putting at risk the potential first-mover advantages summed up in terms of: profitability, leadership and

innovation lead time, temporary monopolistic position. Even if project results cannot be properly forecast, intuitive strategic expectations about the potential of a project may be enough to back up internal financing. Furthermore, financial slack (low leverage) becomes an issue in the attempt to secure the continuity of the company's competitive strategy, particularly in times of scarcity (O'Brien, 2003).

Now, first, the use of external funds may have to do with insufficient internal funds, or, second, the availability of external funds whose cost is lower than that of internal liquidity (that can be used in less risky investments). A third reason may be of strategic nature such as the externalisation of risk and costs through sharing (e.g. joint ventures on innovation), which implies the readiness to share at least some of the expected first-mover advantages according to the type of financing agreement.

In some cases, extreme versions of such motivations have even further implications as the case may be when a project-based start-up is sold out to an established company at an intermediate stage of project development or when the innovative company specialises in developing innovative projects for other firms (R&D outsourcing). The use of external funds is also related to some characteristics of prospective external financiers as shall be examined below.

The validity of these reasons is linked to certain characteristics of project owners and their overall situation at a given time. Would-be and recently founded project-based start-ups, for instance, are usually micro- or small-sized firms and do not have internal funds, so they need to look out for external financing and the available options within reach may range from family and friends to government funding to venture capitalists. On the other end, big, established firms with long R&D experience may resort to a combination of internal and external funding and strategic reasons may dictate different possibilities that include most of the extant financing sources (Figure 2).

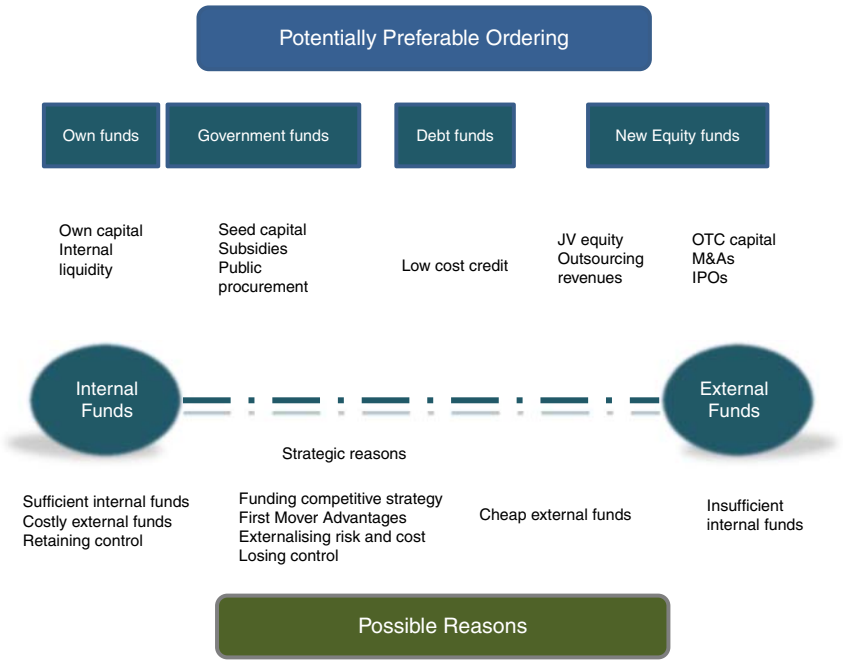


Figure 2.
Project owners' perspective

Source: Author's own elaboration

4.1.3 The reasons of the supply-of-funds side. Two issues seem dominant in the consideration of the finance supply side. First, which funding sources are available and how ready are they to pool funds, and, second, why would they fund a project.

The variety of potential innovation investors can be summed up as follows: governments can provide pre/seed capital, subsidies, low-cost loans, and can support innovative projects through public procurement; banks (e.g. commercial, investment, first and second tier) supply credit funds; established companies provide equity through a number of mechanisms, from equity-based joint ventures to outsourcing to mergers and acquisitions; specialised investors (venture capital funds and angel financiers) provide risk financing and take part in the bond and stock market; and non-specialised investors (including individual investors) provide OTC capital and may acquire bonds and stock.

Which investor categories are present in a setting (country, sector) and under which conditions do they operate is particularly important. The potential reasons for external investors to fund innovative projects can be grouped into: expected high profitability (banks, specialised and non-specialised investors, including established companies); strategic reasons of different orders (governments and established companies); and other reasons (friends and relatives) (Younkin and Kashkooli, 2016; Sierra, 2018).

