R&D and Innovation Empirical Analysis for Tunisian Firms

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R&D and Innovation

Empirical Analysis for Tunisian Firms

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Abstract. In the context of economic globalization and of the internationalization of R&D activity, innovation is becoming one of the most important assets for corporations in developed and emerging countries as well. The aim of this research is to analyze the main determinants of technological innovation of Tunisian firms on the basis of the innovation survey conducted by Tunisian Ministry of Scientific Research, Technology and Skills Development in 2005. Precisely, we analyze the effects of the external technological factors and In house R&D effort variables on innovation performances of Tunisian firms. We, then attempt to explore these relationships and see if they are affected by other moderator variables linked to exportation intensity and foreign capital share. In our estimation, we utilize the binomial logit model. Our preliminary results show that R&D activity is not the only explanatory factor of the innovation. In addition, Tunisian firms with high export ratio as well as firms with significant foreign capital participation are found to be not innovating since they depend primarily on the innovations conducted abroad.

Keywords: Technological Innovation, R&D, Developing Countries, Estimation, Logit Regression, Interactive variables, Exportation Intensity, Foreign Capital share.

1. Introduction

During the two last decades, the R&D activity has become a crucial indicator to measure the development of firms and hence nations and countries. The most important firms in the world, from different industrial or service sectors, have their own labs where they can do research in order to create new products and processes or simply improve the ones they already have. Consequently this activity has been a must for these firms to maintain their position in the market as well as their competitiveness. Many scholars have shown in their theoretic and empirical studies that the economic growth is strongly linked to the R&D activity. For instance Guellec and van Pottelsberghe (2004) show in their article that the long-term impact of private and public R&D investments is relevant. Moreover, R&D investments enable firms to take advantage of R&D spillovers from public and foreign R&D as well. In other words, R&D activity has not only a direct effect on the economic growth but also an indirect effect which is measured in terms of absorptive capacity. Besides, R&D cooperation has emerged as a potent way to cope with cost pressures and technological complexity as it makes knowledge a more public good. The cooperation networks can involve both local and foreign research institutions as well as local and foreign customers and suppliers. These interactions are affected by the existing institution's framework generally called « National System of Innovation » (Nelson (1993).

The literature of National System of Innovation is more concerned by the innovation's borders in the industrialized countries than the technological adaptation capacity in the developing countries. Nevertheless, the concept itself can be adopted in these countries (UNIDO 2003, Edquist and McKelvey 2001). In fact, even though the R&D activity has first emerged in the developed countries, some mechanisms of the National innovation System can potentially be adapted in some developing countries and lead to efficient embryonic innovation systems. Such adaptation is supposed to generate a National Innovation Capacity and has to be founded on four basic objectives:

- The identification of the key economic sectors to be favored by the system.
- The promotion of the incentives of innovation and technological diffusion.
- The definition and implementation of adapted funding policies and Cooperation R&D arrangements.

- The definition of global networking programs in R&D activity especially for the emergent sectors.

In theory, the configuration of a specific innovation system depends particularly on the sectoral specialization of the country or the region. The Sectoral System of Production and Innovation advanced by Malerba (2002, 2004) provides an understanding of the complex articulation that exists between the innovation systems and the sectoral specialization. It is a set of new and established products for specific uses and a set of agents carrying out the necessary interactions for the creation, production and sale of those products. Malerba underlines the fact that the Sectoral Systems undergoes processes of change and transformation through the co-evolution of these interdependent various elements including technologies, markets, organizations…etc. Nevertheless, R&D is still the most important component of this system ad concerned as determinant of Innovation that's why the relation between R&D and sectoral Innovation particularly should be well established in order to define the appropriate instruments devoted to promote technological innovation and hence sustain a better competitiveness.

