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Regional analysis of financial barriers to innovation: A multilevel approach

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***Abstract*— This article aims to highlight, using a multilevel model, the effect of the region on financial barriers to innovation in Tunisian firms. To do this, we used data on a sample of 620 firms observed by the Ministry of Higher Education and Scientific Research in 2008 covering 24 governorates. The results indicate that the impact of financial barriers on the innovation activities in Tunisian firms differs from one governorate to another. This dispersion is partly due to the economic particularity of each region and the specific nature of regional infrastructure in Tunisia.**

***Keywords*— Innovation, financial barriers, region, multilevel model, Tunisia, firms.**

INTRODUCTION

The identification's approach of barriers to innovation is much more recent than that addresses the determinants of innovation [10]. The authors identify different types of obstacles in firms in order to know their nature, origin, importance and also their impact on the innovation process. This aims to measure the effects and consequences of these barriers on the innovation activities, which is not easy [1]. This approach also allows evaluating the effectiveness of public actions and identifying corrective measures to overcome or eliminate these obstacles.

Barriers to innovation are of different nature, and they can play a key role in defining characteristics of the external technological environment. They also influence in determining the attractiveness of a region for multinational and local companies. The decision to locate firms in specific areas and commit oneself in innovative activities could be affected by the assessment of the difficulties that will be encountered in the innovation process.

The main purpose of this paper is to show how the geography of innovation can benefit from the multilevel modeling. We provide a formal evaluation of the hypothesis that the geographical location of the company influences the probability of that to innovate and this, by facilitating access to resources or slowing and stopping its innovative activities.

The paper is organized as follows. Section 1 presents the literature review. Section 2 investigates the importance of financing innovation in Tunisian firms. In Section 3 we provide modelling and data and state empirical results. Finally, the last section concludes the paper and discusses policy implications.

I. LITERATURE REVIEW

There is no doubt that innovation is a necessary key to improve productivity, growth and sustainability of the firm. Given this environment, knowing the factors that raise innovation is the solution. This study identifies and point out the disparities of financial barriers to innovation perceived and experienced by Tunisian companies.

According to [15] innovation is something new. It's about creating something new through the processes of learning or knowledge. [5] found that innovation is widely recognized as a key factor in the competitiveness of nations and firms. Smaller companies that do not adopt innovation in their growth strategies run the risk of losing competitiveness because of their obsolete products and processes.

The study of innovation and firm's innovation attitude is relevant in this context given that innovation is becoming, increasingly, a critical factor for the sustainability and survival of firms. Moreover, it becomes even more important to target the causes that prevent companies realizing innovative activities. [2] stated that there are factors or obstacles that inhibit innovation. These factors, which place the obstruction or inertia in innovation, qualified as barriers to innovation, can occur for various reasons. The identification and categorization of these barriers are essential seeing that this will allow us to create mechanisms to reduce their existence, minimize, remove or convert them into facilitators of innovation.

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For most authors, they divide these obstacles into internal and external obstacles ([6], [2], [5], [24]). Internal barriers are those that occur within the firm and external barriers are those from the external environment of the company. [6] describes the lack of government support as an important barrier to innovation in the European country. [4] revealed two barriers to innovation in a study conducted in five Portuguese SMEs. These obstacles are the lack of qualified human resources or skills and a huge lack of external communication between knowledge generators (universities and investigation institutes). In France, as shown by [10], the Community Innovation Survey highlighted new obstacles to innovation that the major obstacle is the high cost of innovation followed by the lack of appropriate financial sources.

A general analysis of the work that address obstacles to innovation, shows a real lack of studies that focus on developing countries, especially in Arab and Muslim countries.

II. Financing Innovation

The innovation policy is unfortunately not rooted in many firms in Tunisia because of the lack of strategies and traditions. However, Tunisian companies can provide a concrete example of successful innovation activities, never the less technological, financial and trade gaps remain, and innovation continues to be overlooked in many firms. Unfortunately, many companies do not have the necessary, human and material, resources to adopt an innovation policy that will bring joy to creeping companies. This has led many entrepreneurs who believe in the local market and refuse all foreign competition, to constantly undergo competitive attacks, especially as they tend to react too late to new events in the local market.

The technological and commercial breakthrough cannot be achieved without a research and development (R & D) policy. The technological future of any country depends on its level of spending in this area. The more a country is rich, the more it invests in R & D activities. In recent years we saw that financing innovation is over taken the R & D spending. This is due to the support of capital venture that has become a source of finance to innovation.

