

New tools and practices for financing novelty: a research agenda

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Abstract

Purpose – The expectations surrounding innovation as the principal mean by which firms gain a sustainable advantage while simultaneously alleviating social problems are tremendous. However, in the process of developing innovation, many small entrepreneurs, SMEs, as well as large firms struggle to access the necessary finances in order to further develop their innovative projects. The purpose of this paper is to underline some of the most recent tools and practices used to finance novelty.

Design/methodology/approach – This paper synthesizes some thoughts about the financing of novelty and proposes a research agenda based on trends highlighted in the recent literature.

Findings – This paper pinpoints recent advances in finance applied to the field of innovation. In particular, this paper highlights both promising developments as well as the need for more research in this area in order to untangle the links between creativity and financial support, the financing of innovation in developing countries, accounting and evaluation of ideas.

Social implications – The importance of developing innovation and easing access to resources has societal implications. The development of education around finance and entrepreneurship, as well as improving literacy of citizens in these fields could yield a more open view on innovation and financial supports in the future.

Originality/value – Financing novelty, evaluating projects and facing uncertainty are among the most difficult decisions investors take. This paper combines many dimensions of innovation and finance to construct an overview of current and future practices within both domains.

Keywords New technology, Innovation, Corporate finance, Financial institutions, Financial innovations, Venture capital, Financial market, Corporate venturing

Paper type General review

Joseph Schumpeter was among the first economists to accurately describe the links between an economy's innovative capacity, corporate performance and the functioning of credit markets. He is well known for his description of economic cycles, the qualification of different types of innovations and the central role he gives to the entrepreneur. He is less known for his analysis of financial markets and particularly the role of banks. However, he gives a significant place to these themes in his work (Boutillier, 2019). For him, innovation requires appropriate financing. In a capitalist society, the role of the banker is to raise the necessary funds to achieve the new combinations of innovations. Today, traditional banks are fleeing the uncertain innovative activities of start-ups. The latter must then seek alternative financing such as venture capital, crowd lending, etc.

Our objective in this paper is to show the importance of the links between finance and innovation. Thereby, we outline a research agenda to answer some of the pitfalls of the current state of knowledge and some future challenges. However, we do not aim to provide



an exhaustive description of all possible sources of financing for innovation. Firms differ widely in their financial needs. These needs depend on the life cycle of the industry in question, general macroeconomic conditions and of the strategic orientation of the firm. Many other factors come into play by, e.g., an incumbent company will not have the same cost of capital as a new entrant.

Today, it is clear that some financial bubbles can be interpreted as massive processes of making credit available in order to install new technological revolutions. We also know that innovations do not appear in a linear way, but appear in waves and are less the fruit of a sole entrepreneur but rather the outcome of cumulative knowledge exposed to interaction in a cluster or an ecosystem. Therefore, financial models that essentially follow a Gaussian law are often inadequate to capture the true relationship between finance and innovation (Heraud *et al.*, 2019).

In this paper, we first focus on the historical actors in innovation financing, namely banks, financial markets and public actors. Their role has changed considerably in recent years. Then, we will discuss the use of a small set of managerial tools and techniques, which we selected to highlight the many problems that appear at the intersection of finance and innovation management. We will demonstrate that some financial management tools are not neutral when they are used on innovative projects. Finally, we will discuss new sources of financing for innovation and outline a research agenda.

1. Classic actors in innovation financing

1.1 *Financial markets, aid or impediment to innovation?*

Today, nearly 20 percent of European companies abandon their innovation projects because of difficulties in accessing the financial market (Parpaleix *et al.*, 2019). Some then turn to other sources of financing, with self-financing remaining the main financial lever for three quarters of them to carry out innovative projects (Nylund *et al.*, 2019). The share of firms financing their innovative projects internally has fallen sharply in the past 10 years, with the USA cutting their financing in half. Listed companies prefer to use their cash flow for share buyback operations that are favorable to their shareholders, at least in the short term.

Uncertain projects whose results are only perceptible in the distant future are often penalized by the financial markets. When in 2006 Microsoft announced that it would embark on an expensive and uncertain project to compete with Google's search engine, its stock market value fell by 11 percent within 24 h. Microsoft's market capitalization has therefore lost several billions simply because this announcement does not correspond to the type of risk associated with an innovative project that the markets want to take. Fortunately, this company has sufficient financial resources to cope with this type of variation, but it is certain that a smaller company would not have survived. This example illustrates the impact that financial markets can have on innovation. However, there is no rigorous work to determine whether it is the different needs of companies that lead to different forms of financing or whether it is the different forms of financing that lead to different innovation proposals in companies (Nylund *et al.*, 2019).