In developing countries, where modern, emergent and traditional sectors co-exist, the R&D activity is crucial. For traditional sectors which are characterized by a high potential in terms of competitiveness and employment opportunities, Innovation can be efficiently practiced due to the experience and the culture issues of the local economic system. Otherwise, the new potentially innovating sectors have to be promoted in such a way that equilibrium between them and the traditional strategic sectors can be established. The targeted equilibrium then occurs when there is a consideration of the differences in innovation practices and strategies required when we move from traditional to emergent sectors. In traditional sectors, firms do not need to create special R&D units or labs, the innovation is much more incremental and continuous in time. Concretely, products or production processes are improved in order to maintain good quality and competitiveness or simply to enlarge the product range and introduce differentiation. Consequently, the innovation in this context is not disrupting and is enrolled in strategic policies of the firm as a way to gain in productivity and acquire new market sales. On the other hand, in the emergent sectors, the evolution is very fast and complex which induces the necessity of a more structured R&D. Firms are concerned by radical innovation to their products and production processes that undergo a total modification from a generation or a version to another and hence require remarkable evolution in professional skills. The structured R&D allows the

accumulation of knowledge and the improvement of technological learning which constitute the key factors to enlarge the absorptive capacity. This process takes time and is proved to be costly compared to the other innovation practice. For this reason, it has to be supported by continuously improved infrastructures (especially in the field of Information and Communication Technologies), very solid funding programs and a stable and efficient governance system.

All these innovation features are to be examined to provide a better understanding of how to conduct with efficiency this risky R&D activity especially in the developing countries.

In the context of Tunisian economic globalization and of the internationalisation of R&D activity, innovation is becoming one of the most important assets for the Tunisian corporations. Indeed, the free trade agreement with the European Union, and the progressive dismantling of the tariff barriers, create for the young Tunisian industry a situation in total rupture with the protectionist orientation which prevailed until the end of the eighties. One of the most remarkable characteristics of this new competitive environment is the shortening of the lifespan of the products and the processes, and the acceleration of the renewal and the diversification of the ranges. Under these conditions, it is impossible for a company to be competitive if it is unable to integrate the innovations, and to ensure the strategic management of its technology. R&D, technological agreement with universities, laboratories, and foreign research organisations ensure the prosperity of the firms by consolidating their competitiveness, and by improving their profitability, their performance and their positioning within both traditional and new markets.

Actually, the major orientation of Scientific and Technological Innovation policy of the Tunisian government consists of encouraging enterprises and industrial support institutions to integrate innovation, technology transfer and R&D in their strategies.

In Tunisia, since the resources are limited, the idea is to implant technoparks[1] all over the country to establish the ties between training, research and production, to support start-ups and favour the incubation and creation of innovative enterprises by promoting the results of research. Besides the modernization and the improvement of the competitive capacity of the national industrial system, this

[1] *Tunisian Government has planned to create 10 technoparks (with average of one technopark per year). Actually 8 technoparks has been established. Moreover many measures have been taken for the development and privatization of ICT (Information and Communication Technology) sector considered as a determinant for the prosperity of the Knowledge Economy*

policy makes possible the integration into the free-trade zone planned with the European Union. For Tunisia, as for LDC's, the analysis of innovation performance and the determination of the key factors that can enhance innovation ability is one of the most interesting topics for contemporaneous business orientation.

In this paper, we are concerned by studying the impact of the capital opening to the foreign investment as well as the exportation intensity on the innovation activity of Tunisian firms on the basis of innovation survey conducted by the Tunisian Ministry of Research for the period 2003-2005. Precisely, we will examine the effects of the common innovation determinants such as R&D, firm size, cooperation…etc on the innovation activity and explore how these effects are moderated by the intensity of exportation and the foreign capital share.

This paper is organized as follows: Section 2 provides a brief description of the R&D activity and innovation in the South Mediterranean countries and more particularly in Tunisia. Section 3 presents a literature review on internal and external determinants of innovation. Section 4 introduces the methodology used for the empirical study including data and econometric specification. Eventually, section 5 contains concluding remarks and enumeration of the main results of the study.

2. Innovation in South Mediterranean Countries

None can deny the existing gap in the R&D and innovation sector between the North and the South. The performance of research and innovation of firms and universities from the North bank is very high and dynamic compared to the other bank. As illustration the portion of the Maghreb does not exceed 0.2% from the global scientific publications (all disciplines included). Research, then in this part of the world is limited and does not really contribute in the accumulation of knowledge and enhancement of the productive system. In Algeria, for instance, the budget dedicated to Research represents 0.35% from the GDP in 2004. Research is almost totally funded from public organizations but there are not any tools or programs to make it concrete and valuable. The creation of innovating firms is exclusively the mission of large Algerian enterprises (Sonatrach, Sonelgaz, Electricité d'Algérie..) (Khalfaoui ,2006). For Morocco and Tunisia, despite the

existence of programs to incite for R&D and value innovation, research is facilitated mostly by public sectors[2].

