Innovation Determinants in Emerging Countries: An Empirical Study at the Tunisian Firms level

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INNOVATION DETERMINANTS IN EMERGING COUNTRIES: AN EMPIRICAL STUDY AT THE TUNISIAN FIRMS LEVEL

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Abstract: Explaining why some firms innovate and some others do not is an out-of-date challenge in the economic literature. In developing countries context, such exercise is even more complicated by the nature of the innovation (incremental, occasional and rarely continuous and structured).

In this paper, an exploratory tentative logistic regression is presented based on an Innovation survey on Tunisian firms. With regard to the results on the two "traditional" determinants of innovation which are the size of firms and the market structure, the main findings of this work are the following: econometric estimations have put forward the existence of an inverted "U" type relationship between decision to innovate and these two variables. On the other hand, it seems that neither skills of workers nor public incentives were significant to explain the innovation behaviour of Tunisian firms.

Key words: Industry dynamics; Innovation systems; Development economics; Sectoral systems of innovation

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Since J. A. Schumpeter literature in the early twentieth century, innovation has continued to attract the interest of researchers as a driving force for economic growth. Innovation is a key element of economic growth and job creation. States also multiply initiatives and dedicate significant proportions of their budgets to enhance innovation, support and protect innovative ideas.

At the firm level, innovation is a real engine which ensures growth and competitiveness. It includes the development of new processes (production or new and improved distribution methods), as well as new or improved products and services. At the same time, innovating firms record improved financial performance. These findings appear to be quite robust and justify concerns of decision makers and business leaders to promote innovation.

Some case studies describing the process of technological change have been published during the last few decades (Dahlman and alii, 1987; Evenson and Westphal, 1995). This work has led to a better apprehension of the main determinants and characteristics of technological innovation activities of the firms as well as their impact on economic growth. The findings highlight the crucial role of acquisition of technological capabilities by firms in the development process as well as the different nature of these determinants and characteristics of innovation activities. First, it seems that firms in emerging market countries do not develop "new" technologies, in the sense that they would be "new" at the global level. Their activities consist in a broad terms in adapting the transferred technologies (of developed countries) and using them at local level. In response, it seems that innovation activities of firms in emerging countries are "informal" and are "minor" or incremental. In fact, these activities are not carried out by a specialized labour force, but rather by engineers responsible for the production, product design, as well as the planning and organization of production capacity. However, when incremental innovations are implemented in a systematic way and over a long period, they often generate a significant increase in productivity.

The issues raised by these case studies have led to several econometric studies based on samples of firms from different emerging countries. These studies have tested, in addition to the role of "traditional determinants" on decisions to innovate, the specific determinants to these countries. Among these, the characteristics of firms, market structures, the degree of openness to foreign trade, technology transfer and the degree of exposure to foreign competition in the domestic market, have been identified in various studies. Given the differences between the samples used in these econometric studies (number of firms examined, industrial sector, periods of analysis), a comparison of results is sometimes difficult. However, these studies have the advantage of having tested some conjectures advanced by the case studies as well as the expected impact of trade reforms on innovation activities of firms in emerging countries.

Tunisia could be an interesting example to analyze the determinants of innovation activities in an emerging country. In fact, after having pursued a development strategy based on import substitution in the sixties, the economy has opted for a progressive liberal approach. Later, in July 1995, Tunisia has concluded an agreement on FTA with the European Union (EU) predicting a free-trade zone after a transitional period of twelve years.

To carry out its industrialization, and to confront the challenges linked to both the new development strategy as well at its international commitments, Tunisia has tried to make maximum use of dynamic effects accompanying the opening of its economy.

We will, therefore, try to understand the conditions associated with pro-competitive policy based on the promotion of innovation in the Tunisian case. Indeed, if one has demonstrated that success is based on innovation, there is less data on the factors explaining why firms decide to adopt an innovation policy. A number of issues will be addressed. First, to what extent does the intellectual property system helps innovation? Second, by focusing exclusively on R & D, do we ignore the importance of other factors? Third, do the size of the Tunisian firms and the structure of the market affect the intensity of innovation? Forth, what is the role of the state in the decision to innovate local firms? Finally, and how much is multinational present in Tunisia are innovative?