It has been established that financial markets are ineffective in financing highly innovative projects and that this difficulty increases when the project is at a stage far from commercialization. Research in basic science, far from markets, is not a product like any other and its financing is difficult (Levin *et al.*, 1987). For this reason, some actors have specialized themselves in different stages of the invention-innovation process (business angels in the upstream phase, then venture capital for the industrial phase, see Figure 1 for some examples). Nevertheless, many studies indicate that this form of financing limits the originality of the discoveries and reduces the overall performance (Mazzucato, 2013). This is notably due to the fact that each of these actors only thinks of disengaging as quickly as possible by pushing the project to the next stage (and therefore into the hands of another funder).

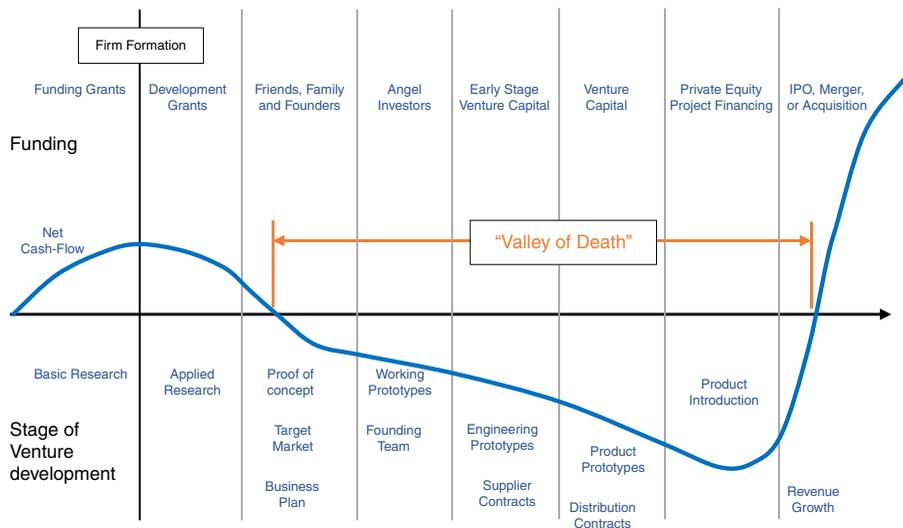


Figure 1.
Multiplicity of actors
in innovation
financing

Source: Authors' compilation

Financial markets sometimes show exuberance when it comes to financing (and evaluating) technology projects. The internet bubble which was carefully nourished between 1995 and March 2000 before it burst is the iconic example. In 1995, internet companies promised fantastic growth potential to which financial investors responded by providing massive capital (e.g. the since disappeared Netscape company reached a market capitalization of several billion dollars in just a few trading days). Financial valuations quickly became unrelated to the turnover of companies until the bubble burst and nearly 4,000 companies linked to the internet economy disappeared. Even strong start-up economies suffered from massive down turn and feared that they could no build another venture capitalist activity in the near future after such a massive burst (Senor and Singer, 2011).

To focus on innovative, small and growth oriented firms, specific stock markets are created to facilitate their access to finance (Carpenter *et al.*, 2003). They go by names such as Junior Stock Markets or Second-Tier Stock Markets. Some markets that specialize in innovative firms are well known like NASDAQ (USA), AIM (UK), Euronext Growth (France), AIM Italia (Italia), Mothers (Market of the high growth and emerging markets) and JASDAQ (Japan) (Granier *et al.*, 2019). In recent years, these markets are increasingly seen as less of a solution but as a source of additional problems (Eberhart and Eesley, 2018).

1.2 Private banks: a supply or demand problem?

Recent financial crises show the inability of traditional financial models to understand how risk is accumulated (or even hidden) through different financial innovations (derivatives, credit default swaps, etc.) (Eberhart and Eesley, 2018). Many studies emphasize that a company's risk is not well measured by banks, especially when the company operates in an innovative sector or when it is itself innovative (Carpenter *et al.*, 2003). Banks have difficulty distinguishing the origin of the risk faced by the company and do not know how to evaluate business models that incorporate innovations. Indeed, these models are essentially based on intangible assets that the bank cannot resell in the event of the company's bankruptcy. Innovations, uncertain by nature, also incorporate strong information asymmetry – the potential innovator always knows more about his real chances of success than the bank

itself. In addition, if the innovative company succeeds the bank only recovers the repayment of its loan in the absence of equity participation. As a result, the supply of credit for innovative companies is limited.