When it comes to meeting the financing needs of innovations, innovative companies face many challenges. The risk for investors is very high, and funding is therefore very difficult to obtain. Funding sources generally come from business angels and personal funds of entrepreneurs and their families. The banks, for their part, are rarely active for small companies. Indeed, bankers are based primarily on the company's historical accounting, on repayment capacity and the guarantees offered.

When companies reported financial barriers to launch an innovative project, that is to say when they lacked appropriate funding sources, their risk of failure is higher. The lack of access to finance is the result of a fragile economic and financial health of a company. These barriers weigh more heavily on small firms. The largest, those whose turnover is important, are less affected.

In our survey, 62% of companies are innovative, 47% of them believe that the major barrier to innovation is the lack of funding. So given the importance of his obstacle for many firms, we conducted a mapping of Tunisia which helped us highlighting the perception of financial barriers by Tunisian regions (Fig1).

Tunisia has 24 governorates. We have divided them, in this analysis, into six regions namely: the North-East (includes 7 governorates), North-West (includes 4 governorates), Center-East (includes 3 governorates), Center-west (includes 3 governorates), South-East (includes 4 governorates) and South-West (3 governorates).

The degree of importance of the financial barrier is measured with a scale that goes from 1 (low importance) to 4 (very strong importance).

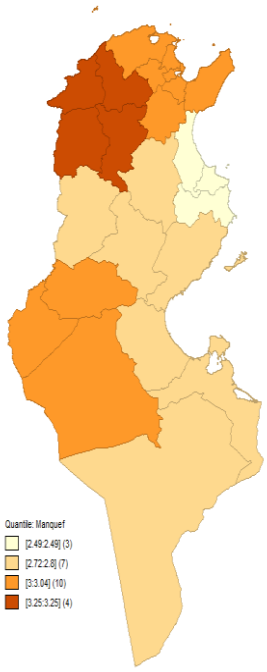

Fig.1. Financial barriers distribution within Tunisians regions

We can see from this map that the impact of the financial barrier on the innovative activity of firms differs according to over regions where firms are located. The darker the color is, the more companies in this region are facing financial barriers to innovation.

For the center-east, the problem of lack of sources of funding practically does not exist; it has a minor impact on the innovative activity of firms. This is due, in part, to the existence of: technology and externalities policy, investors who are willing to invest in such areas and proximity to suppliers, customers and skilled workforce.

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On the other hand, for the north-west region, the lack of funding sources seems to be a major barrier to innovation in this region, we can explain this by the lack of appropriate infrastructure to attract new companies, been far from ports and airports that facilitate exports, the lack of qualified workers and the specific and hard nature of this region.

Therefore, innovation is not fairly shared and distributed in Tunisian regions (difference between center and periphery, city and country, north and south, etc.). Indeed, some areas relatively suffer from having low manufacturing activities and innovative capacities. Hence the importance of the role that the State should play in boosting and fostering innovation, promoting regional attraction of innovation through appropriate policies and by giving companies and investors the same access to knowledge, regardless their geographical location.

Having shown, using mapping, the distribution of financial barriers across Tunisian regions and how these areas bear in a different way the weight of these barriers.

In the next section we will implement, using an econometric tool, the dispersion of financial barriers in Tunisian regions.

III. Regional Analysis of Financial Barriers to Innovation with a Two-Level Model (Random Coefficients)

The purpose of this section is to take into account the influence of the geographical dimensions on financial barriers to innovation.

The spatial concentration of actors, resources and other environmental factors conducive to learning and innovation performance influences firms more than their individual characteristics, such as size, experience or industry. Empirical work in this vision continues to use models at a single level. While multi-level modelling is the most appropriate statistical technique here. This modelling approach ([27] and [12]) is desirable because it allows taking into account the relationships between and among the hierarchical levels, taking into account the variability in levels.

Only the multi-level analysis is able to mount the regional effect. To do this, we adopt a model on two levels: the individual level (level 1) represented by companies and a regional level (Level 2) represented by the governorates. The endogenous variable representing innovation is "innovat" describing the intensity of innovation (no innovation, only one innovation, two innovations, three innovations or four types of innovation (process, product, organization or market).

This multi-level analysis allows relaxing the assumption that the weight of the perceived barriers to innovation (mainly lack of financial resources) is identical for all governorates. Thus, the coefficients are allowed to vary and, by specifying two levels: level 1 (firms) and Level 2 (governorates). We distinguish two models:

1) Model 1: The constants of the model are allowed to vary but not the slopes associated to the barrier: lack of source of funding

The formulation of the two-level model has the following form:

$$innovat_{ij} \sim N(X\beta, \Omega)$$

Level-1 model: $innovat_{ij} = \beta_{0ij} cons + \beta_{1j} Finan_{ij}$

Level-2 model: $\beta_{0ij} = \beta_0 + \mu_{0j} + e_{0ij}$

Where:

$innovt_{ij}$ is the dependent variable which refers to the intensity of innovation..

cons is a unit vector denoting the constant of the model.