1. Data source

In this study data are gathered from a survey of RTD carried out in 2005 by the Ministry of Scientific Research, Technology and Development of Competencies on Innovation spending in companies from 2002 till 2004. It surveyed 739 companies with more than ten employees involved in high-valued-added sectors or sectors, with high-technology intensity.

Of those surveyed, 586 responded and 393 provided quantitative as well as quantitative data. The IT sector accounted for only 4% of the high-value added or high technology companies whereas the largest sectors were Textiles with 19% of respondents, Agrifood with 17% and Electrical and Electronic Equipment (IEEE) with almost 17%. Altogether two out of five companies claimed to have undertaken RTD activities in the period 2002-2004, the most active sectors being Agrifood followed by IEEE.

The final sample selected for our econometric estimates is composed of 507 firms omong which 322 declare they innovated in 2004.

2. Model specification

The variables to be included in a model can be chosen in different ways. The problem is to identify the most relevant variables to build a regression model that meet two conditions: having a high explanatory power while respecting the principle of parsimony; that is say with equal precision, we consider the simplest model (with fewer variables).

2.1 The dependent variable

In this work, we choose not to use the R & D expenditure of Tunisian firms as an indicator of the result of their innovation activities. Instead, a direct measure of the output of innovation from the national survey has been chosen following the procedure of Le Bas and Torre (1994) for several reasons. The most important of them is that "R & D expenditure" is a measure of the input of innovation activities and it does not teach us anything about their outcome at the technical or commercial level. Then, as illustrated by other investigations (UE CIS), these costs do not constitute the main part of spending in innovation activities.

2.2 The explanatory variables

For a given dependent variable, it is possible to imagine a broad mixture of independent variables. In fact, the review of academic studies conducted prior to data collection aims to identify a set of potentially relevant variables. Hence, we are looking by there for incorporating a sufficient number of independent variables to reflect the guiding motivation for firms to innovate.

2.2.1 Firm characteristics

We have included a measurement of the of the firm' size in order to check whether there are benefits associated with size. It is often argued that large firms tend to be more innovative than small businesses. Among the reasons given, economies of scale as well as the economies of diversification (Cohen, 1996) are usually and opportunely mentioned. In addition, it is easier for these firms to obtain financing, and they can spread the fixed costs of innovation on a larger volume of sales and take advantage of economies of diversification as well as complementarities between R & D and other manufacturing operations. However, some argue that large corporations would be less effective in terms of R & D. Levin and al (1987) have reviewed the empirical work and found it inconclusive. There may be economies of scale and diversification, but this may be wiped out long before the detailed final instalment.

In our research, the size was measured by the total number of employees, which includes production personnel and the other employees. The firms are divided into three categories based on their size: less than 100 employees, 100 to 499 employees; 500 or more employees. Based on this classification, we created three binary variables to measure the impact of the size (NEMPLCF).

Studies based on the intensity of R & D have failed to conclude whether the nationality of the owners affects innovation. According to Caves (1982), foreign participation reduced the rate of R&D in Canada. However, a lower intensity of R&D does not necessarily mean that the company is less innovative if it is an “importer of innovations” from its parent company, a multinational company. Based on the results of a survey of a limited number of firms in five industries, De Melto and al. (1980) showed that foreign firms operating in Canada had less intensive R & D activities than their counterparts in the country, but gave rise to an extremely high percentage of innovative processes.

To confirm the relevance of this finding to the scale of manufacturing sector, we have included a binary variable (NAT), which takes the value "1" if the company is owned by foreign interests and "0" if not. It will be possible to check whether foreign-controlled firms are more likely to be innovative.

In a recent study, Baldwin and Johnson (1995) using data from a survey of small and medium-sized enterprises found that the most innovative of them give more importance to skills in human resources than the least innovative. Therefore, it is important to determine the extent to which the company has acquired key skills in areas deemed critical for the purposes of the implementation of an effective innovation strategy. We have introduced into our model the qualification of the workforce (CHT), which is measured by the proportion of senior executives in the staff of enterprises.

2.2.2 The firm activities

Although R&D is not a sufficient condition for innovation (Äkerblom, Virtaharju and Leppäahti, 1996; Baldwin, 1997), its contribution is incontestably important. Firms with a R&D program are more likely to innovate. To measure this effect, we have considered a binary variable (RD), which is equal to "1" if the firm did R&D and "0" otherwise.