However, the financing of innovation also faces a demand problem. Indeed, there are not enough companies that want to deploy a growth strategy (Granier *et al.*, 2019). Also, SMEs have specificities when they search for access to financing but unfortunately, those with innovative projects appear to be the riskiest and do not receive financing. If there were more innovative companies seeking financing, they would not appear as a potentially risky investments compared to the mass of requests for financing of more profitable projects.

With regard to the varieties of capitalism, we know that in a financial environment that favors equity participation, such as in Germany or Japan, banks are more patient in obtaining the results of innovative projects than in countries with shareholder capitalism that are more driven by speculation and short-termism (Tylecote and Visintin, 2009).

1.3 Public financing, the new strategic player

The global R&D capacity in OECD countries, as measured by public and private investments, doubled over the period 1990–2014. This increase in global R&D capacity can be explained in particular by growth in business spending, which has expanded faster than public expenditure in R&D. The financial crises that marked the period (the crisis of emerging countries in the early 1990s, the start-up crisis of the new economy in 2001 and the financial crisis of 2008) have led to cyclical reduction in companies' R&D investments. However, the behavior of companies is rather counter-cyclical, in that they rely on innovation to restart the growth of their activities (Archibugi *et al.*, 2013). The strong growth of overall R&D investment over the period 1990–2014 is also explained by the sharp increase in spending in emerging countries such as China, which can be compared to the decline in the triad countries: the USA, the European Union and Japan.

Moreover, according to Archibugi and Filippetti (2018), from 1981 to 2013, the share of public financed R&D to GDP in OECD countries was reduced from 0.82 to 0.67 percent. By contrast, the industry financed R&D was increased from 0.96 percent GDP to 1.44 percent during the same period. While public research remains predominantly funded by national government, the share of industry funding for public research has increased since the 1980s, with universities taking the lion's share of private funding, through public-private partnerships (OECD, 2016). Another important trend in the evolution of public funding is the change in the modes of allocation of research funding that have blurred the formerly well-established boundaries between competitive and non-competitive funding instruments (OECD, 2018). It means that whereas research remains an important component of public budgets, the way funds are allocated is changing and the various implications need to be scrutinized.

The European project, known as the Lisbon Strategy, which aimed to make Europe the leading knowledge-based economy with 3 percent of each country's GDP devoted to R&D is a failure (only Finland, Denmark and Sweden have reached or exceeded the 3 percent figure). However, in addition to these dismal figures, we find other results for Europe that are much more positive. Roughly one half of European companies declare themselves innovative and this figure is confirmed by the fact that 14 percent of their turnover comes from products created less than two years ago. Europe remains very active in patent filing (Pénin, 2012). It is therefore reasonable to say that Europe embraces a culture of innovation and that private and public actors are increasingly dynamic and determined.

France, e.g., is deploying an impressive set of public measures in favor of innovation (future-oriented investment program PIA1, 2 and 3, IDEX, LABEX, EQUIPEX, SATT, ANR, etc.). Combined with existing structures of competitiveness clusters and investment banks (BPI France) and a research tax credit (the impact of which has been to maintain

existing innovative activities rather than create new ones), France became more strategic in its innovation financing. However, as recent research has highlighted, the effect of tax cuts on innovation are very difficult to predict (Bell *et al.*, 2019). While some of these measures are more a result of the reconfiguration of existing aids and structures than a real creation, they have positive outcomes. In particular, public funding, although still mainly present during the basic research phase, has in recent years investigated the entire funding cycle. The aim is, among others, to reduce the size of the so-called “valley of death” where innovators are suffering a notable lack of finance.

Figure 1 illustrates this situation with a set of public actors acting as a relay before the strongest private financiers intervene (although, as we have indicated, fragmentation of fundings reduces the productivity of innovative systems).

In Figure 1, the majority of public actors are present on the left when research is in its basic science phase. Private actors, called Business Angels, appear as soon as a researcher highlights the potential of an invention (measured in particular by its patentability). The path between invention and concrete economic application is long, valley of death refers to the large number of patents that never find concrete industrial application. A deeper analysis between the more traditional financial market and newer financial vehicles can be found in the literature (Parpaleix *et al.*, 2019). The authors make it clear that firms still struggle today to find financial products to finance risky projects whether they are in stable or unstable environments. More recently, public financed firms, or state-owned firms changed the way the innovation cycle can be split between public and private actors (Chang *et al.*, 2019; Wang *et al.*, 2019).