As far R&D output is concerned, only few patent applications from these three countries of the Maghreb are deposited in the European office of patents. They are totally absent in the American Office (OST 2006). These figures resume the R&D situation in the Maghreb where the integration of innovation and research in the private sector is not a part of their business priorities due to the specialization of these emerging nations in the mass production and in low technological intensity sectors. Nevertheless, the major orientation of Scientific and Technological Innovation policy of the Tunisian government consists of encouraging enterprises and industrial support institutions to integrate innovation, technology transfer and R&D in their strategies. For Tunisia, as for the other countries of the Maghreb, the analysis of innovation performance and the determination of the key factors that can enhance innovation ability is one of the most interesting topics for contemporaneous business orientation.

Furthermore, during this first decade of the 21st century, there is a trend of globalization of R&D all over the world of which the transnational firms are considered the main actors. In these firms, the R&D represents almost half of the global R&D and more than 2/3 of firms R&D activities (valued at 450 billion dollars) (UNCTAD 2005).

The consequence of R&D globalization is immediately detected through the dynamicity of R&D activities in the developing countries. In fact, the transnational R&D in the emerging countris has increased from 2% in 1996 to reach 18% in 2002 with a remarkable concentration in Asia and more particularly in China and India (with respectively 35, 3% and 25% of foreign investments). For South Mediterranean countries, the only country that hosted the transnational R&D is Israel with 4,4 % of actual investments. Recently, the Maghreb has become a destination for the transnational firms that intend to invest in R&D in modern and emerging sectors[3] besides the strategic sectors (Petroleum, agriculture.). In this

[2] *In Tunisia 78% of total R&D is funded by public sector,12.5% by private sector and 9.5% by foreign investments.*

[3] *The French firms SQLI (Software) and Eolane Electronics has respectively installed their R&D centers in Morocco in 2003 and 2004. In the automobile industry sector, Pinfarina/Matra (Italy) has established its R&D center in Morocco in 2004. More recently, during 2008 the German firm Kromberg &Schubert has installed the first R&D center in Tunisia in component sector and is planning to invest 700 K euro by 2010.*

Region, the establishment of the free trade zone and the R&D globalization constitute the most important assets to strengthen the technological abilities of the local corporations and enhance the development of services and products with a high added value. The foreign Direct Investment in R&D then contributes in the strengthening of the innovation system and modernization of different industries and technologies through the R&D spillovers and the leakage of knowledge. However, these spillovers are not valued automatically through foreign R&D and require economic capacity absorption from the host country in order to contribute in its development (UNCTAD 2005).

3. Literature Review

In general, the innovation activity depends on the absorptive capacity of the firm in creating and acquiring the necessary knowledge that serves not only, at creating inventions but at marketing and launching these innovations. This creative capacity of the firm stems from its expertise in resolving its internal issues as well as its external productive capability of creating strategic alliances and forging solid partnerships with its suppliers and its buyers.

In this context, many research studies have provided reasons for the success of the innovation activity by identifying some key factors. These successful factors include the firm's sector of activities, its size and the type of the innovation. However, some studies based on the Schumpeterian school argued that the correlation between the firm's capacity to innovate and its market power is yet to be founded.

But the most important factor of innovation is driven by the R&D activity. However, the value of the R&D activity is directly related to the core competencies of the firm as well as to its efficient innovative processes. The studies by Baldwin & Hanel, (2003) and Duget, (2000), have proven that the firms which spent more resources on R&D activities have the most competitive advantages in the radical innovation and claim more inventions rights. Hall & Bagchi-Sen (2002) studied the relationships among R&D intensity, innovation measures, and business performance in the Canadian biotechnology industry between 1994 ans1997. Their research findings are mitigated. In deed, they found that R&D intensity correlates with patent measures as proxy of innovation. However, there is no significant correlation between R&D intensity and product or process related innovation. Sher & al (2005) investigates the effects of various aspects of innovative capability on

firm performance in electronics Taiwan industry. They demonstrate that R&D activities accelerate innovations development inside the company leading to realization of superior financial performance. Tsai (2005) examine the impact of R&D on innovative performance as measured by total factor productivity and found that the efficiency of R&D expenditures in both small and large firms is significant in achieving higher productivity and competitive advantage.