Firms develop new products and processes hoping to obtain some benefits in return, generally increased profits. If competitors can easily copy their inventions, firms will have little incentive to innovate. There are various forms of intellectual property protection witch are commonly used, such as patents, trade secrets, copyrights and trademarks.

There is little empirical data concluding that the protection of intellectual property is essential to foster innovation (Cohen, 1996). In a study on the effectiveness of patents for the protection of intellectual property rights, Mansfield (1986) noted that patents play an important role only in pharmaceuticals and chemicals. Levin and al. (1987) also found that patents are more important in pharmaceuticals and chemicals. In addition, they stressed that firms consider other forms of intellectual property protection more effective than patents. The complementary marketing activities and production delays were considered the most effective for the protection of innovative products. In the case of innovative processes, it is estimated that patents are much less effective and that the confidentiality ranks first in terms of efficacy. Cohen (1996) found that, although it is clear that the conditions of appropriability differ from one industry to another, there is little empirical evidence showing that these conditions are conducive to innovation in a wide range of industries.

For this reason, we have established five binary variables to estimate the effects of the appropriability on innovation. They are related to the use of patents (BREV), the use of publications (PUB), industrial design and model (DMI), trademarks (MQUE) and trade secrets (SC).

Thus, we sought to determine directly the extent to which the company gives importance to these methods or succeeds in developing a strategy to protect intellectual property. This learning is not easy and requires special skills, especially in legal matters and in the design, marketing and service. Each variable is equal to "1" if the right to property is being used and "0" if not.

2.2.3 Impact of industry

The technological possibilities vary from industry to another given that the scientific framework is more conducive to progress in some industries. Therefore, the progress of technology per unit of R&D is more important in some industries than in others (Cohen, 1996).

Two approximations proposed by Levin and al. (1987) were used in various studies. While the first indicates the extent to which an industry uses scientific research, the second shows the extent to which it relies on external sources of knowledge, such as customers and suppliers, for the purposes of technological progress.

In this study, we opted for the first approach, since it is closer to the concept of the scientific knowledge base edge available in the company. The second is more dependent on the magnitude of the flow of knowledge that varies from one company to another, and indicates the extent to which knowledge can be transferred rather than differences in scientific framework. To measure this effect, we created a binary variable (POSTEC), which is equal to "1" if the company has entered into joint research with universities and R&D organizations outside and "0" otherwise.

Some other studies assumed that firms in highly concentrated markets are more likely to innovate. That is “monopoly power” helps firms to acquire the products of innovation and encourages them to invest in innovation. However, this view is far from being widespread. Other authors (Arrow, 1962) have argued that innovation is more important in a competitive industry than in a context of monopoly. In addition, if the market structure is largely determined by the life cycle of the industry and if the latter is more atomistic in the early stages of the life cycle where innovation is more intensive, we have to expect who has more innovation in the less concentrated markets.

To examine the impact of the market structure on the decision to innovate, we introduce in the regressions an indicator (CONC), which measures the “concentration degree” of production at the sectoral level, defined as the turnover share of the four largest firms in the production sector.

2.2.4 Technological transfer

The propensity to export is defined as the ratio of export firms and their turnovers. We introduced this variable (EXP) to measure the impact of exports on the decision to innovate Tunisian firms.

The payments related to the acquisition of licenses were not available in the outcome of the investigation. A binary variable (LICENSE), taking the value "1" for firms possessing such licenses, and if not "0" has been introduced in the regressions in order to test a possible effect of these acquisitions on the decision to innovate.

2.2.5 Public incentives to innovation

To facilitate the dissemination of innovations on the market, policies have been put in place to act on the request. Some niche markets are created to launch pre-competitive technologies. The range of instruments used to support competitive technologies stretches regulations and standards for financial or tax incentives, through voluntary agreements with industry or the actions of consumer information.

Today, public policy efforts try to improve the functioning of the system of innovation by encouraging interaction among all public and private actors. This approach leads to the development of technological networking. We have thus introduced the variable (INCIT), which helps determine the impact of incentives on the decision to innovate Tunisian firms. This binary variable takes the value "1" if the firm has to use public incentives and "0" otherwise.