A more strategic vision of public actors seeks in particular to reduce the risk of crowding out, i.e. the replacement of private financing by public financing (Dosi *et al.*, 2006). However, this situation is very difficult to quantify. Mazzucato (2013) details famous examples of public funding that has enabled the creation of inventions used commercially by the private company Apple. If the private company Apple, which benefited from these inventions, had paid its taxes, this commercial success would have benefited public actors and the entire economy through a clear redistribution mechanism.

Finally, numerous studies show the very positive impact of public financing of innovation to create a new market. Indeed, many economic models attempt to improve the functioning of certain markets through public investment. We now know that the public actor plays a more important role, that of creating a market where private investors do not dare to venture in the first place (Mazzucato, 2013). By, e.g., innovations in green technology and in the green economy sector still very much depend on public funding.

2. Decisions to finance innovation within companies

The three tools or concepts often used to guide business innovation investment decisions are biased. These are the net present value (NPV), which suffers from an underestimation bias of the actual return on a project, the calculation and use of sunk costs that are highly sensitive to competitive conditions and the return per share that is highly influenced by the time horizon of decision makers. These are not bad tools *per se*, but the way they are used is often inappropriate. Christensen *et al.* (2008) suggest other methods for using these tools to support innovation financing decisions.

2.1 Net present value

The NPV calculation is a simple discounted cash flow calculation. The formula implies that a rational investor will be indifferent to receiving one euro today or to receiving that euro in a few years with extra interest. The formula is simple and well known, but analysts often make two mistakes that lead to a rejection of innovation investments. The first error is to compare the result of the NPV calculation to the current situation, implying that if the

company does nothing, it will preserve the same financial flows without them declining over time (in this context, one even wonders why it should invest in an innovative project!). It is true that predicting the decline of future revenues is just as difficult as predicting the revenues generated by a new investment. However, this approach drastically changes the investment acceptance thresholds.

This difficulty in predicting future flows is the source of the second error. To cope with this relative unpredictability of figures, decision makers use highly sophisticated mathematical models to determine the value of the parameters to be used. However, extreme sophistication, if accompanied by a lack of control over the underlying assumptions, is a source of error and rejection of innovative projects. Many other tools have emerged since the diffusion of NPV. These new tools correct some of the errors, but also create new ones. The tools, however, are only part of the decision-making process as the behavior and opinion of the decision makers are often prove much more problematic (Bollinger Raedersdorf, 2019; Greve, 2003).

2.2 *Sunk costs*

When deciding whether or not to invest in an innovative project, only future cash flows should be considered, regardless of whether this makes existing tangible and intangible assets obsolete (O'Brien and Folta, 2009). Non-recoverable costs are fixed costs of a project that are not transferable to another project. If the project is abandoned, these costs are permanently lost. As a result, many managers choose to keep the old technology, at least for the time it takes to recover the initial investment, rather than invest in a new, more efficient, innovative technology. Unfortunately, the time required to make the initial investment is time that competitors can use to deploy new technology and gain market share. Managers equate the return on investment with its lifetime. However, in a market economy, the lifetime of a technology is essentially determined by competitive strategies (O'Brien, 2003).

To remedy this problem, several authors suggest not to evaluate the innovative project alone, but to evaluate the entire strategy within which this project is articulated. If the strategy provides a sustainable competitive advantage, it will be easier to overcome the bottlenecks caused by the sunk costs of a project belonging to an old strategy (McGrath and MacMillan, 2009).

A classical real world example of this kind of logic is given by the steelmaking industry. In the early 1950s, a new steelmaking technology became commercially viable: oxygen furnaces (OFCs). The OFCs reduced the melting time of steel to 40 min compared to 6–8 h with blast furnaces (BF), which had long been the industry standard. Despite the advantages of OFC technology, few American manufacturers initially adopted it and they increased the capacity of their conventional BF by 50m tones prior to replacing them with OFCs in the late 1960s. Meanwhile, new competitors adopted OFC technology, including Japanese and Korean companies, allowing them to sell their products at low cost in the US market (Laperche and Uzunidis, 2008). Why have US manufacturers continued to invest in less efficient technology? The usual explanation is to blame management. For example, industry observers have written that the reason managers are reluctant to adopt a new technology is that they all have the same thinking pattern, namely that innovations are risky and that it is better to wait for others to experience them before embarking on them.

