Financial innovation, risk management and banking performance

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Abstract:

Several research studies dealing with the direct relationship between financial innovation and bank performance have reported mixed results. The specific risk management incurred by the bank, as a mediating variable in this relationship, has not been thoroughly investigated. In this context, the present work provided contribution consists in highlighting the direct and indirect relationships binding financial innovations and bank performance, as observed through rigorous risk management procedures. In this regard, the present work is conducted to examine the empirical data relevant to a sample involving six Tunisian deposit banks, concerning the period ranging between 2008 and 2017. The aim is to verify the central hypothesis stipulating that the financial innovations related characteristics are positively associated with bank performance through risk management. The linear regressions reached results prove to outline the persistence of noticeable relationships binding the risk level, the innovations 'horizon and specificity, on the one hand, and banking performance, on the other, as mediated via risk management. Accordingly, the present article is designed to provide a kind of plausible explanation of the mixed results documented in the relevant studies, already conducted in this respect, (i.e., to examine the specific relationship between financial innovation and bank performance). More specifically, through stressing the need for an effective risk monitoring and management procedure, while considering it as an intermediate phase or mechanism whereby the effect of innovation on bank performance could be plausibly explained.

Keywords: Risk, Horizon, Specifics, Performance, Risk Management, Financial Innovation

JEL Codes: G21, G32, O30

1. Introduction

More recently, banking activity has witnessed a remarkable evolution. Indeed, the increased competition, deregulation, technological change and development of financial markets have led banks to adapt to the newly established order. In this context, adapting to financial innovation, by changing the structures characterizing the existing financial products or the emergence of new products and services, turns out to stand as a major challenge for banks to effectively meet the increasingly complex requirements of their clients.

A significant proportion of literature dealing with investigating the direct link associating financial innovation and bank performance has displayed mixed results. In effect, while some researchers argue that financial innovation proves to represent an effective strategy for banks, other authors question such a claim, highlighting that such a strategy stands as a source of increased costs and dispersion of banking skills and efforts. Hence, adopting a simplistic approach that ignores or neglects even the indirect relationships binding both concepts might well helpbridge the gap and provide explanations as tothe noticeable differences marking such findings.

Actually, applying and implementing the risk management procedure has become a major concern for the banking institution. Such a procedure is primarily guided by the supervisory bodies and authorities, through introduction of prudential regulations within the Basel Committee framework. Yet, following the recurrence of financial crises, such as that of the "supbrimes" (2007), the financial authorities have been enticed to set up new methods, products and processes in a bid to consolidate and restructure the financial system, through enhancing quality research, added value promotion, technological evolution, and implementation of new risk-monitoring methods. In this respect, the major determinant of the banks'survival and development process lies in these institutions adopted strategies, undertaken to manage the risks generated by their vocation of the financial services'providers.

It seems, therefore, reasonable to include risk management as an explanatory variable, whereby banking performance can be thoroughly understood. In this regard, performance stems, primarily, from an effective implementation of a risk management system, through implementation of innovative financial products (derivatives, securitization and hedging instruments). In this way, exploiting opportunities and more beneficial risk management prospects is a prerequisite for an effectively improved bank performance to take place. This state suggests that the relationship binding financial innovation and bank performance is rather an indirect relationship, predominantly affected with the influence of risk management policy. In this context, the present research is primarily focused on studying the indirect effect of the specificities of financial innovation on bank performance via risk management.

Tunisian banks have not been excempt from the wide-spread financial innovations, as judged by the acceleration of financial reforms in Tunisia. These new facts have stimulated banks to invest heavily in matters of innovation, thus, challenging a number of habits, procedures, and even structures that have been underway within the context of a protected economy (Zhong, 2018). In light of all these considerations, it is interesting to examine the major features characterizing the Tunisian banking sector. From this perspective, and given the divergent works and results reached in this respect, we intend to provide a plausible answer to the following issue question: in what ways has financial innovation impacted the risk management process, as a means to improve the bank sector's performance?

As an answer to this question, we consider it useful to adopt a hypothetico-deductive approach, as subject of the two following sections. The first section involves a presentation of the theoretical model postulating that financial innovations contribute in influencing performance. Amidst this direct relationship, a number of variables are interposed, including risk management. In addition to its being influenced by innovations, this last variable helps, in turn, influence performance. As for the second empirical section, it is devoted to test the potential effect of financial innovations, as a mediator between risk management and performance, in accordance with three separate models (each model corresponds to each of the innovations' components).

2. Literature review and hypotheses development

The theoretical framework of this research is based on the major contributions provided by the genesis of financial innovation related theories. More specifically, the contributions provided by Schumpeter[1]'s theories of technical progress, Silbert's theory of constraint, the Lancasterian perspective, as well as the Baumol's contestable market paradigm should stand as appropriate analytical frameworks whereby financial innovation, risk management, and performance can be harmoniously reconciled.

According to the Silbert's analysis, regulation stands as a major constraint enticing agents to innovate. Indeed, this might well represent the main factor driving financial innovation.Moreover, and to take effective position against their competitors, banks are obliged to make intense efforts to distinguish themselves from each other.These efforts involve devising a wide range of new products or services offered to different customers, in a bid to allow the banking institution to have a comparative advantage over its competitors. Still, the remarkable increase in exchange rate volatility, interest rate variability and intensification of inflation rates remain the major constraints facing economic agents. They have led to the implemenation of various management and control instruments, and even to the acceleration of financial innovations, in an attempt to protect against such risks. In this regard, Caresoli and Guillaud (1992) even provide a complementary list of stimuli inciting banks to innovate, involving external and State budgetary constraints. Indeed, for the sake of maintaining their banking systems'competitiveness, some countries have turned to adopt an imitative attitude. Other countries have issued laws introducing new instruments, targeted to finance public deficits and companies of certain specificities.

Following Lancaster (1966) inspired analysis, the regulation restricts the transfer of products, introduces some alterations in consumer preferences enabling them to express a new demand.

[1] According to Schumpeter (1935), innovation is simply defined as "new productive combinations", which can involve five categories: the manufacture of a new product; the introduction of a new production method; the opening of a new market; the use of a new source of raw materials or semi-finished products; the realization of a new organization.

A review of the literature has allowed us to provide a brief overview of the different forms of financial innovation:

- Product innovation: it occurs when a firm or bank decides to put on the market new products, or to offer more efficient products than the present ones, because they offer more functionality, or because they fulfill the functionalities more efficiently.
- Process innovation: it is based on the technical improvement of production processes or production management methods. These allow the company or the bank to be more flexible, reduce production costs or increase the quality of products manufactured.
- Organizational innovation: it is very difficult to define as it can take multiple forms. Indeed, it affects the organization of a market, distribution, marketing, marketing and all the procedures that make up the strategic tools of the company.

The products are required to have specific features with fixed proportions, and it is actually through these features that consumers may exercise particular preferences. Accordingly, the characteristics'demand theory relates to the will to respond to consumer demand, while offering new financial instruments. In its full form, this approach stands as a complementary to the strain theory.

Similarly, the financial innovation process is also associated with the Baumol's theory of contestable markets. Accordingly, markets are perfectly contestable if they check two conditions, namely, that new entrants do not have a handicap compared to the already installed agents (no cost discrimination with regard to the entrants) and that the exit cost is nil. Both conditions appear to help enhance financial innovation and even competition from banks, through entering the market either with new products / services or by improving the existing ones.

As a matter of fact, the entirety of these theories helps but magnify the list of challenges the financial institutions are faced with on attempting to offer innovative financial products. These institutions are required to develop effective managerial skills[2] and operational systems to be able to cope with this new environment. Actually, the notion of skills and abilities stems from the concepts provided by there theory of resources. Accordingly, the institution's heterogeneous resources are classified into three categories: human, intangible, and material (Grant, 2002), likely to affect the company's actual performance.

In effect, banks lie at the heart of the world's recent financial crisis, whose asset portfolios'deterioration, due largely to mismanagement, stood as a major structural source of the crisis (Steven et al., 2002).Since global economies have been globally shaken, risk management has become a major key banking function, necessary for the stability and profitability of the financial sector. In a current dynamic context, Al-Tamimi and Al-Mazrooei (2007) document that banks are exposed to several risks[3], likely to create serious threats to the bank's survival and success. Hence, the major determinant for the survival and development of the banking industry consists in the way these institutions would manage the relevant risks. In this repect, Wanjohi et al. (2017) have discovered that a robust risk management framework can help banks attenuate their exposure to risk and enhance their market competitiveness.