In the first case, standard financial assumptions apply: the higher the risk, the higher the expected returns. That does not imply that returns achieved will be equivalent to the expected returns, though.

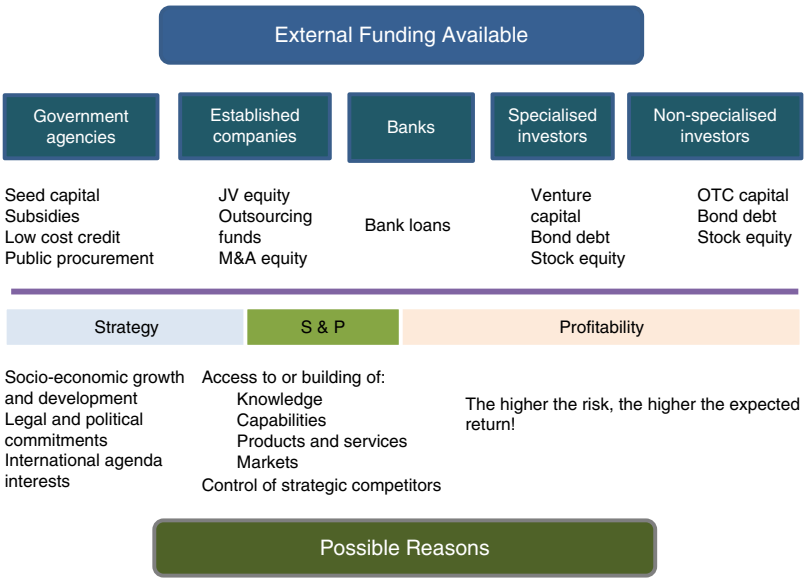
In the case of the strategic motivations of governments and established companies, the underlying reasons do differ. Government strategic reasons are usually of macro nature and are embodied by public policy design and implementation concerning socio-economic growth and development goals, legal and political commitments, and replies to international agenda interests. Expected returns assume the form of social returns that are widely appropriable by different actors.

The reasons of established companies are visualised at the micro/meso level where business competitiveness is the main driver of strategic moves to become dominant in markets/segments, to lead the run for sectoral leadership, and to improve revenues and profit altogether. Their reasons have to do with access to or the building of knowledge, capabilities, products and services, markets and the control of strategic competitors in such areas (Figure 3).

The characteristics of external financiers play a role in their interactions with project owners. Venture capitalists and business angels, for instance, differ in their screening procedures, *ex post* involvement in investments, exit mechanisms and times, and expected returns. Such differences seem to explain the dissimilar contribution of business angels and venture capitalists to start-up financing in the USA (Mayer, 2002, p. 317).

Actually, capital investors differ in their criteria for selecting projects: financial investors favour potential return as set out in business plan; technology investors favour technology protection, contact with investment manager and product uniqueness; and people investors favour human factors such as leadership capacities of the entrepreneur and quality of the team (Knockaert, Clarysse and Wright, 2010). Technology investors also manage significantly less capital than people investors, are more heavily funded by public sources than financial investors, and fund projects during the seed phase much more often than other investors.

Thus, the behaviour of venture capitalists is influenced by their characteristics and their interaction with project owners on the basis of their own traits and project features. This premise might be extended to other funding sources; government agencies devoted to fostering innovation, state-owned and privately-owned banks, non-specialised investors and established companies, ready to invest in innovative projects, are likely to exhibit distinguishing features



Source: Author's own elaboration

Figure 3.
Potential external funders' perspective

and preferences regarding investment partners and projects that will be reflected in their investing behaviour[5].

Hence, it may be asserted that the interaction of the parties' (financier and project owner) traits may be better explained in terms of the strategies that each party designs and follows in relation to innovative projects.

4.1.4 Demand and supply matching: a continuum of preferable funding options. The considerations made above have different implications on the preferences of project owners as to the funding sources to be used. First, the interplay of different reasons and the uncontrolled conditions external to project owners may not necessarily produce a given ranking of preferred sources. In fact, there are many cases in which the proposed hierarchical order of the available sources[6] preferred by project owners may change due to factors such as expected future liquidity constraints, high asset specificity, stockholders/managers' individual characteristics, preferences and perceptions on external financiers' capacity to handle information asymmetry, and financial innovation (new funding sources and mechanisms) (Saltari and Travaglini, 2001; Hogan and Hutson, 2005; Atherton, 2009; Sierra, 2014; Nirjhar *et al.*, 2018).