Without rejecting the hypothesis of managers' short-sightedness and reluctance, other explanations can be put forward. During the first half of the twentieth century, American companies had developed considerable knowledge and know-how in the use of BF. Investment in the development of know-how represents an irrecoverable cost or sunk cost. This know-how was of no use in handling OFCs. This cost was such that for some time it was more attractive for American companies to continue working with BFs than to invest in OFCs and in the development of new knowledge and know-how.

Academic research shows that American steel manufacturers made their choice of technology based on a criterion of profit maximization. Consequential sunk costs are difficult for a company to ignore when it comes to making a technological choice. The presence of these costs differentiates American, Japanese and Korean manufacturers. Nevertheless, these differences are the source of the decline of the American steel industry in the 1970s and 1980s.

2.3 Earnings per share and performance measures

Companies listed on stock exchanges are judged at regular intervals as to their financial results and the variations that this implies for the shareholders of these companies. This approach leads many managers to make only profitable short-term investments in order to obtain regular financial results, to the detriment of investments that would be more strategic in the long term. Between 1999 and 2016, the share of financial resource US large companies dedicated to R&D investments is always smaller than the share allocated to share buybacks.

The puzzle about the optimal management of firm finance is intimately linked to the best way a firm should finance its innovation? Many authors compare the options of financing internally, externally, by debt or equity (O'Brien, 2003; Orlando *et al.*, 2018). Those decisions are also strategic because they impact the future governance of the firm. If a firm wants to preserve the liberty of decision making, debt is the preferred choice because the debt holder obtains no decision rights (or only when the firm is not able to pay back in time). The usual equity finance will give voting rights to the investor. However, pecking order theory suggests that this consideration is secondary and that only the cost of capital is considered.

The relation between firm innovation and firm performance is a conundrum (Pillai and Rao, 1996; Tkotz *et al.*, 2017). For established firms, it is both and antecedent and a consequence. Many researchers find a constant relationship between R&D intensity in a sector and the average profitability in the sector (Bartoloni and Baussola, 2018). The same relationship exists at the project level (Vittorio *et al.*, 2009). However, this relationship is not necessary constant over time at firm level especially in sectors where imitation is easy (Geroski *et al.*, 1993).

In troubled times, R&D is often one of the first expenses that managers cut. Unwisely because these investments in innovation are the solution to create new growth and recover from recession. However, culture and institution play an important role as well. Japan is a notable exception where R&D expenses increase when profit go down (Hundley *et al.*, 1996; Hurry *et al.*, 1992). Because of risk and exposure to financial market variation, profitable firms will limit their dependence on external finance for their R&D activities (Lai *et al.*, 2015; Wang and Thornhill, 2010).

In a nutshell, overall performance measures of firms are subject to many bias and limitations. When it comes to evaluation innovation performance, the traditional techniques are pushed to their limits. The existing literature on the two topics briefly presented (main external actors and decision tool used inside a company) are the source of a mammoth literature. The literature is constantly renewed, fueled on the one hand by new innovation management techniques and on the other hand by new financial tools. In the next section, we present some important topics that should attract the attention of researchers, innovation managers and financial professionals in the coming time.

3. A research agenda

There are many links between finance and innovation. In this section, we highlight some of the obstacles to the financing of innovation (multitude of actors, difficulties in evaluating internally, externally innovative projects, etc.). However, positive progress has been made in recent years: a more strategic public actor and the emergence of new forms of financing can

take over when traditional private actors fail. By, e.g., recent financial innovations such as crowd lending and crowdfunding complement the range of existing funding sources.

In the following section, we present some important topics that need to attract more research in the future. These points have in common that they impact both the decision maker and the traditional actors of the financial sphere.

3.1 *Aligning strategy, governance and resource allocation during the innovation process*

Competitive advantage of firms trickles down from the innovations the creative firms put in place. It is admitted that innovation is the best source for long-term competitive advantage (Chatzoglou and Chatzoudes, 2017). The logical order for a firm would be to attract resources, allocate them to innovative projects, obtain a sustainable advantage (creating long-term value) that attracts new investors, collect more resources, etc. The story is simple enough but executing it in reality is extremely complicated. It is well recognized that strategy and other essential activities inside a firm are not always aligned, leading to bad performance. The situation gets even more complicated when the strategy (and governance) needs to be orchestrated, harmonized, between several actors.