As a result, the relationship between risk management and performance has been met with noticeable attention in the literature. In addition to being influenced by innovations, risk management represents a critical variable that all financial institutions have begun to admit and recognize to continue to survive. It is actually this new concept that brought about noticeable challenges to the relationship binding innovation and performance.

For this reason, we consider devoting the present section to briefly depict a relevant literature review, and formulate the study related hypotheses.

2.1. The association between financial innovation and performance

In a competition struck environment, financial innovation stands as a strategic challenge, or even an essentialcondition, for banks aspiring to remain competitive. Such a prerequisite

[2] Resources or skills are generally defined as assets, capabilities, organizational processes, and knowledge (Barney and Arikan, 2001). Banks can identify, develop and deploy strategic resources to generate optimal returns, thereby, improving efficiency and effectiveness (Amit and Schoemaker 1993, Peteraf 1993, Fahy 2000).

[3] Such as credit risk, liquidity risk, foreign exchange risk, market risk and interest rate risk.

confirms well the crucial role financial innovation can play to achieve economic growth and value creation. Hence, studying the relationship binding financial innovation and performance turns out to be considerably important.

Actually, a great part of the relevant literature has been devoted to examining the relationship between innovation and performance. In effect, the studies, previously conducted in this respect, have displayed mixed results.While some studies highlight that the relationship binding both concepts is positive (Batiz-Lazo and Woldesenbet, 2006; Zahra and Das, 2009; Mwania and Muganda, 2011; Gunday et al., 2011; Atalay et al., 2013; Cherotich et al., 2015), others argue that financial innovation proves to have a negative impact on banking performance (Franscesa and Claeys, 2010; Pooja and Singh, 2011). Noteworthy, however, is that despite the undeniable importance of financial innovation in explaining bank performance, the impact of innovation on financial performance does not seem to be thoroughly addressed. There seems to be a lack of understanding concerning the innovation associated elements and their impact on financial performance. In fact, most studies appear to adopt a simplistic approach as to the innovation-performance binding relationship, without seriously accounting for the major characteristics of financial innovation and other factors affecting the relationship. Bearing in mind such mixed conclusions, it seems necessary to conduct a Tunisian context relevant study, whereby the influence of the financial innovation associated characteristics on bank performance is thoroughly considered.

It is worth noting, in this cotext, that financial innovation stands for a specific type high-risk investment, whose value creation contribution is long-term, rather than short-term, targeted, i.e., requiring several years for returnsto be generated. As a matter of fact, analysis of such characteristics entails us to highlight the informational and agency related problems, taking place between the manager and the various implicated stakeholders, remarkably influencing performance.

a. Innovation: a risky and uncertain asset

It is often maintained that financial innovation is usually bound to uncertainty. According to Van Der Pann et al. (2003) and Faleye et al. (2014), this is mainly due to the fact that it is closely associated with a high probability of failure. This activity related uncertain nature can be manifested throughout the different relevant phases, from the implementation of research, development, to the preparation of the industrial and commercial launch. It also involves the competitors' adopted attitude.

In effect, the relating uncertainty level varies depending on the nature of the innovation. When it comes to incremental innovation, the risk level turns out to be lower (Keizer and Halman, 2009). When it comes to the outcome of learning and changing production scale, for instance, incremental innovation proves to be less expensive. It may exclusively concern the improvement of a product, process or technological transfer from one type of application to another.

Yet, when it comes to radical innovation (Lee, 1995; Germain, 1996; Koberg et al.; 2003) or a breakthrough one (McDermott and Handfield, 2000; O'Connor and Rice, 2001), it turns out to be usually characterized with a high degree of uncertainty. As a result of a planned research and development effort, innovation of this type requires the application of a new technology using enormous scientific and technical means. In this respect, the cost of developing financial products is not only too high, but also liable to further competition.

In a highly turbulent environment, an innovation that succeeds in achieving a distinctive or unique competitive position may well provide the bank with a pioneering competitive advantage, thus enhancing performance even more (Roberts and Amit, 2003). This can only be maintained through progressive innovation as well as product and process improvement. Inversely, however, Petersen and Carpenter (2002) document that when a company invests in process or product improvements, it may make valuation errors likely to render the investment either entirely or partly unprofitable.

Nevertheless, the development of new products may well result in the emergence of new issues, related mainly to the conceptualization, constitution and evolution of the product over time. In this regard, novelty and product modifications are predominantly associated with customer benefits, increased functionality and market value (Leifer et al., 2001, O'Connor 2008). Through such strategic initiatives, banks aim at improving their performance (Kim and Min, 2015), while reducing the new business developing related risk (Hacklin et al., 2018).

By engaging in an innovation process, the bank can have access to new procedures, techniques or different production means, likely to promote its customer value. According to Dziallas and Blind (2019), customer satisfaction represents a main factor for the success of the product and / or service offered on the market. Long lines, transaction errors, queues, insecurity and network failures are considered as the most common problems associated with banking services (Osewe and Muturi, 2017). This lower perception of the clientele concerning the offered service quality could well reduce the bank's credibility and, therefrom, its profitability (Osewe and Muturi, 2017). In such a context, many companies have an interest in perceiving such a considerable pressure, through engaging in radical financial innovations, in a bid to gain and maintain a competitive advantage (Chandy and Tellis, 1998; McDermott and O'Connor, 2002). Such a strategy may certainly help improve profitability, but the risk will be rather high. Any additional risk taking meaure is thus reflected in an improvement in expected profitability. Hence, should the bank aspire to increase performance, then, riskier investments, such as financial innovation, are imposed.

Accordingly, the initial assumption (H1.1) to formulate turns out to be:

H1.1: The innovation associated risk positively affects the bank's performance.

b. Innovation: a long-term asset

Unlike physical investments, innovative projects are considered as long-term investments in relation to the payback period. These projects refer to the innovative ideas associated commercial success on the market. They are characterized with a return on investment concentrated in the distant future, along with a great deal of uncertainty about future cash flows. Indeed, these new technologies tend to be informational opaque (Rajan and Zingales, 2001). The moral hazard problem is usually very significant regarding this type of investment. It is therefore difficult for an outsider investor or customer to select "good" projects when it comes to innovative products (Leland and Pyle, 1977). In effect, an innovation that is not quite understood by third parties implies a long gestation period during which little cash flow is available.

In this regard, Eloranta et al. (2002) and Saad et al. (1992) identify innovative projects according to the relevant temporal position and innovative nature, more or less discontinuous. They distinguish between incremental and radical innovation. According to them, the life cycles

of radical innovations[4] are usually longer and more unpredictable (Saad et al., 1992; Leifer et al., 2001). As for incremental projects[5], they are rather linear and predictable, as they encounter fewer uncertainties about resources and involve less complex collaborative relationships (Cardinal, 2001; McDermott and O'Connor, 2002; O'Connor and Ayers, 2005). As a matter of fact, through offering a new product on the market, the bank can create a new revenue stream and diversify its business. It can gain greater attractiveness due to the widening scope of its product range (Verganti, 2008), while enhancing its customers' satisfaction and, thereby their loyalty, in an innovative way (Chandy and Tellis, 1998).

Thus, radical innovations are often associated with cost reduction (Leifer et al., 2001), high profitability and high value creation (Tellis et al., 2009). Ultimately, they could well contribute in improving the institution's growth and long-term renewal (Leifer et al., 2001; McDermott and O'Connor, 2002), which would bring about greater financial performance (Coccia 2016, Rubera and Kirca 2012). Noteworthy, however, is that in the short term, such an investment may well adversely affect financial performance.

Based on the already cited ideas, one could well postulate the next relevant hypothesis (H1.2):

H1.2: The horizon of innovation positively affects the bank's performance.

c. Innovation: a redeployable asset

Another major characteristic of innovation, distinguishing it from ordinary investment, is the assets' non-redeployable nature. In the sense of Williamson (1988), a "non-redeployable" asset (non-reusable) occupies a prominent place and refers to the asset's peculiar specificity. An asset is considered to be specific if it is imperfectly imitable, transferable or interchangeable, and corollary, if it is not reusable by other actors without losing all or part of its usage value.