Table 2 : Summary of variables

Variables	Description
DEPENDENT VARIABLE	
Innovation : INNOV	Innovative firm or not innovative
EXPLANAROTY VARIABLES	
Size	
NEMPLCD	Fewer than 100 employees
NEMPLCD 1	100 to 499 employees
NEMPLCD 2	500 or more employees
Property: NAT	Under Tunisian or foreign control
Strategies	
TEXP	Propensity to export
LICENCE	Acquisitions or not of foreign licenses
POSTEC	Actions (or not) to technological possibilities
Workforce qualification: TCS	Senior executive rate
R&D Activities: R&D	Making (or not) R&D
Intellectual property rights	
BREV	Using (or not) patent
PUB	Publication (or not) of innovation
DMI	Deposits (or not) of industrial designs
MARQ	Deposits (or not) of trademark
SC	Using (or not) trade secret
Public incentives to innovation: Incit	Appeal or not to public incentives
Industry characteristics: Conc	The degree of market competition

3. The econometric methodology

3.1 Logistic regression

If the variable is explained qualitatively, logistic regression allows studying the effect of variables such as qualitative and quantitative. The exact nature of the variable of interest (binary, ordinal, nominal), will require the use of binary, orderly polytonal or conditional logistic regression (Thomas, 2000).

For a dependent binary variable (as is the case of our research), a logistic regression "classic" can be implemented. If the variable to explain includes more than two terms, then we will have to resort to a multinomial logistic regression.

As a nonparametric procedure, the logistic regression has the advantage of not requiring constraints on the normality of distributions of variables. The explanatory variables are not of a continuing nature and the relationship between explanatory and explained variable is not necessarily linear. Logistic regression is less a method of statistical inference than a method of classification, because the equation studied reflects the probability of belonging to an individual who has a class or group (Sheskin, 2007). Thus, contrary to the traditional regression, the variables can be explained by a quantitative and qualitative nature.

Let Y a binary variable (yes / no for example). Let X an independent variable contributing to the explanation of Y. It may take the value 1 with the probability P (Y = 1 / X) and the value 0 with the probability (1-P (Y = 1 / X)). The model then is expressed as:

$$P(Y=1/X) = \pi(X) = \frac{e^{\beta_0+\beta_1 X}}{1+e^{\beta_0+\beta_1 X}}$$

π(X) Reflecting a probability, its value must be set in the interval [0,1].

Either logit function defined by:

$$g(p) = ln(\frac{p}{1-p}).$$

If one applies the function to logit π (X), the expression becomes:

$$g(\pi(X)) = \beta_0 + \beta_1 X$$

The field of variation of g (π (X)) is between - and +, while π (X) varies between 0 and 1; regression can be implemented. The estimation of parameters β0 and β1 is made by the method of maximum likelihood.

In cases where several variables explanatory (x1, x2,…, xn) are included in the regression, the model then is expressed as:

$$\pi(X) = \frac{e^{\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_n x_n}}{1 + e^{\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_n x_n}}$$

The analysis of the results of the logistic regression can be done as for a regression, at the global level through the analysis of the value of the square of the correlation coefficient R (value ranging between 0 and 1, the value 1 reflecting the perfect balance of model) and for each factor.

3.2 Pre-selection of candidates variables

Based on the principle that if a variable contributes to the overall regression model, then it is statistically linked to the variable of interest, a univariate analysis is carried out in this work.
The idea is to test the statistical relationship between the dependent variable and variable of the survey. Each link with the dependent variable is evaluated. According to the value of the probability of rejection, the tested variable is or is not introduced in the model. At the end of this phase, a list of variables candidates is selected.
The preselection tests used in this research are:
• The Chi-2 test needed to compare the frequencies of two variables.
• The independent t-test to compare two groups, created by a categorical variable, depending on their average in a measure (continuous variable).

4. Logistic regression of the determinants of innovation

4.1 Pre-selection of explanatory variables in the decision to innovate

We began by analyzing associations between the qualitative independent variable (s) and the dependent variable. Test results of independence are shown in Table 3.