This is precisely the situation that became the new normal for many innovative firms. They innovate in groups, relying on open innovation. The literature recognizes the beneficial effect of open innovation as a practice creating long-term value for organizations by reducing costs and risks (Vanhaverbeke *et al.*, 2008). Open innovation is just one of many concepts that describe possibilities of collaboration between firms, ranging from co-opetition to alliances.

Many studies have investigated the potential benefits of open innovation (Ahn *et al.*, 2017). However, the capacity of firms to attract significantly more financing when they develop open innovation projects has yet to be proven. It is probable that such a complicated project can only be financed internally, e.g., and that banks react negatively to open innovation projects.

An additional research topic could be to develop real option thinking, strategy and finance. Real option is a tool born out of corporate finance. In recent years, it has become a more strategic or organizational tool. Therefore, researchers should try to do the road in the opposing direction to close the gap that appeared between finance and strategy (McGrath and MacMillan, 2009; Vanhaverbeke *et al.*, 2008).

3.2 *Financial incentives and managerial control techniques during the innovation process*

Among the difficulties encountered in carrying out an innovative project within firms, one point of divergence is particularly salient between innovative project managers and finance departments: they do not use the same management tools. Communication is particularly difficult between those in favor of using highly standardized tools that focus on traditional financial ratios and those who wish to move away from these indicators and use more interactive management methods. A recent study conducted with 169 project managers or financial directors showed that not only are there no universal tools used, but that each user also relied on a different set of tools depending on the maturity phase of the innovative project (Bollinger Raedersdorf, 2019). Thus, the ideation phase of the project is totally lacking control, but the more innovation becomes a reality, the more standardized tools are put in place. This lack of tools shared by the various participants in a project increases the risk of stopping the project or of it being poorly managed (Tkotz *et al.*, 2017). Finally, the use and impact of the tools partly determine the type of innovation that companies will obtain (marginally innovative or disruptive innovation). Because the tools are not the same, the evaluations differ and the incentives are not based on the same KPI.

Firms make decisions between innovation projects but also many other choices: advertising, quantity to produce, financing schemes and so on. Therefore, they have several portfolios (R&D portfolio, product portfolio, finance portfolio, etc.) that they need to balance dynamically over the long run. This balancing necessitates a more elaborate way than the venerable BCG matrix but

shares some of the financial logic. Whether a simple project, or a portfolio, new research about the tools and techniques used, especially about convergence in the usage of the tools between different fields (finance, marketing, innovation, etc.) becomes a necessity.

3.3 Funding for disruptive innovation vs marginal innovation

R&D activities are very specific. They are not evaluated as simple investments in production or logistics. Their uncertain nature impacts the decision-making process. The multiple interactions between R&D, uncertainty and investment decisions have given rise to an extensive academic literature (Bartoloni, 2013; Orman, 2015). The access to finance depends on a multitude of factors, sectors, size, age, including the geographic area (de Faria *et al.*, 2019; Hall, 2002). Czarnitzki and Hottenrott (2011), who looked at the links between finance and the type of innovation, found that the type of the firm (size) and the nature of the innovation have a strong influence.

Very few works, if any, properly differentiate between the nature of the innovation funded. Radical (or disruptive) or marginal innovation should not be judged by the same criteria, and should not be funded by the same actors. However, few investors are able to differentiate between the disruptive and radical innovation. Radical innovation requires financial resources that can be larger than the treasury of a specific firm allows. Therefore, additional sources of finance need to be located. At the same time, the radical innovations are by definition so different that it is difficult to explain them to people outside the firm.

Therefore, past market opportunities and market successes on R&D products influence the ability of firms to obtain finance in the future (Weng and Söderbom, 2018). The situation is firm specific. As a firm that is innovative and is able to bring the innovation to the market becomes better known for their successes, they often have better access to finance (Aghion *et al.*, 2004; Bragoli *et al.*, 2019). Moreover, the finance available for R&D is not constant over the long period and suffers from cycles facilitating or discouraging investment in radical innovations (Brown *et al.*, 2009).

The use of external finance is not always seen as the solution for radical innovation. One obvious reason is that firms worry about the additional risk if their ideas are leaked and that a fast second wins over the market (Markides and Geroski, 2004). For several authors, the research of external finance for R&D is an act of communication, a signal that is given to the market (Dziallas and Blind, 2019; Laperche and Uzumidis, 2008; Yao *et al.*, 2019). Under this approach, not all projects can be publicized to get external funding.