Innovation creates an intangible asset (know-how, technological development etc.) that requires special skills. In this regard, Sabatier et al. (2010) highlight that the development of a new product allows banks to extend their core competences or redeploy them to new markets. Conceptually, according to the theory of resources, the company stands as a combination of resources and capabilities. Once scarce, these resources, become sources of competitive advantage (Barney, 1991). In this context, the implementation of product, process and organizational financial innovation entails skilled human resources from the part of banks, thereby, reducing operational and transaction costs (Cruz et al., 2014).

In reality, the emergence of banking on the Internet has altered the way business is conceived, giving greater importance to intangible capital (De Montmorillon, 2001). Actually, this online emergence has enticed any bank to apply its necessary skills to remain competitive and gain a competitive advantage. In this context, Hernando and Nieto (2006) examined the impact of creating a transactional website on the Bank's financial performance on the Spanish banking market. They came to conclude that adoption of the internet as a delivery channel has gradually helped in reducing overhead costs, which has in turn increased the banks' economic performance (ROA) for about a year and a half following this adoption, along with their financial performance (ROE) three years after. Similarly, Hasan et al. (2010) analyzed the performance of banks' multichannel commercial applications in relation to the traditional

[4] According to Saad et al. (1992), radical innovation aims to achieve a practical result based on an existing but insufficient scientific knowledge; the turnaround time is usually 2 to 7 years.

[5] According to Saad et al. (1992), incremental innovation is not aimed to discover and develop new knowledge, but rather artfully applying existing knowledge; the lead time is often 6 to 24 months.

channel application in Italy. They were led to discover that adoption of the Internet proved to have a positive effect on bank performance, as estimated via both of the ROA and ROE releted measures.

In a model studying the impact of innovative activities on business performance, the focus of interest is usually laid on the complex innovation process and the channels whereby innovation inputs can be transformed into a rather effective performance (Loof and Heshmati, 2006; Hashi and Stojcic, 2013). Thus, financial innovation can help in promoting the products and services related performance, facilitate learning, and improve the ability to absorb environmental knowledge necessary for future research (Cohen and Levinthal, 1990), while maintaining the firm's dynamic capacity to innovate (Kor and Mahoney, 2005).

It follows, therefore, that, the specificity of innovation appears to have a positive effect on banking performance. Accordingly, the following relating hypothesis turns out to be (H1.3):

H1.3: The specificity of innovation positively affects the banks' performance.

Actually, the sub-hypotheses **H1.1**, **H1.2 and H1.3** appear to indicate well that the impact of the variables "innovation risk", "innovation horizon" and "innovation specificity" on performance is positive. Consequently, our **hypothesis H1**, stating that innovation proves to have a positive effect on banks' performance, can be formulated as follows:

H1: Financial innovation positively impacts the banks' performance.

2.2. The financial innovations' effect on risk management

The recent decade has been marked with a generally growing interest in studying innovation, particularly, financial innovation. More specifically, financial innovation denotes the creation and commercialization of new financial instruments, new technologies and institutions (Tufano, 2003). Actually, this procedure represents a risky activity accompanied with a high probability of failure (Finkelstein and Boyd, 1998; Barker and Mueller, 2002), long-term scope (Xu and Zhang, 2004; Tribo et al., 2007) and specific character (Williamson, 1988; Goel and Ram, 2001).

The globalization of financial markets and the technological information revolution have forced financial institutions to put out their activities across borders. Many banks have adopted innovative banking products and services to retrieve and maintain customers (Lundvall 2010; Frank and Hesse, 2009). Through the Internet, banks have set up a number of cross-country ATMs, making a rupture with traditional banking. According to Malerba et al. (1997), new innovators, likely to enter the financial sector, may grow or even disappear with time.

The rapid pace of change taking place in the financial sector, along with the diversity of risks faced by the banking institutions, require the implementation of real contingency plans as well as an effective evaluation of the risk management systems' efficiency. As part of our study, we seek to investigate the relationship binding these innovative strategies, while considering the various risks associated specificities and management, related to the wide range of these institutions implemented financial operations.

a. Innovation: a risky / uncertain asset

Despite the wide-scale implementation of financial innovation, most banking instituitions appear to detain a limited knowledge of the potential risks associated with new products and services. Due to the emergence of new technologies, these risks should involve the global reflection conceived by these institutions, and must be effectively measured, monitored,

managed and minimized. A number of banks, mainly small banks, do not prove to enjoy adequate risk management structures, whereby they could adequately assess and monitor the risks and challenges associated with such innovative products and services. In this regard, Cumming and Hirtle (2001) argue that risk management is a critically useful strategy. It "concerns the overall process a financial institution pursues to define its strategy, identify the risks to which it is exposed, quantify these risks, understand and control the nature of the risks it is called upon to face" (p.3).

Several studies have stressed that the absence of a rescue mechanism can well threaten the health of the financial system and might, in some cases, culminate in a complete cessation of these institutions' activity. For this reason, banks have an incentive and interest to manage their risks and implement a security policy adopted in conformity to their size and trades.

As a matter of fact, risk constitutes one of the constraints stimulating financial innovation and risk management. In effect, several recurrent devaluations and speculative crises, often accompanied with a worsening of the interest rates and exchange rates associated variability, have culminated in the system's overall destabilization commonly known as "Bretton Woods". Such a situation helps favorize the acceleration of financial innovations as a crucial risk reducing measure. In this respect, Beston (1994) outlines that risks prove to decrease when banks are entitled to carry out new risky activities. Similarly, Tufano (2003) states that financial innovation can correct, or regulate, market inefficiencies or imperfections. Whenever markets prove to be incomplete, financial innovation can interfere to promote the risk-sharing opportunities. In case of prevalent agency conflicts, new types of security measures can interfere to maintain the interest alignment conditions.

Given the risky nature of the innovation strategy, it is necessary to proactively manage risks, through identifying hazards emanating from the earliest stages of product development (Wheelright and Clark, 1992; Cooper, 2006; Blondel and Gaultier-Gaillard, 2006). Based on the above cited arguments, a positive relationship is discovered to persist between the innovation related risk and that associated with management system. Hence, banks opting for risky products and services tend to manage their risks in such a way as not to undermine the financial system's stability. Accordingly, the following hypothesis seems worth advancing:

H2.1: The innovation associated risk positively influences banking risk management.

b. Innovation: a long-term asset

More recently, innovative financial products have gained greater importance not only as risk mitigating instruments, but also as revenue generators. Indeed, a successful financial innovative initiative can help significantly in reducing costs and risks and/or provide better services to users. According to Greuning and Bratanovic (2003), risk often tends to increase exponentially with the pace of change, but bankers are usually slow to adjust their perception of it. More specifically, the market's ability to innovate is, in most cases, greater than its willingness to understand and properly manage the associated risk.

In turn, Frame and White (2004) outline the importance of adopting and disseminating innovation in the financial sector, highlighting that the faster the innovation's diffusion is the higher the yielded returns will be. Xu and Zhang (2004, p. 246) argue that "Innovative projects can take enough time to see their rewards, or even result in failure." Actually, even though substantial gains and losses can be generated as major outcomes of innovation, it is still a source of long-term competitiveness (Perdomo-Ortiz et al., 2006). Similarly, some financial

instruments are available for a bank allowing it to maintain a long-term relationship with a client without incurring excessive credit risk (Mathews and Thompson, 2008). Among credit derivatives[6], securitization transactions represent the most effective means whereby credit risk can be transferred to other institutions, enabling them to reduce their credit concentrations and diversify their risks.

Similarly, financial instruments, including derivatives, were originally created to protect against financial risks, such as interest rate risk, fluctuating foreign exchange, and failure. In effect, derivative contracts[7] can be multiplied and an asset can be covered by several derivative contracts[8], whereby to immunize against the decline risk or value loss (Beets, 2004; Saunders, 1999).

Inspired by the investment portfolio theory, assuming a positive correlation to be maintained between risks and return (Sharpe, 1970; Fama, 1976), the option value is usually appreciated following adoption of risky products, thereby contributing in amplifying the risk management. In this respect, risk protection techniques include standardizing the entire activities and process, building a diversified portfolio and implementing a motivational and accountability plan.