Second, even if there is an ordinal set of preferred financing sources on the demand side, there is a high probability that the effective observance of such hierarchical preferences be challenged by potential external financiers because of their own preferences or because of changes in meso/macro conditions over time that might affect a whole economy or specific sectors/activities in particular.

Hence, it seems advisable to refer to a continuum of preferable funding sources that are loosely and flexibly ordered according to the reasons of innovative project owners. That continuum admits either the extreme cases of using only internal or external funds or different combinations of both types.

Also, combinations of financing may be not as simple and are necessarily not fixed over time. For instance, nothing prevents the possibility that a start-up company founded by a

university researcher may be financed by "internal funds" represented by own, friends' or family funds (OTC capital) and, simultaneously, by external funds in the form of government seed capital[7] and private venture capital. Furthermore, over time, such a project-based company may find fresh funding from equity investors, be absorbed through an M&A operation by a bigger established company or be listed to incorporate external funding through an IPO, for instance (Sierra, 2014).

On the other side, the available sources of financing do not necessarily conform to the ordering of preferences held by project owners. To begin with, some funding options may simply not exist in a given context (country) or may be utterly unsuitable to be used by project owners (e.g. underdeveloped capital markets).

Also, investors' characteristics may condition access by project owners. Investment objectives, time horizon and exit times, and capabilities differ among venture capital investors and are also different in the case of business angels; banks usually set very harsh conditions (e.g. collateral) to grant high-risk loans; government funds are prone to follow macroeconomic and political shifts; and established companies adjust their strategic investment interests/actions following variations in their inner and outer milieu (Sierra, 2014). They are all affected by macroeconomic variables and policies such as interest, exchange, inflation rates, long range policy (e.g. industrial/innovation policy), as well as other key socio-economic and political factors that help shape the strategic intent of all the relevant players engaged in financing innovation.

Hence, it is proposed that the matching between funding sources preferred by project owners and available financing options goes well beyond a fixed ordering of fancied sources. It implies a complex interplay between the characteristics and reasons of each player and the role of the systemic conditions of the setting where such a coupling takes place.

4.2 Demand/supply relational dimension

Two aspects are central to understand the matching possibilities of project owners and investors: the matching environment and the mechanisms that grant the meeting of funds supply and demand; and the conditions under which the two parties interact and reach an agreement.

The matching environment and mechanisms refer to where and how are project owners and funders able to find information about their potential business partners. This is a variable characteristic of the macro/meso environment (country, region, sector) that depends on the existence of agencies implementing innovation public policy, venture capital funds and associations, a well-developed stock market where bonds and stock of innovative companies can be traded, and innovative companies incubators/accelerators and supporting organisations.

The second issue regards how and under which conditions do project owners and external financiers relate to one another. It is when the actors' reasons come into play. Financial and strategic reasons will compel project owners to look for appropriate available external financing and potential external funders will pursue those projects that better fit their profitability goals and strategic reasons.

The matching probabilities are a function of the quantity and nature of projects "on the market" (any competing ideas? which projects are perceived as more feasible?), the availability of funding sources (specialised investors? government funds?), the characteristics and preferences of project owners (are they start-ups or established companies? how experienced are they research-wise?) and those of potential financiers (knowledge/preference for specific sectors/projects?).

Once the initial contact has been taken, the interaction will revolve around the conditions for entering into a formal contractual relation. This is when strategic decision making will shape the relationship. Project owners and potential financiers characterised by such a

variety of traits, preferences and goals will design and implement different strategies to compete[8].

Hence, the innovation-based competitive strategy of a company will have an impact on the decisions that regard such firm's capital structure. Firms will value innovativeness differently if they mean to be leading innovators, fast followers or low-cost mass producers (O'Brien, 2003), which means that risk, uncertainty and costs faced by each player are different[9]. This view complements stereotypical systems of corporate governance and finance that arise in different environments (Tylecote and Visintin, 2008) and shape firms' funding behaviour.

4.2.1 Conditions for effective interaction. Innovation strategic decisions regard a sort of interpretive process that takes place in the middle of an unceasing learning process. It necessarily involves adapting to favour matching the motives and strategies of preferred business partners[10].

Thence, resource allocation to innovation may be ideally characterised as a developmental (resources must be committed to irreversible investments with uncertain returns), organisational (returns are generated through the integration of human and physical resources) and strategic (resources are allocated to overcome market and technological conditions that other firms take as given) process (O'Sullivan, 2000). Innovation should be supported through corporate governance via the generation of three ideal conditions: financial commitment to counter investor's short-termism, organisational integration to facilitate in-house learning and help contain knowledge spill-overs, and insider control to strengthen strategic decision making.