Table 3: KHI-2 test results and measures symmetrical (decision to innovate)

	KHI-2	PHI	V cramer	P.value
NEMPCD	29,223	0,240	0,240	,000*
R&D	32,497	0,253	0,253	,000*
BREV	6,340	0,112	0,112	,012**
PUB	2,262	0,067	0,067	,133
DMI	22,127	0,209	0,209	,000*
MQUE	12,251	0,155	0,155	,000*
SC	6,319	0,112	0,112	,012**
INCIT	3,786	0,098	0,098	,049**
LICENCE	6,570	0,114	0,114	,010**
POSTEC	41,885	0,287	0,287	,000*
NAT	47,370	0,306	0,306	,000*

(*) Significant at 1% level (**) Significant at 5% level

We then analysed the associations between the quantitative independent variable (s) and the dependent variable. Test results of independence are shown in Table 4.

Table 4: Test t results of independent samples and symmetrical measurements

	t value	(η2).	P.value
TEXP	0,970	-	,332
CONC	-2,723	0,014	,007**
TCS	-2,567	0,012	,011**

(**) Significant at 5% level

Our pre-selection of independent variables in the decision to innovate brings us to keep 12 of the 14 variables departure which will subsequently be integrated into our logistic regression. Indeed, univariate analysis which was carried out has certainly helped to demonstrate the dependence of the majority of our explanatory variables vis-à-vis the decision to innovate. However, it does not clarify the meaning of these relations, hence the need to use the method of logistic regression.

4.2 Results of the Logistic Regression of the determinants of innovation

The model chosen explaining the phenomenon to innovate decision therefore includes 12 variables that have a relationship of dependency with the decision to innovate.

The estimated equation is:

INNOV= α_0 + α_1.NEMPLCD+ α_2.CONC + α_3.R&D + α_4.BREV+ α_5.MQUE + α_6.SC + α_7.DMI + α_8.TCS + α_9.POSTEC + α_{10}.INCIT + α_{11}.LICENCE + α_{12}.NAT.

We made two regression methods, ascending regression and descending regression. The results are summarized in Tables 5 and 6.

Table 5: Results of the ascending regression

	Estimated coef	Standard deviation	Wald	P.Value	OR
RD	,833	,228	13,370	,000*	2,300
DMI	1,258	,396	10,071	,002*	3,517
MQUE	1,347	,447	9,100	,003*	3,848
SC	,855	,294	8,465	,004*	2,352
CON	,015	,006	6,093	,014**	1,015
POSTEC	,818	,229	12,785	,000*	2,266
NEMPLCD			5,994	,050**	
NEMPLCD(1)	-2,535	1,044	5,899	,015**	,079
NEMPLCD(2)	-2,406	1,043	5,320	,021**	,090
NAT	-1,211	,228	28,250	,000*	,298
Constante	1,575	1,089	2,089	,148	4,829

(*) Significant at 1% level (**) Significant at 5% level

Table 6: Results of the descending regression

	Estimated coef.	Standard deviation	Wald	P.Value	OR
RD	,833	,229	13,282	,000*	2,301
DMI	1,249	,398	9,830	,002*	3,486
MQUE	1,181	,451	6,854	,009*	3,259
SC	,866	,295	8,621	,003*	2,377
CON	,014	,006	5,812	,016**	1,014
POSTEC	,794	,230	11,890	,001*	2,211
NEMPLCD			5,659	,059***	
NEMPLCD(1)	-2,477	1,046	5,610	,018**	,084
NEMPLCD(2)	-2,368	1,045	5,131	,023**	,094
NAT	-1,234	,229	29,032	,000*	,291
Constante	1,534	1,095	1,965	,161	4,638

(*) Significant at 1% level (**) Significant at 5% level (***) Significant at 10% level

Both used regressions' methods have attracted and rejected the same explanatory variables. However, we will base our interpretation on the results of the descending regression as more performing, in our case, than that of the ascending method as shown in Table7.

Table 7: Performances logistic regression of determinants of innovation

	Model 1	
	Ascending regression	**Descending regression**
-2 log vraisemblance	512,863	509,658
Pseudo R^2	0,355	0,368
KHI-2	152,504	155,709

4.3 Variables not included in the descending regression

The indicator constructed to test a possible positive impact of incentives on the decisions of firms to innovate was not retained by the selection method. It seems that the conditions on regulatory frameworks are not specifically evaluated in the light of the objective of innovation. The Tunisian funding system of innovation introduced loopholes because public incentives are limited to amounts far below levels of investment from which private investors can expect to amortize the cost of their study work of the file and the accompanying of the company.