Hence, the following hypothesis can be advanced:

H2.2: The horizon of innovation positively influences the banking risk management.

c. Innovation: a redeployable asset

Nowadays, banks are called upon to perfect their organization to promote efficiency, improve customer service and better support banking competition. Moreover, they have to engage in a more effective staff management policy, adequate motivation and more intense training and retraining activities to improve the productivity of their human resources. In addition, innovation in the marketplace requires a rather thorough imaginative thinking, coupled with cute collection or outsourcing of profitable and specific information, along with an efficient initiative to draw greater benefits from available resources.

Thus, for an effective measuring, monitoring, control and report on the relevant risks involved to take place, banks need to undertake specific information management systems. Recent financial innovations, such as Real-Time Gross Settlement (RTGS), have created opportunities for commercial banks to better manage their risks. Hence, getting credit information on a potential borrower is not as difficult a procedure as it used to be. This can have a positive impact on reducing the amplitude of adverse selection risk. This leads to effective referrals, likely to help in reducing fraudulent cases associated with an unfavorable selection.

Similarly, some innovative initiatves require the availability of significant human potential to be deployed for commercialization purposes. Indeed, a new banking product should certainly attract additional customers. Thus, a highly qualified staff capable of effectively executing its mission would accord the maximum importance to the clientele in a bid to retain it.

According to Kraus and Lehner (2012), the bank management is able to successfully run the risks and exploit all favourable opportunities and prospects to promote organizational value.

[6] A bank worrying the solvency of one of its clients, who may not be able to repay the loan, can protect itself against a loss by transferring the credit risk to another party while retaining the loan.

[7] A derivative is a contract between two parties agreeing on the price of an asset; so it is an underlying financial instrument of an asset that sets the price. The value of a derivative will depend on the value of its underlying asset over time.

[8] There exist various forms of derivative contracts, including futures (forward contracts in French), Forwards (over-the-counter), Options (Call / Put), Swaps: interest rate swap, currency swap, Credit Default Swap (CDS) etc.

Indeed, the bank must clearly identify the people and/or committees responsible for managing risks, and clearly define the reporting relationships and responsibilities allotted to everyone.
In sum, one could well conclude that specific financial innovations are frequently used as shields to protect against market volatility and as a risk hedging instrument. Hence, our relevant hypothesis is the following:

H2.3: The specificity of financial innovations has a positive impact on banking risk management.

Indeed, the sub-hypotheses **H2.1**, **H2.2 and H2.3** appear to reveal that the impacts of the variables "innovation risk", "innovation horizon" and "innovation specificity" on banking risk management prove to be postive and, consequently, our **hypothesis H2** stating that innovation has a positive effect on risk management**,** can be formulated as follows:

H2: Financial innovation positively influences risk management.

2.3. The risk management and bank performance association

It is worth noting that banking activities are generally characterized with the predominance of a high-risk level, and that if risks are not well managed, the firm's financial results will be put at stake. Hence, an overriding interest has aways been directed to banking risk management. The focus of this particular managerial area has been primarily laid on controlling and complying with the regulatory requirements, rather than improving financial performance. Noteworthy, however, is that risk management often brings about improved financial performance. In addition, the concerned managers keep confirming that through risk management, the bank is able to achieve promoted performance and, therefrom, shareholder profitability (Edwards and Bowen, 2005; Pagano, 2001).
In this sense, Fatemi and Luft (2002) state that a company usually engages in risk management schemes to enhance shareholder value. It is, therefore, critical for every company to actively maintain and manage a certain level of risk to promote its value on the market. In turn, Brown et al. (2009) outline that risk management represents an important function for banks to create value for their shareholders and customers.
In the same vein, effective risk management stands as a crucial task or mission in the bank's daily operations for financial losses to be avoided. Loss prevention through precautionary measures is the key to reducing risk, and therefore, a key driver of profitability. Indeed, the effectiveness of risk management process usually has remarkable impacts on the banks' financial returns (Zhong, 2018).
In this respect, Cebenoyan and Strahan (2004) document that banks with noticeable advancements in risk management usually enjoy greater credit availability, rather than a risk reduction in the banking system. Actually, a more noticeable availability of credit helps enhance the opportunity to promote the bank's productive assets and profits, i.e., creating greater value.
Thus, our third hypothesis to put forward is:

H3: Risk management positively influences the bank's performance.

2.4. The indirect impact of financial innovations on performance as mediated by risk management

In a banking universe, a noticeable profitability enhancing means lies in promoting financial innovations and customer commitments, even in presence of a high default risk. Such a strategy should certainly gelp in improving short-term profitability through the possibility of charging these customers higher rates, but the risk to take will be greater. Indeed, this undertaken policy increases the chances of the banking institution's future losses, through accentuation of the counterparty, liquidity and solvency risks. Hence, the major challenge facing banks consists in how to effectively manage the different risk types to achieve respectable profitability.

As Frame and White (2004) note, "profit-seeking institutions are constantly looking for new and improved products, processes, and organizational structures that will not only enable them to realize greater benefits, but also reduce their production costs and better meet the demands of their customers".

Considering risk as one of the main characteristics of innovation, Taplin (2005) states that innovation facilitates risk management through improving the organization's ability to manage it at all stages. Actually, an important goal of risk management policy is to improve the performance of innovative projects through the identification, evaluation and systematic risk management of the relevant projects (Chapman and Ward, 1997).

Moreover, financial innovations contribute in improving economic performance through promoting the risk-sharing opportunities. According to Dowd (2005), on managing the innovative products related risks, banks usually help increase value, thereby reducing bankruptcy risks and the company's cash flow variability. In addition, risk management helps investors reduce losses and maintain a rather equitale distribution of innovation risks. Innovate decision-making strategy should help in promoting and enhancing risk management undertakings within a more coherently controlled organization, thus, rendering it rather efficient (Edwards and Bowen, 2005).

In other words, product and service diversification leads to a noticeable improvement in banking performance, for such a strategy allows them to substitute the losses incurred for one product and / or service with gains acquired in others. As already outlined, financial innovations prove to have a positive effect on risk management, which in turn affects banking overall performance. It can therefore be concluded that:

H4: Financial innovations positively influence the bank's performance, as mediated by risk management.

It is worth recalling that within the present study's framework, a major variable is considered to determine firm performance, as observed through risk management, namely: financial innovation.

3. Research methodology

The banking system is considered as a corner stone in the financing of the Tunisian economy. It appears, therefore, necessary for this industry to be effectively developed to meet international competition, through the creation of a more liberal environment and promoting the depositors associated protection mechanisms.

As stated by the Tunisian Central Bank Governor, the banking system associated restructuring scheme is devised to account for the Tunisian banks' specificities, and aimed at favorizing and enhancing the emergence of a new banking landscape marked with financial innovation. So,

will this new financial architecture help Tunisian banks promote efficiency and better withstand international competition?

It should be noted that since the 1990s, the Tunisian government has been trying hard to improve the banks structure and activities through encouraging investments in this industry related financial innovation, which represents the nerve of the national economy.

This section is designed to describe the relevant sample, tools and procedures applied for data collection, statistical analysis, and research design purposes, necessary for the conduction of the present study.

3.1. Data collection and sample

It is worth reminding that our subject matter deals with investigating the issue of financial innovation associated role in improving the banking system's performance through effective risk management procedure. Noteworthy, also, is that the choice of the study related population has been dominated by the legal jurisdiction under which the involved banks operate. It follows that the first criterion involved in the selection of our targeted population concerns, exclusively, the private banks.

Considering the diversity of variables, our data collection procedure has been predominantly based on the following sources of information:

- The financial statements (balance sheets, income statements and explanatory notes) published in the official bulletins of the Tunisian Stock Exchange and the Professional Association of Banks.
- Banks' reports available at the financial market council.

To note, our sample contains a total of six privately owned Tunisian private banks, namely: Amen bank-BIAT-BNA-UBCI-STB-ATB. These banks have been observed over a three years period, ranging from 2008 to 2017. In this study, we are exclusively interested in deposit types of banks. This choice is justified by the fact that it is actually this category of banks that plays the most important role in financing the Tunisian economy. Indeed, their contribution to the economy represents 94.42% of the total amount of bank loans.

3.2. Research approach

As risk management could stand as a mediator for one financial innovation related variable and not for the other, the verification of the mediating effect is accomplished by setting up three elementary models (an elementary model for each of the financial innovation characteristics pertaining variable). It is also worth noting that two control variables (size and financial resources) are incorporated in these models with regard to their effects on the bank's performance and risk management.