In our view, much financial work would gain relevance by being more specific in terms of the nature of the innovation studied. Radical or marginal, product, process or service, with or without patent or copyright, etc., are far from being the norm. In many quantitative studies, innovation is a simple dummy variable that does not allow one to differentiate the critical aspect of innovation.

More globally, due to high risks and uncertainty, the emergence of new streams of radical innovations (especially technological ones) contributing to a variety of societal challenges (sustainability, inclusiveness, gender equality, etc.) not only depends on firms' behaviors but also on public funding of basic research. The recent trends in public funding (see above) and the focus on the commercialization of research (triple helixes-based policies, entrepreneurial universities, etc.) have increased the tendency toward the privatization of knowledge or of the orientation of knowledge production toward the needs of private companies (Laperche, 2017). According to Archibugi and Filippetti (2018), such privatization of knowledge can have adverse implications for long-term innovation and economic welfare: no guarantee that market-led opportunities correspond to social needs and priorities; possible reduction in the diffusion of knowledge; possible obstacle to scientific breakthroughs, generated by basic research and carried out in public institutions. This challenge has certainly to be taken into account, especially in a social context characterized by a stronger demand for responsible research and innovation (Von Schomberg, Hankins, 2019).

3.4 Behavioral accounting and the financing of creative activities

Greve (2003) made it clear that the decision-making variables in innovation research need to be emphasized. Historical events explain many of the differences in innovativeness. Knowledge management or innovation process management differences are firm specific behaviors that explain a huge part of the difference in innovativeness, hence, in the valuation and financing of the firm. Those units are difficult to measure at the market level and even on a soft information level when discussing a credit with a bank.

The same can be witnesses about the notion of slack is recognized as having a positive long-term effect on firms' innovativeness (Suzuki, 2018). However, the relationship between slack and innovation depends on the type of innovation expected and the organization of the firm. Monitoring of the appropriate slack is especially challenging for firms. Suzuki (2018) precisely underlines that without a clear understanding of idiosyncratic contexts, it is very difficult to judge if slack is appropriately used. Hence, monitoring the usages of organizational slack is very challenging for shareholders. Corporate finance modeling, keen to use agency theory, should integrate such differences in the future.

Slack is one unit of analysis of all the constrains that happen in a firm. The usual reaction is to say that the more important the constraints, the less innovation and creativity are possible (García-Quevedo *et al.*, 2018; Hyytinen and Toivanen, 2005). A firm with greater access to finance and with more resources allocated to each project is more innovative. These results have been confirmed by many studies about the impact of financial constraints (Giebel and Kraft, 2019). Earlier in this paper, we highlighted public funding as a way to diminish those financial constrains or to facilitate the survival of small firm during the early stage of innovation development. However, some researchers have pinpointed that constrains, even financial constraints, may have positive effects on creativity (Woodman *et al.*, 1993).

Many companies today use so-called stage-gate processes to determine whether they are devoting more time and resources to an innovation project. The evaluation consists of an audit of the results obtained so far and an evaluation of the project's potential. Often, this stage-gate process only amplifies the biases we have just highlighted. The more innovative the project, the more inappropriate the stage-gate process is. In addition, project managers know which figures it is appropriate to highlight in order for project funding to be allocated. McGrath and MacMillan propose to start not with the assumptions of a project and then it is costing as is often the case, but with the indication of minimum figures for the project to pass the stage-gate, and then to determine the assumptions to which the project must respond for these figures to be reached. Finally, the progress of the project must make it possible to validate or invalidate the hypotheses, starting with the most important, simplest and easiest to test.

In the light of those results, it seems that behavioral accounting could bring many answers to the question we raised in this paper. Behavioral accounting focuses on the key decision makers as part of the value of a firm and examines how accounting practices and processes affect the behavior and processes of personnel working in the firm. Thereby, the development of this field of research can help us to explain the specific creative behaviors of some personnel under financial constraints and the way decision maker handle organization slack.

3.5 New vs traditional sources of finance

Large firms have easier access to external finance than small and medium firms (Cowling *et al.*, 2018; Nylund *et al.*, 2019). However, it is unclear if a specific entrepreneurial project has more or less chances to be financed let us say by VC as a standalone project or as an intra-preneurial project in a big company. Bootlegging among other novel techniques advocates that the battle for internal finance is strategic and reckless.