The indicator constructed to test a possible positive effect of skills on the decisions of firms to innovate was not retained by the selection method. Even if this result is perplexing, we should keep in mind that using skilled labour (quantified by the type of diploma) is not enough to innovate.

The test concerning the possible positive effect of foreign technology licensing on firms decisions to innovate was not retained by the selection method. These technology licenses do not therefore heighten the likelihood of firms to innovate. The lack of positive impact comes from restrictive clauses contained in these technology licenses.

The indicator constructed to test a possible positive effect of patents on the decisions of firms to innovate was not retained by the selection method. This is due to the absence of a culture of patent and intellectual property protection in Tunisia.

Exports of Tunisian firms have no significant impact on the decision to innovate. This confirms the results of univariate analysis. In fact, the nature of Tunisian exports explains this result because in Tunisia, the bulk of exports is low-tech (textiles, olive oils…).

Scientific publications rarely lead to new innovations. They are mainly the work of public R&D laboratories, and universities in particular. This largely explains the non-significance of this variable.

4.4 The variables considered by the descending regression

The R & D activities are one of the variables that most affect innovation (whatever regression used). Innovation depends directly on the R & D activities which are, therefore, the engine of the knowledge-based economy.

The report ratings is quite high with an OR equal to 2,301> 1 and means that the probability of innovation for a company that has a cell of R&D is twice as large as (2,301 exactly) a company that does not.

The results indicate that the size of a company has a negative impact on the likelihood that it is engaged in innovation activities. This sign is confirmed by the report rating which is in cases less than 1, 0084 for medium-sized firms and 0.94 for firms to large sizes.

Both values are less than 1, which means that in Tunisia, small businesses innovate more than medium and large firms. This result is consistent with the findings of most studies devoted to the empirical determinants of innovation in developing countries, regardless of the indicators used for the size and technological innovation. This is mainly explained firstly by the fact that the medium and large Tunisian enterprises, typically located in traditional sectors, are reluctant to engage in innovation activities and secondly by the fact that the Tunisian firms enjoy more benefits than their smaller sizes to innovate.

Indeed, one of the features that seems recurring in studies on innovation in the context of small businesses is that their resources are generally limited (Keogh and Evans, 1998; Major and Cordey-Hayes, 2003; OECD, 2005 ; Rothwell and Zegveld, 1982; Storey, 1994). Small businesses may be disadvantaged in their pursuit of innovation by the lack of resources and the optimisation of their use becomes a necessity. This may explain why the efficiency of R & D department of small businesses may be greater than that of large enterprises (Acs and Audretsch, 1991; Vossen, 1998). However, their lack of resources can also lead them to limit their involvement in risky activities, such as R & D (as in the case of Tunisian firms). It will also be more difficult for them to recruit engineers and scientists, and the proportion of their employees devoted exclusively to R & D activities will be minimized. Moreover, as a general rule, what small businesses are losing resources vis-à-vis large firms, they are gaining flexibility (Wolff and Pett, 2006). It allows them to be in a favourable position in the context of innovation, or where economies of scale are not important, as is generally the case of the Tunisian market. The flexibility of SME can result in particular through better reaction time vis-à-vis the changes through internal cohesion, which is facilitated by the small number of employees (Dodgson, 2000).

Finally, and as underlined by Burns and Stalker (1961), the organizational "organic" form would be more appropriate in changing environments, so in conducive environments to innovation. In its research, Strebel (1987) comes to the conclusion that radical innovation is grown in organic organizations, ie more flexible vis-à-vis fluctuations in the environment, while incremental innovations are in structures more mechanistic. In addition, Slappendel (1996), in a review of the literature on innovation, says that the levels of professionalism of an organization are very contradictory in searches, from a positive effect on innovation to no effect, and even to a negative influence.

The nationality of the foreign company has a negative effect on the decision to innovate. In addition to the negative sign of the estimated coefficient, the OR displays a value equal to 0.291 <1, which confirms the fact that foreign firms located in Tunisia innovate much less than local firms.

In fact, foreign firms in Tunisia are concentrated in industries which are little carriers in terms of innovation. Similarly, the integration of these foreign firms in the local productive fabric is virtually non-existent. The fallouts in terms of technological innovation are limited. Finally, and in most cases, the products of these foreign firms are not sold on the local market, the effects of competition are negligible and prevent the emergence of a virtuous circle in terms of innovation.