Actually, the existence of a mediating effect is going to be tested through implementation of the hierarchical multiple regression analysis. To establish that an independent variable X proves to affect a distal dependent variable Y through a mediating variable M, Baron and Kenny (1986,) recommend the administration of three tests:

(a) variations noticeable at the independent variable levels significantly account for variations in the presumed mediator (i.e., Path "a");

(b) variations in the mediator significantly account for variations in the dependent variable (i.e., Path "b"), and

(c) once Paths "a" and "b" are controlled, the previously significant relationship binding both of the independent and dependent variables is no longer significant, with the strongest

demonstration of mediation occurring when Path "c" attains a zero value. Note that condition (c) requires a significance test concerning the "direct" Path "c".

In our study, variable X denotes the financial innovation relevant characteristics, variable M stands for risk management, while variable Y refers to the bank's performance.

3.3. The research variables and models

In this study, we are seeking to examine the direct and indirect effects of the financial innovation characteristics on banks' performance through the risk management. Three financial innovation relating characteristics are considered, namely, risky, long-term and specific investment. Two control variables have also been incorporated to ensure the reaching of valid results, namely, firm size and financial resources.

To retrieve the measuring indicators relevant to the study variables, an appeal is made to the relevant literature to identify the most frequently available and used measuring indicators. A major problem encountered during the execution of this work is the paucity of empirical studies dealing with this particular subject.

3.3.1. Dependent variable

As it is the case with most of the previously conducted studies, we consider to define banking performance by two measurements, namely: the Return On Assets "ROA" = operating income before depreciation and R&D expenses / total sales (Yang et al., 2007; Zouari et Zouari-Hadiji, 2014 a and b)[9], and the Return On Equity "ROE" = net income / equity (Pramod et al., 2013; Zouari and Zouari-Hadiji 2014 a et b).

3.3.2. Independent variables

The literary indicators frequently used to measure financial innovation are R&D intensities, an often non-declared amount by banks. In the context of our survey, financial innovation is considered as a risky, long-term and specific investment. Banks engaged in innovative activities are characterized with a high-risk level, long-term return and strong specificity.

Noteworthy, also, is that three measurements have been applied in this work to assess the innovation associated risk.

Following Jensen et al. (1992), as well as Bah and Dumontier (1996, 1998), the first measurement to apply is the standard deviation ratio of return on total assets σ (ROA). The second is the standard deviation ratio of return on sales σ (ROS). As for the last measurement, it consists in the standard deviation ratio of return on equity σ (ROE). Concerning our study case, we will admit the standard deviation measurement of the σ (ROA).

Regarding the innovation related long-horizon aspect, Balakrishnan and Fox (1993), Gaver and Gaver (1993) along with Bah and Dumontier (1998) discovered that banks engaged in innovative activities prove to display a significant growth opportunity. With respect to these cited studies, three measurements have been specified by the growth opportunities. The first measurement is the ratio of tangible assets expenditure to profit before interest, depreciation and tax (Balakrishnan and Fox, 1993). The second and third are, respectively, the ratio of the market to book value of equity ((MBVE), Bah and Dumontier, 1996; Gaver and Gaver, 1993) and the price-to-earnings ratio ((PER), Zouari-Hadiji and Zouari, 2010 a and b). As part of our study, we will be relying on the measurement of the PER = market capitalization / net income.

[9] This accounting performance related measurement has the advantage of eliminating the effect of accounting choices relevant to the treatment of depreciation and R&D expenses in the financial statements, largely subject to the managers' opportunism.

Regarding the innovation specificity[10], Balakrishnan and Fox (1993) along with Brailsford and al. (1999) and Fakhfakh and Zouari-Hadiji (2011) considered measuring it through the intangible assets to total asset ratio.

3.3.3. Mediator variable

For an effective risk management measurement, Osoro Bonyi (2015) made use of the annual risk value (VaR)[11]. Accordingly, this particular index involves operational risk, liquidity risk, credit risk as well as market risk. The VaR is characterized to incorporate three main components: a period (the longer the horizon is, the more significant the losses would be), the confidence level (usually set at 95% or 99%) and the estimated loss of investment (expressed in amount or percentage). Actually, three VaR computing methods are available, namely: the Historical VaR[12], Monte Carlo Method[13] and Parametric VaR[14].

The VaR Parametric method proves to be rather complex, depending on the portfolio size. For a single position, the calculation is relatively simple. Spreadsheets, such as Excel, include a formula enabling to directly compute a parametric VaR for a particular position. In case of portfolio availability, one has to go through a variance / covariance matrix. In our study case, we are actually faced with a unique single position, for this reason, we will rely on Microsoft Excel to determine each security bank associated VaR.

Hence, the following formula is applied to extrapolate a VaR:

= REVERSE NORMAL LAW (probability, expectancy, standard deviation)

- Probability: results in the difference recorded between 1 and our proper confidence level
- Expectancy: it is the sum of the financial returns of assets divided by their numbers. In the banking sector, this average is used mainly to determine an average yield.
- Standard deviation: It reflects the risk attached to a financial asset. In concrete terms, this indicator measures the performance differences relevant to an asset around its average. This is referred to as the standard deviation of returns.

3.3.4. Control variables

These variables are used to attain a reduction in variance, through exploiting the correlation between several statistics. In regard to our study case, two control variables are introduced corresponding to the bank related size and financial ressources. Bank size is measured by the natural logarithm of the bank's total assets (Mabrouk and Mamoghli, 2010; Zouari and Zouari-Hadiji, 2015, 2014 a and b). As for financial resources, they are measured through the average net profits (Mabrouk and Mamoghli, 2010).

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[10] That is, an imperfectly immovable, transferable or interchangeable asset that is not reusable by other actors without losing all or part of its initial value. So innovation creates an intangible asset (know-how, goodwill etc.) that requires special skills.

[11] The Basel Committee 2 defines VaR as a market risk measuring method. The realization and emergence of this new indicator have soon become considered as a standard in the evaluation of financial risks. VaR is a risk management tool used in most financial institutions. This instrument rests on mathematical and statistical methods, making it possible to calculate a potential loss of a position or portfolio.

[12] Historical VaR: The historical method relies on past variations to estimate the distribution of future variations. Yet, this method requires a sufficiently large history.

[13] The Monte Carlo Method: it is a numerical method that uses random draws to compute a deterministic quantity. However, it is an instrument with enormous calculations.

[14] Parametric VaR: it rests on the assumption that the distribution of returns depends on a relevant law. This model is based on statistical estimators such as: average yield and standard deviation of returns.

3.4. Econometric modeling

At this level, hierarchical multiple regression analysis is implemented to test the hypotheses relevant to the direct and indirect effects of the financial innovation characteristics on bank performance through risk management. In a first stage, the independent (predictor) and control variables have been regressed on the dependent variable (outcome) (see equations 1, 4, 7). In a second stage, the process variables have been regressed on the predictor explanatory variable, and the controls regressed on the mediator variable (see equations 2, 5 and 8). Finally, to test the mediating effects, the intervening variables have been subsequently and jointly introduced (see equations 3, 6 and 9), while the adjusted R^2 as well as the individual coefficients have been compared to those reached through the previous equations.