Besides, R&D, the cooperative strategies with different actors in the industry can be decisive factor of the performance of the innovation activity. Fritsch & Lukas (2001) argued that the cooperation depends primarily on the specificity of the innovation, the size of the firm and its human capital.

Other studies, related to the business management approach, focused on the internal characteristics of the firm as critical factors of the innovation behavior. These internal characteristics stem from the resources and the tangible and intangible cumulative capabilities of the firm which make-up its core competencies. These resource-based competencies include the technological competencies due to the intensive R&D activities as well as the human resources competencies based on skillful and cumulative know-how capabilities. Other factors, such as organizational competencies based on the internal performance of the communication process contribute to further strengthening the resource-based competencies of the firm and stimulate its innovation activities.

These aggregated resources allowed the firm to develop an innovative strategy based on its internal strength as well as on the appropriation of the external technology-based knowledge. Cohen & Levinthal (1989) defined the results of the research as a process that included any original and useful knowledge acquired for and by the public domain, whether it was a radical innovation or a cumulative knowledge. These spillovers would be felt when R&D efforts deployed by those firms create externalities that can impact the innovative decisions of other organizations and other actors of production. But, how can those firms benefit from those spillovers? Cohen & Levintahl, (1989) argued that research activity can facilitate the dissemination of the knowledge provided by the external sources and consequently, in house R&D, and the external R&D complement each other.

The adoption of the new technologies requires an absorptive capacity of the innovative firm. Hence, if the outcomes of R&D lead to the flow of the non

incorporated technologies, otherwise, it is the absorptive capacity of the firm that determines the effective level of the R&D activities outcomes. Firms are destined to learn from these external technologies through their intangible investment processes. These investments represent essential factors of the firm's absorptive capacity of the external technologies, in particular, those information technologies that are of public domain and are of complex and cumulative nature.

Other studies highlighted the importance of learning by interacting. This is a learning process through knowledge sharing and tying the firms to other actors of the socio-economic environment. These interactions, often lead to trustworthy cooperative ties that facilitate the exchange of useful information between firms and their clients and other stakeholders as well. These interactions led to the creation of networks of synergies based on cumulative studies and shared knowledge among the members of the same network. These networks grew out of structured performances based on the transfer of the new knowledge. Such transfer led to the flexibility and the fluidity of the exchange of information and knowledge available in hybrid structures made up of a market economy in one extreme and administrative hierarchy on the other. The learning by interacting can involve many actors including clients, rivals, suppliers, research centers, consultants, and centers of knowledge transfer.

In conclusion, the precedent studies of the relationship between the learning process and the innovation pinpointed the different forms of the learning curve. Among the most prevailing forms of the learning, we cite the learning by learning and the learning by interacting. Furthermore, these studies highlighted the importance of the innovation to the activities of the firm. These innovations are tributary to external factors favorable to the learning process and belonging to certain productive industries. Other attributes of the learning process are related to the firms' sizes, their exporting activities, their structures, and their productive resources. All these factors are vital to the innovation process of the firm.

4. Empirical study

4.1. Data Description

Our empirical study is based on the innovation survey conducted in 2005 by the Ministry of Scientific Research, Technology and Skills Development in Tunisia. The survey measures the innovation intensity of Tunisian firms for the period 2002-2004. A sample of 586 firms was mailed and asked to respond to a questionnaire

that include, besides their characteristics (recruitment, turnover, exportations, foreign capital share..), several items related to R&D activities, employees skills, level of innovation and innovation obstacles. It also includes information about R&D cooperation with universities, research centres ad foreign investors as well as information about government mechanisms and tools in order to value innovation and promote R&D in Tunisia. In our study we are interested only to manufacturing firms. After eliminating companies in service activity we obtain a sample of 543 (Appendix 1)

4.2. Variables Description

The variable INNOV is a dichotomous, qualitative variable which takes the value 1 if the firm has undertaken process or product innovation during the period 2002-2004 and the value 0 otherwise. For the product innovation, there is no distinction between innovation for the firm or for the market.