This implies that funders should deeply understand projects and be able to make decisions as projects evolve. Altogether, such conditions guarantee a better organisational control of the critical inputs to innovation (knowledge and money) in contrast to market control.

Now, the question is how do strategies interact to facilitate the matching between fund seekers and suppliers? A first issue regards keeping enough financial slack (low leverage) to secure the continuity of the company's competitive strategy in times of hardship[11]. This is more likely to be the case of established firms that have had the chance to build up some internal liquidity, to accumulate some R&D experience, and to earn a certain reputation concerning their innovative capacity to support their strategy implementation. Seed-phase firms or start-ups may not be in such condition and may need to use a different funding strategy to support their innovation activity, including the recourse to OTC equity. This implies that there are two categories of innovators that might appeal to different external financiers[12].

Since the information asymmetry gap can never be completely filled up, the use of internal funds or close substitutes such as OTC equity will send a good signal to potential external financiers that project owners do believe in their own proposal despite the (fundamental) uncertainty and risk involved.

The relational dimension among innovative project owners and potential external financiers depends on the role played by the characteristics of each player, the characteristics of the project, and the innovative/financial strategy that each actor pursues to bridge differences and build up trust (Hallen and Eisendhardt, 2012). The only evident boundaries of this interaction regard the availability and readiness of players in a given setting. Everything else is a part of the game itself where meso and macro dimensions have a function as proposed in most systemic approaches to innovation.

Project owners can establish multiple possible interactions with as many potential external financiers as are available and interested in their projects, and investors of all kinds may explore a wide range of projects and may establish relations with other funders. The divergent characteristics of both project owners and financiers may determine diverse strategic approaches to interaction and such diversity is enriched by the relevant institutional and macro features of the context where such interactions take place (Table IV). Since there is no standard heuristics to secure a successful supply-demand match, the end results can only be

Exogenous factors		
Funds demand	Project characteristics	Funds supply
Preferences and reasons Cost Availability	Innovation/Uncertainty/Risk Degree Development placement (in-house/outsourced) Usage setting (internal/external) End result (product/process)	Preferences and reasons Relevant competing funders Expected profitability
	Matching environment and mechanisms	Characteristics Investment base Time horizon and timing Investment structure Entry stage Exit mode
Strategy: First-mover advantage Financial slack Risk/cost/profit sharing Business model	Where and how info about potential partners is available Innovation public policy agencies Investors associations Developed stock market Incubators/accelerators Other supporting agencies	Strategy: State/government Political agenda Public policy Company Market/segment lead Knowledge/capability building Other (OTC)
	How/under which conditions can potential partners relate	
	Conditions for interaction	
	Interplay of strategies (preferences and reasons) of potential available investors and investees Signals to third parties	
Investees' behaviour		Investors' behaviour
Project selection criteria		Project selection criteria
Systemic specificities of milieu		

Table IV.
Key elements of alternative approach

Source: Author's own elaboration

assessed *ex post* when tangible project outcomes – from sheer rejection at initial screening to full success at late stages – are known.

In short, funding demand/supply matching is determined, other than by exogenous factors, by the strategic motives of investors/investees, which are shaped by the characteristics of projects and mediated by the matching environment/mechanisms and the conditions that allow potential partners to reach an agreement or not. Matching refers to project selection and management, and the outcomes involve a range of possibilities. Thus, this approach overcomes the failures of traditional purely financial explanations and presents a more realistic account.

5. Closing remarks and implications

An exam of an economy, be it emergent or developed, shows that typical POT funding choices are not standard practice among innovative companies. Furthermore, it also shows that normative proposals on this regard are not entirely feasible since contextual conditions, the availability of financing sources/mechanisms and actors' strategies may challenge theoretical expectations as shown in the case presented.

We consequently propose that funding innovation is not simply a matter of innovators' (companies) preferences favouring some financial sources/mechanisms over others, as stated by the proponents of traditional "pecking order". The features of projects, particularly highly innovative ones, and the characteristics of both companies and potential funders become inextricably intertwined by way of their strategic reasons/behaviour in the search for a business partner and help determine several POT-related preferences.