Econometrically, we will estimate the models from one to three, by testing the indirect relationship binding innovation risk, risk management and banking performance. Actually, these models prove to validate the sub-assumptions: H1.1, H2.1, H3.1 and H4.1.

$$\mathrm{PERF}_i = \beta_0 + \beta_1 \mathrm{RISKINNOV}_i + \beta_2 \mathrm{LOGTA}_i + \beta_3 \mathrm{RF}_i + \varepsilon_i$$

$$\mathrm{RISKMGT}_i = \beta_0 + \beta_1 \mathrm{RISKINNOV}_i + \beta_2 \mathrm{LOGTA}_i + \beta_3 \mathrm{RF}_i + \varepsilon_i$$

$$\mathrm{PERF}_i = \beta_0 + \beta_1 \mathrm{RISKINNOV}_i + \beta_2 \mathrm{RISKMGT}_i + \beta_3 \mathrm{LOGTA}_i + \beta_4 \mathrm{RF}_i + \varepsilon_i$$

Equations from four to six, they serve to test the indirect relationship binding the innovation's long-horizon and bank performance through the mediating effect of risk management. Indeed, these equations prove to validate the sub-hypotheses: H1.2, H2.2, H3.2 and H4.2.

$$\mathrm{PERF}_i = \beta_0 + \beta_1 \mathrm{HORIZINNOV}_i + \beta_2 \mathrm{LOGTA}_i + \beta_3 \mathrm{RF}_i + \varepsilon_i$$

$$\mathrm{RISKMGT}_i = \beta_0 + \beta_1 \mathrm{HORIZINNOV}_i + \beta_2 \mathrm{LOGTA}_i + \beta_3 \mathrm{RF}_i + \varepsilon_i$$

$$\mathrm{PERF}_i = \beta_0 + \beta_1 \mathrm{HORIZINNOV}_i + \beta_2 \mathrm{RISKMGT}_i + \beta_3 \mathrm{LOGTA}_i + \beta_4 \mathrm{RF}_i + \varepsilon_i$$

As for the quations from seven to nine, they help to test the indirect relationship binding innovation specificity and the banking performance through the risk management. These equations enable to validate the sub-hypotheses: H1.3, H2.3, H3.3, H4.3.

$$\mathrm{PERF}_i = \beta_0 + \beta_1 \mathrm{SPECIFINNOV}_i + \beta_2 \mathrm{LOGTA}_i + \beta_3 \mathrm{RF}_i + \varepsilon_i$$

$$\mathrm{RISKMGT}_i = \beta_0 + \beta_1 \mathrm{SPECIFINNOV}_i + \beta_2 \mathrm{LOGTA}_i + \beta_3 \mathrm{RF}_i + \varepsilon_i$$

$$\mathrm{PERF}_i = \beta_0 + \beta_1 \mathrm{SPECIFINNOV}_i + \beta_2 \mathrm{RISKMGT}_i + \beta_3 \mathrm{LOGTA}_i + \beta_4 \mathrm{RF}_i + \varepsilon_i$$

Where:

- PERF_i: designates the performance of bank_i as mesured via ROA and ROE,
- RISK INNOV_i: the innovation related risk relevant to bank_i as measured via the standard deviation (σ ROA).
- HORIZ INNOV_i: bank_i associated long-horizon innovation, as measured via PER ratio,
- SPECIF INNOV_i: the innovation specificity relevant to bank_i, as measured via the ratio: intangible assets / total assets.
- RISK MGT_i: total risk related to bank_i, as measured via the VaR variable,
- LOGTA_i: size of bank_i, as measured via the natural logarithm of the total assets,
- RF_i: bank_i associated financial ressources, as measured via the average net profit.
- $\beta_0, \beta_1, \beta_2, \beta_3, \beta_4$: Parameters to estimate.
- ε_i : random error,

4. Empirical results

This section is devoted to depict the four hypotheses reached test results, relating to financial innovation as apprehended via risk level, innovation associated horizon and specificity and to bank performance as estimated through risk management.

4.1. Assessment of the hypothesis related to the model "innovation risk / management risk / bank performance"

This hypothesis is designed to test the mediating role or effect associated with the risk management variable ("RISK MGT"), in the relationship binding the innovation related risk ("RISK INNOV") and bank performance ("ROA" and "ROE"). For the purpose of evaluating our set hypothesis, we consider estimating some distinct regression-models relevant to each of the Baron and Kenny (1986) approach associatd three steps.

Model 1 (reduced model) simultaneously involves the independent variable along with the control variables, intended to predict banking performance. As for model 2 (reduced model), it is designed to help explain the variation associated with the variable "RISK MGT" (a third-step mediating variable), as estimated through the variable "RISK INNOV" along with some control variables. Regarding model 3 (full model), it involves the entirety of variables: the independent variable (RISK INNOV), the mediating variable ("RISK MGT") along with with the control variables (size and financial resources), with the aim of providing a plausible explanation helping depict banking performance.

In effect, the relationship binding the variable "RISKINNOV" and "ROA" proves to display a moderately strong explanatory power (adjusted $R^2 = 0.534$). As for the model's overall quality, it turns out to be significantly acceptable ($F = 21.257$, $p < 10\%$, Table 2). It is certain that at least one of the explanatory variables brings a significant contribution amidst the overall fluctuations marking the "ROA". Noteworthy, however, is that on measuring performance by means of "ROE", the concerned model turns out to exhibit a lower explanatory power (adjusted $R^2 = 0.031$), along with an insignificant Fisher test ($F = 0.473$; $p>10\%$). As for the Student tests, they appear to reveal that the variable "RISKINNOV" turns out to have a positive and significant impact on economic performance ($ß = 0.580$, $t = 6.025$, $p <1\%$). Indeed, this result does partially **validate** the sub-hypothesis (**$H_{1\text{-}1}$**).

Table 2- Testing Mediator Effects Using Multiple Regression for Model 1 to 3

Testing steps in mediation model	**Beta**	**T-Student**
Testing Step 1		
Outcome: ROA		
Predictor: RISK INNOV	0,580	6,025***
Control variables: LOGTA	-0,377	-3,956***
RF	-0,043	-0,448 n.s
Statistic model	**Adjusted R^2 = 0,534 ; F value = 21,257*** **	
Outcome: ROE		
Predictor: RISK INNOV	0,0510	0,353 n.s
Control variables: LOGTA	0,153	1,080 n.s
RF	-0,056	-0,393 n.s
Statistic model	**Adjusted R^2 = 0,031; F value = 0,473 ns**	
Testing Step 2		
Outcome: RISK MGT		
Predictor: RISK INNOV	0,007	0,052 *
Control variables: LOGTA	-0,372	-2,79 *
RF	-0,035	-0,266 n.s
Statistic model	**Adjusted R^2 = 0,097; F value = 2,790***	
Testing Step 3		
Outcome: ROA		
Predictor: RISK INNOV	0,099	0,653 n.s
Mediator : RISK MGT	0,077	0,764 *
Control variables: LOGTA	-0,406	-3,944 ***
RF	-0,045	0,475 n.s
Statistic model	**Adjusted R^2 = 0,630; F value = 25,956*** ** Adjusted R^2 variation = 0,096	
Outcome: ROE		
Predictor: RISK INNOV	0,050	0,346 n.s
Mediator : RISK MGT	0,579	5,994 ***
Control variables: LOGTA	0,116	0,759 n.s
RF	-0,059	-0,415 n.s
Statistic model	**Adjusted R^2 = 0,108; F value = 2,980*** Adjusted R^2 variation = 0,077	

(Thresholds: *** significant at 1 %, ** significant at 5 %, * significant at 10 %, n.s: non significant).

As for the second condition, it consists in demonstrating the independent variable's "RISKINNOV" remarkable impact on the mediator variable ("RISK MGT"). It appears from equation (2) (reduced model), figuring on table 2, that the relationship binding the variable innovation risk and the bank's risk management proves to be statistically significant at the level of 10% (ß = 0.007, t=0.052, p <10%). Hence, the second Baron and Kenny (1986) approach related condition turns out to be verified. These findings allow us to **accept** the sub-hypothesis **($H_{2\text{-}1}$)**. In this way, our empirical results prove to confirm well that innovation risk helps noticeably entice commercial banks to manage their risk rather effectively so as to achieve the desired performance.

In a last stage, the ultimate condition remains worth verifying, namely, the predictive variable's "RISKINNOV" effect on the dependent variable (bank performance), which should no longer remain significant once the mediating variable (RISK MGT) is considered. In effect, the third regression reached results appear to indicate that "RISK MGT" (as a mediator variable) proves to stand as noticeably important in explaining the dependent variable (both measures of performance) on accounting for the predictor variable. Indeed, the variable "RISK MGT" turns out to display a positive and significant coefficient relevant to the ROA (ß = 0.579, t=5.994, p <1%) and the ROE (ß = 0.077, t=0.764, p <10%). Accordingly, it could be noticed that risk management proves to represent an important element useful for explaining the dependent variable. Consequently, the third condition is in turn respected. Such a finding helps in **supporting** the sub-hypothesis **($H_{3\text{-}1}$)**.