R&D is measured through two variables. RD which is a dichotomous, qualitative variable takes the value 1 if the firm has R&D activity and 0 otherwise. In case of existence of R&D activity, and in the same orientation of Hall & Bagchi-Sen (2002), Nieto & al. (2005), Shefer & al. (2005), we define RDI (R&D intensity) as the share of R&D costs in the total of expenditures dedicated to innovation. This variable is codified over an ordinal scale of 0-4. We have restrained the total expenditure of innovation as a basis for our calculations instead of the turnover because the Tunisian firms dedicate only a very little proportion of the turnover to innovation activities. The total expenditures of innovation include patents acquisition, costs for training and for technological learning methods and tools as well as product improvements…

As for cooperation, the partners considered in our survey include universities, research laboratories, research centres, foreign corporations and firms. COOP (technological cooperation) is a variable scaled from 0-5 to measure the number of firm's partners.

SIZE is a multinomial variable to measure the size of the firms and is codified aver an ordinal scale 1-4. It represents the level of the firm turnover relative to the industrial sector in which it operates. Rather than testing the Schumpeterian hypothesis, the objective is to check if there exist disparities in the size impact from one sector to another or not.

SKILL is a variable that measures the skilled labour intensity and is calculated on the basis of the proportion of qualified employees (managers and high qualified personnel in the administrative, technical and R&D departments) over the total number of employees. Its value is codified over an ordinal scale ranged from 0-5 (5 for the highest skilled proportion and 0 for the lowest proportion). This variable indicates the capability of the firm to mobilize the necessary qualifications for innovation development and new technologies acquisition.

FKI is a variable that measures the foreign capital share and is codified over an ordinal scale ranged from 0-5 where 0 stands for absence of the foreign capital share in the firm and 5 for a total foreign capital. This variable is integrated into the innovation equation in order to verify if the open capital of the firm to foreign investment leads to more innovating performances or not.

Same is for EXI which the variable that measures the share of the firm turnover dedicated to exportation. It is also codified over an ordinal scale ranged from 0-5. This variable is considered in the innovation equation to examine if it has a positive impact on firm's innovation activities. Theoretically, exportation activities constitute a real motivation for firms to innovate since the opening to foreign markets creates business opportunities and requires more dynamism in terms of innovation and research.

In addition, we consider other moderator variables. TECH is one of them. It represents the technological intensity of the sector according to the OCDE classification. It is codified over an ordinal scale ranged from 1-4 with 1 for low technological intensity sectors (LT), 2 for middle-low technological intensity sectors (MLT), 3 for middle-High technological intensity sectors (MHT) and finally 4 for High technological intensity sectors (HT).

4.3. Econometric Specification and Estimation Techniques

As for the econometric purpose, we utilize the binomial logit model due to the qualitative nature of the dependent variable (process or product innovation). Precisely, we deploy the logistic regression since the endogenous variable is dichotomous whereas the exogenous variables are either qualitative or quantitative. Therefore, it allows us to estimate innovation propensity of the firm as a function of its in-house R&D effort, its external technological factors such as cooperation as well as moderator variables. In our modelling, when the estimated coefficient of

the explanatory variable is positive, then it affects positively the probability that the explained variable INNOV takes the value 1. In return, when the estimated coefficient is negative, then this probability is reduced.

In order to examine the different hypotheses of this research, we suggest five different econometric models.

Model 1:

$$INNOV = \beta 1 + \beta 2\,(RD) + \beta 3\,(COOP) + \beta 4\,(SIZE) + \beta 5\,(FKI) + \beta 6\,(EXI) + \beta 7\,(SKILL) + \beta 8\,(TECH)$$

The first model considers the sectoral characteristics as explanatory variables besides the specific characteristics of the firm (COOP, SIZE, RD, FKI, EXI, SKILL and TECH). The objective is to estimate, for the totality of the sample, the impact of each variable on the probability of innovation in the Tunisian firm**.**

Model 2 A:

$$INNOV = \beta 1 + \beta 2\,(RDI) + \beta 3\,(COOP) + \beta 4\,(SIZE) + \beta 5\,(SKILL) + \beta 6\,(TECH)$$

Model 2 B:

$$INNOV = \beta 1 + \beta 2\,(RDI) + \beta 3\,(COOP) + \beta 4\,(SIZE) + \beta 5\,(SKILL) + \beta 6\,(TECH) + \beta 7\,(FKI) + \beta 8\,(EXI)$$

In models 2A and 2B, we keep only 224 firms that have R&D activities during the period 2002-2004 and we propose to estimate the same equation but we replace the dichotomous variable RD by the quantitative variable RDI[4] which reflects the intensity of R&D and hence represents better the innovation process in general. In the model 2A, we try to explain the endogenous variable only by the variables RDI, COOP, SIZE, SKILL and TECH. Then in 2B, we add FKI and EXI which represent respectively the share of the foreign capital and the intensity of exportation. The main purpose is to compare these two modelling and evaluate the impact of capital opening and exportation intensity on innovation performances.