The listed variables appropriability are which refer to the standards of IPR bit complicated to carry out and relatively easy to be undertaken for small and medium-sized enterprises. Their estimate factor is greater than zero, which leads us to conclude that there is a positive relationship between these variables and the decision to innovate.

• MQUE: Firms applicant trademarks of fabric have a higher probability to innovate almost three times higher than those who do not.

• DMI: Undertakings of DMI have a higher probability of innovating around three and a half times greater than those who do not.

• SC: Firms using the SC have a higher probability to innovate approximately two times higher than those not using this technique.

The indicator of the level of concentration of production was chosen by the method of selection. The impact of this variable on the decision to innovate is positive and significant and demonstrates that innovation can come from greater appropriability fruits of innovative activity concentrated in the sectors, i.e., sectors characterized by the presence of large firms with a degree of market power.

Note that this explanatory variable is quantitative, the interpretation of the report of the symbol is different from the one used previously. Indeed, we calculate in this case an OR associated with increased unit. In the case of market concentration, the explanatory variable is expressed in terms of rates. For example, to calculate an OR associated with an increase in "z%” it is sufficient to raise the power "z %" the OR calculated for the concentration ratio of the market.

Thus, the increase in concentration of the market for a rate of 10% implies an increase in the probability of innovation of the company in the order of 10.08%.

The technological possibilities are a statistically significant determinant of innovation. Firms in industries that rely on scientific research are more likely to be innovative. This finding corroborates the findings of other works of research according to the possibilities of innovation are greater in industries that place a high value on basic sciences (Arvanitis and Hollenstein, 1994; Crépon et al. 1996). Firms that place greater emphasis on technological possibilities are more likely to innovate. As revealed by Mowery and Rosenberg (1989), R & D is not the only factor that plays a key role in the innovation process.

The probability for a firm using the possibilities of technological innovation is twice as high (2.26-fold) as that did not appeal.

Our econometric estimates lead to results that do not routinely confirm the theory. Thus, the factors related to technology transfer have a near-zero impact (foreign licenses and export) or even negative (nationality of the firm). In fact, this confirms the results of earlier research on the impact of technology transfer on the growth of developing countries (Koubaa, 2006 and 2008). Several of these studies have confirmed that the emerging countries still had to take advantage of external technologies.

The effect of size goes against the one announced by the theory. Indeed, we have noticed that it is the smaller firms that innovate in Tunisia. This is explained by the traditional landscape in which large or medium-sized firms operate.

Regarding the market structure - measured in terms of the degree of concentration of production - our results show that the benefits accruing from oligopolistic markets to innovation activities of firms are real but these benefits have limits, particularly because of the dangers of collusion between the firms.

The indicator of the level of skills of workers is not significant, suggesting that the engineers and technicians are unable to make amendments and minor improvements necessary for the efficient use of technology imported from western countries. There is in this case the problem of training and the upgrading of senior managers within Tunisian firms.

The public incentives to innovation do not seem effective in the decision to innovate Tunisian firms. To better understand the reason for such a result, it may be necessary to shed light on the impact of each incentive in the project (sometimes in areas seemingly disconnected), i.e. studying the positive effects and negatives of each incentive and regulation with regard to innovation and alert on the limits of the system and its adverse effects.

Finally, apart from patents and publications, other IPR are significant and positively influence the decision to innovate Tunisian firms. Still, the Tunisian enterprises must engage in a culture of patents already prevalent in many developing countries.

The determinants related to the type of innovation (product, process) were not considered separately. It is therefore desirable to provide further analysis by addressing the determinants of the structure of innovation. The wealth of data from the survey of innovation used in this research would carry out such an analysis, which would certainly contribute to increased understanding of the process of innovating firms in Tunisia.

CONCLUSION

Among the specific determinants of the decision to innovate for emerging countries, we can mention those that reflect the effects of the reforms on foreign trade on the activities of innovation of Tunisian firms. The econometric estimates lead to results that opposed to the expected effects. Thus, our results reveal that most of the determinants of the decision to innovate closely related to foreign trade reforms do not have a significant impact on these decisions: it is so in the flow of foreign direct investments, agreements of the technology that local firms contend with foreign firms and technological externalities. These results indicate that the benefits of economic openness in emerging countries are far from to be automatic at the technological level and that government intervention in one form or another is necessary to address them.