Crowdfunding (and crowd lending) is already extensively studied (Assadi, 2018; Assadi *et al.*, 2018; Chaboud and Caseau, 2018; Leone *et al.*, 2018). However, after the success of some financing platforms, it appears that the number of projects selected is relatively

small compared to the financing granted by traditional banking actors. The originality of the projects is a decisive factor for financing via these platforms. The amount funded is generally more modest.

Nonetheless, the implications of this new financing technique on firm innovativeness only start to be investigated (Chemla and Tinn, 2019). In their work, Chemla and Tinn proposed a model in which reward-based crowdfunding enables firms to obtain not only ideas but also a reliable proof of concept. This proof of concept allows them to test the intensity of the demand (via the crowd). In the light of the results obtained they can, or not, decide to invest and go to mass production. In this work, we see that a crowdfunding activity allows a firm to collect information about the demand and to learn about customer tastes and practices.

We think that we are only at the beginning of the information and knowledge exchange that will occur between customers, backers and firms. Not only will they exchange ideas and coproduce some of them, but we also believe that financing those activities in advance, during or after the realization of the product, will open a wide range of innovation financing models. These crowd platforms raise the question of reforming the financial system, so that it supports value creation through innovation rather than its extraction in favor of the financial system.

3.6 *The rise of non-traditional actors*

Creativity and innovation can be valued by markets in several ways or points in time, classically at the stage of the final product or earlier in the forms of patent (Pénin, 2012). But, as the open innovation model made it clear, ideas should and can be exchanged, traded and therefore valued. The market for ideas appears in many different forms (Natalicchio *et al.*, 2014). Those specific markets are created by firms or individuals, often they exist because non-traditional actors were aware of the supply and demand of those ideas. Boundary spanners are needed to facilitate the transaction and the emergence of a price, some call them knowledge angels by comparison with business angels (Muller *et al.*, 2015).

Besides those new actors, research centers and especially universities play a greater role in bringing finance and innovation. Growing links between invention, innovation, universities and financial markets come into existence. Historically seen as limited to basic research and depending on public finance, nowadays some universities develop explicit links with firms, are able to attract financial support for specific research projects and in some case collaborate explicitly with firms to obtain some industrial or public grants (Dosi *et al.*, 2006; Giannopoulou *et al.*, 2019; Öcalan-Özel and Péning, 2019). Future work should consider universities as active actors between the financial world and applied innovation and not corner them as sole basic research units.

Online crowd, as above reported, became another relevant non-traditional actor for financing innovation (Leone *et al.*, 2018). Crowdfunding opens new ways of financial contribution to both individual and organizational innovators. In the forthcoming years, researchers could pay more attention to how innovators using crowdfunding can mix different financial sources (and actors) with the crowd in order to develop and commercialize successfully new products and/or services. Another interesting line of research for scholars could be to explore if the crowd is just an “unorganized mass” or if some specific behaviors and preferences emerge when its members finance innovation.

The last of the non-traditional actors we would like to draw attention to are developing countries. Many works have highlighted the incredible development of frugal innovation and reverse innovation (Burger-Helmchen and Hussler, 2017). However, these stories concern mainly Asian countries or India. Africa has not been a center of attention for researchers in finance or innovation for a long period of time. This is about to change. Africa will probably not become the next hotbed for high-tech products, but many African deciders are orienting the continent toward a more innovative economy (Ayalew *et al.*, 2019; Nguena, 2019). The specificities that this continent exhibits raise many innovation financing challenges.

4. Conclusion

The present paper proposed a research agenda for scholars willing to explore and apply new concepts, tools, practices and frameworks for financing innovation. The suggestions just reported derive from the technological, industrial, entrepreneurial and organizational changes that occurred in all the business sectors over the last few years. In sum, the present paper offers a rich, heterogeneous and challenging set of ideas that scholars and practitioners in the field of innovation financing should consider when they decide to launch a new research project or to design and implement a company report.

Our final thought concerns financial and entrepreneurial education. The corporate finance literature establishes that maximization of profit/value is the main criterion for decision making including innovation-related decisions. Some limits to those approaches are well known (Grilli *et al.*, 2018). Nevertheless, much research has illustrated that the financial literacy of many citizen is weak and harms their decision in many domains (Aprea *et al.*, 2016). The same case has been advocated for education about entrepreneurship. Education should, at all levels, develop knowledge in finance, entrepreneurial competences and promote creativity. New education tools, revising classic syllabi and courses that mix different managerial fields are must for the future of teaching and research.

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