[4] *Many firms declared in the questionnaire that they have undertaken R&D activities but their R&D expenditures are null. In fact, these firms do not have an R&D account in their accounting system. These activities are then funded by another budget.*

Model 3:

$$INNOV = \beta 1 + \beta 2\,(RDI) + \beta 3\,(COOP) + \beta 4\,(RDI)*(FKI) + \beta 5\,(COOP)*(FKI) + \beta 6\,(SKILL)*(FKI) + \beta 7(SIZE)$$

Model 4:

$$INNOV = \beta 1 + \beta 2\,(RDI) + \beta 3\,(COOP) + \beta 4\,(RDI)*(EXI) + \beta 5\,(COOP)*(EXI) + \beta 6\,(SKILL)*(EXI) + \beta 7\,(SIZE)$$

In models 3 and 4, we propose to estimate the impact of R&D intensity and cooperation with partners on innovation while controlling this impact through specific variables that represent the exportation intensity and the foreign capital share. To examine the moderator effects of the interactive variables of FKI and EXI on the relationship existing between innovation, R&D intensity and cooperation with partners, we proceed as Tsai (2005) and Nieto (2005). We calculate these interactive variables by multiplying the moderating variables (FKI and EXI) by the moderated variables (RDI and COOP). By doing so, we have an indication on the impact of the R&D intensity and cooperation on innovation performances when the exportation intensity or foreign capital share is increased by one unit (a little increase).

When the corresponding estimated coefficients of these interactive variables are significant, we can confirm that the effect of the R&D intensity and cooperation on innovation depends on exportation intensity and foreign capital share.

4.4. Results

Table 1 presents the results of the regression analyses for each of the four models. In general terms, the econometric specifications have an acceptable predictive power. The percentage of correct predictions exceed 68,3% for all models. Moreover, the Chi-2 values corresponding to each model are significant which allows us to reject the null hypothesis that all parameters, except the constant, are null. Eventually, we notice that the integration of interactive variables (RDI*FKI) and (COOP*FKI) in the model 3 and (RDI*EXI) and (COOP*EXI) in the model 4 improves the explained variance since the term R^2 Mc Fadden increases from 0,27 to 0,31 and 0,33.

The results of model 1 show that for industrial Tunisian firms, the common effects of R&D, cooperation and size are verified. R&D makes possible not only the creation of new products and processes but also facilitates the absorption capacity of the firm to adapt and acquire new technologies. In addition, when a firm cooperates with partners (universities, research centres, foreign corporations…), its probability of innovation is positively affected. Big size firms are more tempted by innovation than small size firms. For Tunisian firms qualified as SME and that suffer from limited financial resources, innovation strongly depends on bank funding which is not easy for them especially for risky innovation activities.

Furthermore, our estimation reveals some surprising results in the model 1 concerning the effects of the variables SKILL and TECH. The qualification of employees and the technological intensity affect negatively the probability of innovation in Tunisian firms. The situation in Tunisia can be then interpreted as follows: the Middle or Low technological intensity firms are more motivated to innovate. This innovation does not require highly qualified personnel and mobilization of costly R&D resources. The negative sign of the variable SKILL puts into doubt the role of managers and qualified executives in the innovation process. They are not able to stimulate innovation and their vocation is rather limited to operational tasks that slow down innovation performances

Another surprising result consists in the negative effect of exportation and foreign capital share on innovation for Tunisian firms. The estimated coefficients of theses two variables are negative and significant which rejects the idea that they constitute incentives for innovation in Tunisia.

The estimation of the model 2A, confirms the results of the model 1 concerning the expected effects of R&D intensity, cooperation, firm size, personnel qualification and technological intensity. Moreover, when we introduce the variables FKI and EXI into the model 2B, the results show that their estimated coefficients are negative and significant but COOP and RDI are no more significant. Once again, our estimation proves that exportation intensity and foreign capital share have negative effects on innovation for Tunisian firms that declare undertaking R&D activities. Thus the innovation probability of exporting firm is less than innovation probability of a non exporting firm. In the same way, a local firm has more incentive to innovate than a non resident firm.