With regard to foreign direct investment, this intervention would be to encourage foreign firms to become more involved in the technology transfer process for local firms. The purpose of the location of foreign firms in the Tunisian market is not related to market access, but rather a target for relocation. This result is confirmed by the fact that among the 1744 foreign-invested enterprises operating in Tunisia, more than half are 100% foreign enterprises and 1433 wholly exporting (INS, 2006). These figures show that the strategic goal of dominating FDI located in Tunisia is more a target of relocation than a target of penetration in the local market. In general, foreign firms that are settled in developing countries are more attracted by the local workforce than in the local market. This directly implies the concentration of foreign firms in little bearing industries in terms of technology transfer.

As for the agreements of technology, our results show that they have no impact on the decision to innovate Tunisian firms. On the one hand, it appears that they have obtained licences to low prices and technological content with a primary goal of the start of production regardless of its effectiveness. On the other hand, the lack of positive impact can also come from restrictive clauses contained in these technology licenses. Governments could set up bodies to limit the covenants contained in these agreements, but that it might lead to overly restrictive legislation in the field of technology transfer, which could greatly reduce the flow of international technology to Tunisia.

With regard to the results on two "traditional" determinants of innovation which are the size of firms and the market structure, the econometric estimates have put forward the existence of a relationship of inverted "U" type between decision to innovate and these two variables. For the market structure - measured in terms of the degree of concentration of production - this result shows that the benefits accruing from oligopolistic markets to innovation activities of firms are real but that these benefits have limitations, particularly because of the risks of collusion between the firms. In contrast, the identification of a non-linear relationship between the size and the decision of firms to innovate is surprising for an emerging country like Tunisia, where small and medium firms face real constraints in the innovation field. If we explain this result to the low propensity to innovate of the major Tunisian firms in traditional sectors, it is clear that other econometric studies using data from individual firms may be required to reach a final opinion on this point. One should take into account several factors that play in favour of small enterprises in terms of innovation, namely flexibility and organizational form.

Other specific determinants of decisions to innovate firms in emerging countries were introduced in the regressions. The effect of qualification and skills, measured by the rate of senior executives, was not significant, in all types of innovation. This confirms the idea that the absorption and assimilation of new technologies depend rather on the quality of training conducted within innovative firms, and not only that gained during the years of schooling.

Collaboration in various forms between firms and universities is required to overcome such a finding. Firms must take into account that each university has its own priorities and that the strengths are different from one university to another. In addition, a firm must clearly define its strategy for R & D and assess the ability of the university to understand and carry out the research project, in a timely manner. The university, for its part, must assess the company's ability to share information and to support the research effort and the possible exploitation of the results. Such cooperation has expanded very rapidly in developed countries through the establishment of joint projects between these two types of institutions. These projects have resulted in the signing of a multitude of research contracts which vary in nature and complexity. Unfortunately this association remains weak in developing countries and mainly in Tunisia.

If innovation is theoretically closely related to the conditions of appropriability, Tunisian firms do not consider patents as an effective mean of protection. However, the use of industrial designs, trademarks and trade secrets are more significant. The trademark applications is a condition of appropriability of the most significance in the context of product innovation, whereas trade secrets, deposits of industrial designs and models are more required in the context of innovation process.

It is important for the Tunisian innovative firms to focus on R&D, mainly for innovation processes. The acquisition of skills in a number of areas is generally a prerequisite for innovation. Thus, firms concerned with technological evolution are more likely to innovate. This is particularly significant in product innovation cases.

Finally, we have found out that the public incentives to innovate had no impact on firms' decision to innovate. However, the State is supposed to play the role of regulator and intermediary between the different actors in the system. Indeed, in the context of technological programs, the State is only the facilitator of both research and the promotion of innovation. Under the incentive for innovation, it must not only support and help public research institutions such as universities in their development phase, but also by encouraging firms to develop activities integrated in R & D. The state also contributes to the regulation of financing structures to innovations.

The importance of the survey data on innovation used has helped the validation of the theoretical analysis of the determinants of innovation. Moreover, given the key role of productivity in economic growth, the results of the empirical study could be important lessons for emerging countries other than Tunisia.

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