The allocation of resources to innovation and the formulation and implementation of innovation-based competition as strategic activities render all decisions around innovation funding strategic by default. Hence, the matching of the players involved does not depend exclusively on the cost of funds because a number of non-financial reasons and circumstances may reverse a seemingly cost-effective range of preferences. This is particularly true because strategy, when referred to highly risky and uncertain innovation, is essentially emergent as it refers to a "learning-on-the-spot process" and this seems to be an accurate description in the case of both innovative companies and their potential financiers.

Moreover, the matching of both sides' reasons and strategies is also affected by a number of contextual factors that beget a myriad of variations. Such coupling possibilities may be modified over time and this opens the way for further deviation. This is the basis of a proposal whereby no fixed ranking of funding preferences exists among highly innovative companies, but there is rather a continuum of possible funding sources/mechanisms where the most favourable ones will be determined by the interplay of the actors' reasons and the environmental conditions, according to the characteristics of projects and a given set of circumstances.

Higher innovation/uncertainty/risk projects with intangible outcomes aimed at new external markets and showing difficult appropriability (IP protection) pose harder decisions to both, investors and investees, in tough matching environments. Furthermore, the proposed approach explains emerging paradoxical situations in given contexts better than the traditional financial theory and help diagnose an STI system more accurately.

This framework has serious implications for the different parties involved in innovative projects financing. For companies, it means that strategic decision making on innovation should be considered under a different light as long as closer interaction between CEO, CFO, and CSO positions and domains is capital for a better formulation and implementation process wherever innovation is the ground of long-term competitive strategy. This may, in turn, have further repercussion in organisational terms at different levels concerning knowledge management and strategic decision making in general.

For fund providers of different kinds, it entails a further effort to understand the subtleties of innovation processes within companies of potential interest and, relatedly, a need to comprehend competing funding sources that may somehow be not only potentially strategic counterparts, but also beneficial partners under certain conditions and in particular settings (e.g. access and exit opportunities, new knowledge and capabilities).

Finally, policy makers and practitioners need to devise better support measures to assist innovative companies, especially when these struggle to develop their strategic activities in a constantly changing environment that may even restrain and threaten not only profits, but highly convenient socio-economic outputs.

Notes

1. Lots remain to be investigated about the way in which other innovation producers (e.g. HEIs, research centres, technological parks) fund their STI activities.
2. The authors follow Knight's (1965) distinction between "measurable uncertainty or risk proper and unmeasurable uncertainty or true uncertainty" (pp. 243-244).
3. The analysis of the benefits derived from successful innovative projects goes beyond the calculation and distribution of financial profits and includes the analysis of the social benefits or losses produced by successful and failed innovation projects (Stoneman, 1983). This means that not only firm value and stockholders' profits should be accounted for, but all the effects on different actors that eventually get involved in the "innovation wave" should be taken into account (Perez, 2004).
4. Fern *et al.* (2012), for instance, provide interesting insight into variations of this by discussing the role of knowledge in the formulation of strategy in new ventures and bring forth interesting contrasting aspects that arise under different circumstances.
5. A very illustrative case has been raised through the exploration of corporate venture capital investment made by larger established firms in young ventures, where the financial goals of both parties are generally dominated by their strategic objectives (Dushnitsky, 2006; Basu *et al.*, 2011).
6. The varied characteristics of the different types of bonds and equity and their implications for the financing strategy add to the complexity of the decision making (Becchetti and Sierra, 2002, p. 13).

7. Government equity/loans is considered on its own because its nominal cost is usually lower than that of private funds, though red tape may effectively hinder the use of such funding source.
8. In fact, "if competitive strategy guides the firm's investment decisions, and the choice of investments can influence the choice of financing, then we should expect that different capital structures best serve the needs of different strategies" (O'Brien, 2003, p. 415).
9. Empirical evidence supports that the "intended strategy (i.e. **attempting** to compete on the basis of innovation) impacts financial slack, and that the interaction between strategy and slack, in turn, influences performance" (O'Brien, 2003, p. 428).
10. The ties among firm strategy, corporate governance and innovation become evident as "[…] the relation between investment in productive resources and economic performance depends on who makes investment decisions in corporate enterprises, what types of investments they make, and how returns from investments are distributed" (O'Sullivan, 1998, 2000).
11. Particularly, avoiding cash volatility to secure R&D funding, ensuring funds to take new products to markets, supporting M&As to expand knowledge stock (O'Brien, 2003). This is compatible with a sensible interpretation of POT.
12. Studies have found evidence which suggests that firm heterogeneity is more important than industry and time effects in determining capital structure and, particularly, that "the relationship between traditional financial variables and capital structure might be contingent upon the firm's strategy" (O'Brien, 2003, p. 418).

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