Table 1: Results of the logistic regression analyses

	Model 1	**Model 2A**	**Model 2B**	**Model 3**	**Model 4**
Intersection	- 4.765	- 5.673	- 5.673	-4.762	-5.876
RD	1.098*				
COOP	1.143*	0.342*	(ns)	1.102**	0.876**
RDI		0.453*	(ns)	0.766*	0.453**
SIZE	0.277**	0.245**	0.325*	0.324*	0.325*
SKILL	-0.123*	- 0.321**	(ns)	(ns)	(ns)
TECH	-0.415**	-0.357 * *	-0.342**	(ns)	-0.254**
EXI	-1.186*		-0.122**		
FKI	-1.089*		-0.142*		
RDI*FKI				-0.213**	
COOP*FKI				-0.342**	
SKILL*FKI				(ns)	
RDI*EXI					-0.124*
COOP*EXI					-0.342*
SKILL*EXI					(ns)
Mc Fadden R^2	0.23	0.27	0.25	0.31	0.33
LR statistics	739.657	934.123	765.34	876.671	998.876
Overall % of correct predic	76.45%	68.31%	71.34%	74.14%	77.23%
*significant at 1%; ** significant at 5%, (ns): non significant					

The models with interactive terms (model 3 and model 4) emphasize these results since the estimated coefficient of the interactive variable is negative and significant for both FKI (in model 3) and EXI (in model 4). In other words, the effect of cooperation and R&D intensity on innovation performances is reduced when FKI or EXI increase by one unit. These effects are justified by the nature of activities of exporting firms in Tunisia. In fact, the average of foreign participation in the capital of Exporting Tunisian firms is about 70%. These firms are either affiliates of foreign business groups or simply subcontracting firms which totally export abroad. In the first case, the affiliate firms in Tunisia do not conduct R&D activities since they primarily depend on innovation conducted abroad either in the parent firm or in any other attractive region of the world in terms of R&D

execution. In the second case, the subcontracting firms are just asked to respect the predefined specification and are not allowed to undertake any research activity.

5. Conclusion

The main concern of this study is to examine the significance of two main determinants of innovation such as the in-House R&D expenditures and the outside absorbed knowledge via the technological cooperation agreements. Then, it permits to explore how the relationship between innovation, R&D intensity and cooperation is moderated by exportation intensity and foreign capital share. Several results derive from this study and are of interest in explaining the innovation level of Tunisian manufacturing firms. First, the significant estimates in the logistic model suggest that Tunisian firms have to deepen their efforts in innovation by internal R&D activities and by improving the efficiency of skilled workers as well as by adopting external know how via technological collaboration agreements. Second, the efficiency of innovative efforts could depend negatively on the exporting intensity and the foreign capital share. This result corresponds to the reality of the activities of foreign direct investment and exports in Tunisia which are concentrated in the low intensive technologies sectors. Thus, the opening to the foreign capital and the opening of the economy did not lead, so far, to reinforce innovation incentives in Tunisian manufacturing sectors.

The preliminary conclusion of our study is a set of recommendations to policy makers and organisations aiming at further strengthening the innovation process of the non resident firms and the reinforcement of the activities of innovation in the high tech sectors. It is worthwhile to mention the strengthening of tools for the creation of partnerships and mutual visibility of the foreign and Tunisian research systems, the reinforcement of regional cooperation at Mediterranean level, and the development of project management capabilities for potential Tunisian participants in future research and technological development tools in the world.

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APPENDIX

Table A1: Distribution of Firms in the Sample (MRSTDC)

Sectors	No of firms	% of Total
Agro-alimentary	89	16%
Chemicals	32	6%
Electrical and electronic material	100	18%
Mechanical and Metal	64	12%
Textiles and clothing	110	20%
Leather and footwear	16	3%
Wood and cork	16	3%
Publishing and Printing	10	2%
Rubber and plastics	24	4%
Mining and energy	11	2%
Constructional material, pottery and glass industry	43	8%
Other not specified industries (Autres)	27	5%
Total	**543**	**100%**

Table A2: R&D Conducted by Resident and Non Resident Firms in Tunisia

	R&D	No R&D	Total
Non Resident (*)	36	125	161
Resident	188	194	382
Total	224	319	543

(*) Non resident firms are firms where the share of the foreign capital is higher than 50%