The same table indicates that on introducing the innovation risk variable in the model's third step, simultaneously with the initial variables and the mediator variable, the "RISKINNOV" variable associated coefficient turns out to bear a non-significant value relevant to the ROA (ß = 0.099, t=0.635 p >10%), and also in relation to the ROE (ß = 0.050, t=0.346, p >10%). This finding enables us to check the fourth and last condition related to the Baron and Kenny (1986) methodology. Indeed, the managerial risk mediation between the innovation risk and bank performance is discovered to be almost complete for the ROA, though partial for the ROE. Such a result leads us to support the partial hypothesis associated with the mediating effect. Thus, sub-hypothesis **($H_{4\text{-}1}$)** can be considered to be **accepted.**

Additionally, the direct and indirect effects of the variable "innovation risk" on performance prove to be significantly reliable in regard to the present study. The innovations related risk proves to help in considerably increasing the the bank's performance through its effect on risk management.

According to table 2, still, the third regression equation (full model) appears to exhibit an explanatory power that is moderately acceptable for a specific measure of banking performance: the ROA. More particularly, this regression which serves to account for the mediating effect of risk management, helps in enhancing the predictive power of the performance prediction model relevant to the first regression equation (without any consideration of the risk management mediating effect). Concerning the case in which performance is measured via "ROA", the adjusted R^2 goes up from 0.534 to 0.630, and the F statistics gives evidence that equation three turns out to be noticeably significant. Similarly, concerning the case in which performance is measured by "ROE", adjusted R^2 proves to shift from 0.031 to 0.108, and the F statistic testifies well that model three appears to stand as rather significant in respect of model 1 (a non-

significant model). This increase in adjusted R^2 is naturally related to the taking into consideration of the risk management's mediating effect. Thus, the variation in adjusted R^2, relevant to both of the mediating variable incorporating models, proves to be significant (with rates of 9.6% and 7.4%, respectively). This finding highlights well that this variable proves to stand as an affective predictor of the dependent variable, i.e., banking performance.

4.2. Assessing the model "innovations' horizon/risk management/bank performance" associated hypotheses

As already cited, for an effective identification of the risk management's mediating role, Baron and Kenny (1986) document that three conditions must be verified for our advanced research hypotheses' to be validated. Both of the models four (reduced form) and five (reduced form), incorporate the independent variable (innovation's long-horizon "HORIZ INNOV") and the control variables, while successively predicting the dependent variables, namely: bank performance (measured via the ratios "ROA" and "ROE") and risk management ("RISK MGT"). As for model six (full model), it encompasses the entirety of the variables: the independent variable ("HORIZ INNOV"), the mediating variable ("RISK MGT"), the control variables (size and financial resources) along with the dependent variable: banking performance.

Table 3- Testing Mediator Effects Using Multiple Regression for Model 4 to 6

Testing steps in mediation model	**Beta**	**T-Student**
Testing Step 1		
Outcome: ROA		
Predictor: HORIZ INNOV	0,499	3,628 ***
Control variables: LOGTA	-0,049	-0,354 n.s
RF	-0,131	-1,062 n.s
Statistic model	**Adjusted R^2 = 0,188; F value = 4,059***	
Outcome: ROE		
Predictor: HORIZ INNOV	0,059	0,378n.s
Control variables: LOGTA	0,118	0,757n.s
RF	-0,059	-0,378n.s
Statistic model	**Adjusted R^2 = 0,030; F value = 0,479 n.s**	
Testing Step 2		
Outcome: RISK MGT		
Predictor: HORIZ INNOV	0,357	2,435**
Control variables: LOGTA	0,031	0,212n.s
RF	-0,033	-0,249n.s
Statistic model	**Adjusted R^2 = 0,087; F value = 2,690***	
Testing Step 3		
Outcome: ROA		
Predictor: HORIZ INNOV	0,046	0,334 n.s
Mediator : RISK MGT	0,527	3,605 **
Control variables: LOGTA	-0,081	-0,604 n.s
RF	-0,134	-1,076 n.s
Statistic model	**Adjusted R^2 = 0,198; F value = 5,359**** Adjusted R^2 variation = 0,010	
Outcome: ROE		
Predictor: HORIZ INNOV	0,056	0,357 n.s
Mediator : RISK MGT	0,097	0,645 n.s
Control variables: LOGTA	0,083	0,502 n.s
RF	-0,069	-0,492 n.s
Statistic model	**Adjusted R^2 = 0,043; F value = 0,459 n.s** Adjusted R^2 variation = 0,013	

(Thresholds: *** significant at 1 %, ** significant at 5 %, * significant at 10 %, n.s: non significant).

The reached results, as figuring on table 3, appear to confirm well that a simultaneously direct and indirect relationships between the long-horizon of innovation and economic performance, as estimated through risk management, have been depicted. Indeed, all of the three conditions specified by Baron and Kenny (1986) have been met: (1) variations in "HORIZ INNOV" significantly accounted for variations in one of the two indicators of banking performance "ROA" (ß= 0.499, t=3.628, p<1%), (2) the relationship between "HORIZ INNOV" and "RISK MGT" has been discovered to be (ß= 0.357, t=2.435, p<5%), and (3) the "RISK MGT" variable figuring in equation three has helped significantly in accounting for variations in economic performance "ROA" (ß= 0.527, t=3.605, p<5%). The regression coefficient for "HORIZ INNOV"on the ROA does not appear to be statisticallly significant (ß= 0.046, t=0.334, p>10%). It follows, therefore, that risk management tends to have a partial mediating effect on predicting banking performance. Thus, the sub-hypotheses **$H_{1\text{-}2}$**, **$H_{2\text{-}2}$**, **$H_{3\text{-}2}$** and **$H_{4\text{-}2}$** can be considered to be acceptingly **validated.**

It is also important to note that the adjusted R^2 associated value has increased with each dimension of banking performance in the final model (including both of the direct and indirect effects, with rates of 19.8 % (ROA), 4.3% (ROE), respectively; while regarding the direct effects, the only model yields were 18.8% (ROA), 3.0% (ROE)). The adjusted R^2 variation, associated with the inclusion of the mediating variable, is discovered to be significant, indicating that this variable proves to stand as an effective predictor of the dependent variable (banking performance). Such a finding indicates well that the weak explanatory power associated with the traditional governance model could have its explanation in the quasi absence of analysis relevant to the intermediary variables' mediating effect in the causal relationship binding financial innovation and banking performance.

4.3. Assessing the model "specificity of innovation/risk management/bank performance" related hypotheses

For the purpose of highlighting the mediating role associated with risk management, in the relationship binding innovation specificity ("SPECIF INNOV") and banking performance ("ROA" and "ROE"), the Baron and Kenny (1986) proposed approach has been implemented and detailed in the paragraphs below.

Table 4 - Testing Mediator Effects Using Multiple Regression for Model 7 to 9

Testing steps in mediation model	**Beta**	**T-Student**
Testing Step 1		
Outcome: ROA		
Predictor: SPECIF INNOV	0,395	2,485 **
Control variables: LOGTA	-0,273	-1,717 *
RF	-0,134	-1,046 n.s
Statistic model	**Adjusted R^2 = 0,321; F value = 5,851*** **	
Outcome: ROE		
Predictor: SPECIF INNOV	0,097	0,489 n.s
Control variables: LOGTA	0,190	0,962n.s
RF	-0,122	-0,769 n.s
Statistic model	**Adjusted R^2 = 0,039; F value = 0,493n.s**	
Testing Step 2		
Outcome: RISK MGT		
Predictor: SPECIF INNOV	0,171	0,911 **
Control variables: LOGTA	-0,221	-1,174 n.s
RF	-0,082	-0,540 n.s
Statistic model	**Adjusted R^2 = 0,093; F value = 2,720***	
Testing Step 3		
Outcome: ROA		
Predictor: SPECIF INNOV	0,121	0,704 n.s
Mediator : RISK MGT	0,414	2,560**
Control variables: LOGTA	-0,297	-1,824 *
RF	-0,143	-1,105 n.s
Statistic model	**Adjusted R^2 = 0,338; F value = 7,676*** ** Adjusted R^2 variation = 0,017	
Outcome: ROE		
Predictor: SPECIF INNOV	0,117	0,584 n.s
Mediator : RISK MGT	0,108	0,783 *
Control variables: LOGTA	0,163	0,807 n.s
RF	-0,132	-0,822 n.s
Statistic model	**Adjusted R^2 = 0,119; F value = 3.012*** Adjusted R^2 variation = 0,08	

(Thresholds: *** significant at 1 %, ** significant at 5 %, * significant at 10 %, n.s: non significant).

The relationship between the variable "SPECIF INNOV" and "ROA" (model 7) proves to display a high explanatory power (adjusted R^2 = 0.328). The overall quality of the model is significantly acceptable (F = 7.676, p<1%, Table 4). It is certain that at least one of the explanatory variables appears to bring a significant contribution amidst the overall fluctuations marking economic performance. However, once performance is measured by "ROE", the concerned model proves to exhibit a very weak explanatory power (adjusted R^2 = 0.039) along with an insignificant Fisher's test statistic (F = 0.393; p>10%). As for the Student test statistics, they appear to reveal well that the variable "SPECIF INNOV" proves to have a positive and significant impact on economic performance (ß = 0.395; t = 2.485, p < 5%). Indeed, this result does partially **validate** the sub-hypothesis (**$H_{1\text{-}3}$**).

Concerning model 8, it stands as statistically significant at the threshold of 1% (F = 2.720), while the variable "SPECIF INNOV" is discovered to be positively and significantly associated with the Tunisian banks associated "RISK MGT" (ß = 0.171, t = 0.911, p < 5%, (see Table 4)). Thus, the second condition advanced by the Baron and Kenny (1986) approach turns out to be verified. Actually, these results lead to the **acceptance** of the sub-hypothesis (**$H_{2\text{-}3}$**).

As for the Model 9 administered tests (full model), they prove to indicate that "RISK MGT" (as a potential mediating variable) remains significant in explaining the dependent variable (both forms of banking performance) on considering the predictor variable. The statistical coefficient associated with the variable "RISK MGT" appears to bear a positive and significant value relative to both of the "ROA" (ß = 0.414, p < 5%) as well as the "ROE" (ß = 0.108, p < 10%). Based on these achieved results, the third condition proves to be entirely fulfilled. This result allows **supporting** the sub-hypothesis **(**$H_{3\text{-}3}$**)**.

Table 4 figuring results highlight that the variable "SPECIF INNOV" associated coefficients are by no means statistically significant, whatever might be the performance measurement applied, though they have been statistically significant over the first step of the Baron and Kenny's (1986) proposed model. It follows, therefrom, that mediation, as undertaken through the "RISK MGT", is discovered to be achieved between innovation specificity and banking performance ("ROA"). These findings allow us to **accept** the validation of sub-hypothesis (**$H_{4\text{-}3}$**).

It is, therefore, likely that the relationship between financial innovation (characterized with a high-risk level, long-term return and strong specificity) and performance increase (ROA and ROE) proves to be rather enhanced in banks with a noticeable risk managing tendency. Based on these research findings, there is ground to conclude that the hypotheses 1, 2, 3 and 4 turn out to be well sustained and consolidated.

Indeed, the tests' results, relevant to the sub-hypotheses **$H_{1\text{-}1}$, $H_{1\text{-}2}$ and $H_{1\text{-}3}$**, prove to reveal well that the impact of the variables "innovation risk", "innovation horizon" and "innovation specificity" on economic performance is direct. Consequently, the **hypothesis H1,** stipulating that innovation has a positive effect on banking performance is actually **validated** with respect to the Tunisian context. Accordingly, should the bank aspire to increase performance, it is

compelled to engage in financial innovations. This idea corroborates well the findings documented by Coccia (2016), Rubera & Kirca (2012) as well as Kor and Mahoney (2005).

As regards the results relating the three dimensions of financial innovation (risk, horizon and specificity) to risk management, they prove to confirm the sub-hypotheses **$H_{2\text{-}1}$**, **$H_{2\text{-}2}$** and **$H_{2\text{-}3}$**. They outline well that the impact of financial innovation on risk management is significant and direct. Thus, **hypothesis H2 is validated** with regard to the Tunisian banks' context. Most often, financial innovations are frequently used as a shield to protect against market volatility, and as a risk hedging instrument, as confirmed in the studies conducted by Kraus and Lehner (2012), Blondel and Gaultier-Gaillard (2006), along with Greuning and Bratanovic (2003).

Concerning the tests estimating the relathionship "risk management/banking performance", the results of hierarchical regressions prove to validate the sub-hypotheses **$H_{3\text{-}1}$**, **$H_{3\text{-}2}$**, and **$H_{3\text{-}3}$**, highlighting that the variable "innovation risk" positively affects the banks' performance. Consequently, **hypothesis H3 is validated** with regard to the Tunisian bank's context. This idea is in conformity with the line thought of Brown et al. (2009), confirming that risk management stands as an important undertaking for banks to create value.

As a result, the final hypothesis **H4** outlining the indirect effects of the variable "financial innovation" on banking performance through risk management turns out to be satisfied. In addition to the hypotheses already validated (**H1, H2 and H3**), the conducted hierarchical regressions do, in turn, validate the sub-hypotheses **$H_{4\text{-}1}$**, **$H_{4\text{-}2}$**.and **$H_{4\text{-}3}$**. Consequently, the **hypothesis H4** advancing that financial innovations positively influence the banks' performance, as mediated via risk management, **is validated** within the Tunisian context ramework**.** This finding corroborates well the results documented by Dowd (2005) along with Edwards and Bowen (2005). By effectively managing the innovative products related risk, banks could well achieve performance increase, thereby, reducing bankruptcy risks and corporate cash flow variability and instability.

In sum, even though the direct effects of the three financial innovation related dimensions (risk, horizon and specificity) on banking performance are significant, these effects do not appear to bear any noticeable significance on introducing "risk management" as a mediator variable. In addition, the variable "financial innovation" proves to have a positive and significant effect on "risk management". These risk management activities do, in turn, positively affect "banking performance" and, consequently, the direct effects of the three financial innovation related dimensions on performance turn out to decrease. This finding reveals well that the impact of the variable "financial innovation" on "banking performance" turns out to be simultaneously direct and indirect.

It is worth specifying, then, that the introduction of the mediating effect in the complete model proves to help improve the model's global significance. Indeed, incorparating the mediator variable "risk management" allows improving the model's explanatory power.In this context, it is necessary to outline that the weak explanatory power of the traditional corporate governance model might well have its justification, according to these achieved results, in the quasi absence of analysis of the risk management mediating effect in the cause-effect relationship between financial innovation and performance.

In sum, the present study achieved results turn out to have important implications, both theoretically and practically. On the one hand, our research provides a further contribution to existing knowledge by proposing an integrative model enabling to measure the simultaneous

effect of the financial innovation characteristics on risk management and performance. Indeed, to the best of our knowledge, mediating-variable modeling, as undertaken in the current research, has not yet been thoroughly developed in the corporate-governance related literature. Still, the present modest study serves to provide an initial step towards responding to such an issue, both conceptually and methodologically.

It is also worth mentioning that our reached findings appear to demonstrate well that Tunisian banks prove to have interesting motives and benefits leading them to invest in financial innovation, enticed mainly by the desire to significantly increase their performance. Moreover, if one is to focus on the individual effects of financial innovation, our results appear to suggest that these banks would take advantage from placing a high value on the risk, horizon and specificity aspects of the assets. As a matter of fact, three variables seem to be positively and significantly associated with these banks' performance, as investigated through the risk management dimension. The mediating effect of risk management, though partial, has been demonstrated to be prominent as far as these variables are concerned. Similarly, this modest study provides a further contribution to the relevant literature, given the fact that, so far, it is only the investment decision that has often been taken into consideration, overlooking the financing decision.

4. Conclusion

The objective of this empirical study has been to analyze the links associating the financial innovation, risk management and performance dimensions relevant to the deposit banks operating in Tunisia. The empirical analysis has been conducted on a sample involving six commercial banks listed on the Tunis stock market, and observed over the period ranging from 2008 to 2017.

The findings reached prove to indicate well that Tunisian deposit banks appear to respond positively to the technological developments concerning banking products and services. Indeed, financial innovations are discovered to have a positive impact on improving the Tunisian banks' performance. Additionally, these innovative procedures appear to play a critical role in reducing and attenuating banking risks and effectively managing them.

Similarly, a positive relationship has been discovered to persist between the risk management procedure and performance dimension associated with Tunisian banks. Actually, it appears clear that these two factors prove to vary in the same direction. In effect, the most efficient of these banks are those which manage the related risks in the most effective ways.

Ultimately, one could well deduce that an indirect and positive impact of financial innovation seems to be noticeable on the performance of Tunisian banks, as mediated by risk management. Therefore, an effective risk management, through the deployment of different financial innovation procedures, seems imposed for a noticeably efficiet and improved performance of Tunisian banks to take place.

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