$Finan_{ij}$ is a variable representing the financial barrier to innovation.

And μ_{0j}, e_{0ij} are random effects (normally distributed residual terms for each equation),

i is the firm (i =1...n)) and *j* is the region (j =1...m).

The estimation results of the first model are in the following table:

TABLE I
Estimation Results

	Average	**Variance**
Slopes associated to governorates	-0.34(0.051)	0.073(0.049)
Constants associated to governorates	2.289(0.171)	1.711(0.098)

We can see that the slopes vary between governorates when they are supposed to be identical; this proves that there is an effect of the region in the perception of barriers for firms specially the lack of financial sources for innovation activities.

2) Model 2: The constants and the slopes are allowed to vary

Model 1 assumes that the variation between governorates is due to constants. However, there is a possibility that the slopes also differ from one governorate to another. This implies that the coefficient of lack of sources of funding varies from one governorate to another. The formulation of the model takes the following form:

$$innovat_{ij} \sim N(X\beta, \Omega)$$

Level-1 model: $innovat_{ij} = \beta_{0ij} cons + \beta_{1j} Finan_{ij}$

Level-2 model: $\beta_{0ij} = \beta_0 + \mu_{0j} + e_{0ij}$

And $\beta_{1j} = \beta_1 + \mu_{1j}$

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Where:

$innovat_{ij}$ is the dependent variable which refers to the intensity of innovation.

Cons is a unit vector denoting the constant of the model.

$Finan_{ij}$ is a variable representing the financial barrier.

And $\mu_{0j}, e_{0ij}, \mu_{1j}$ are random effects (normally distributed residual terms for each equation) respectively to level 1 (firms), Level 2 (governorates constant) and level 2 (governorate, slope).

i is the firm ($i = 1...n$) and j is the region ($j = 1...m$).

The estimation results of the second model are given by table 2.

TABLE III
ESTIMATION RESULTS

	Average	**Variance**
SLOPES ASSOCIATED TO GOVERNORATES	-0.368(0.072)	-2.822(0.388)
CONSTANTS ASSOCIATED TO GOVERNORATES	2.409(0.225)	9.638(1.173)

The slopes and the constants vary. These results confirm our hypothesis: geographical location of companies influences their probability to innovate.

3) Implementing the governorate effect by a graphical representation of residues

To illustrate the difference of the regional impact on the financial barrier to innovation activities across Tunisian regions, we proceed to the graphical representation of residues of hazards constants and slopes, which have the following shape:

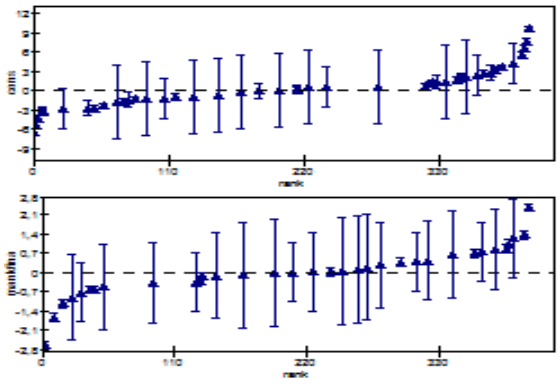

Fig. 2. Graphical representation of residues

We find that regional differences into financial barriers to innovation not only characterize the constants of the model, but also cover the slopes. Despite a generally positive correlation between the random components of the constants and slopes, the differences between these two components are not perfectly proportional. This confirms the existence of a regional disparity in terms of financial barriers to innovation in Tunisia.

The assumption is that firms located in the more developed regions are more likely to innovate, because they have all kinds of external economies geographically limited and agglomeration effects related to the production and the dissemination of localized knowledge. Moreover, the structural problems of the region, such as long-term unemployment and concentration of industries in declining, are expected to have negative effects on the frequency of firm's innovation and then inhibiting their activities.

IV. CONCLUSION AND POLICY IMPLICATIONS

This paper investigates financial barriers to innovation activities in the Tunisian context. The geographical location is crucial in the perception of obstacles to innovation. The existence of technological and strategic externalities favorable to innovation makes dispersion between regions evident. Indeed, the concentration of the national economic activity in the regions of Tunis, Sfax and Sousse can explain the level of innovation of firms in these regions through the facilities available to them (technology and information transfer, proximity to suppliers, customers and a skilled workforce).

Multilevel analysis allows taking into account the effects of regions, using random effects. They include the different levels by taking into account the hierarchical structure of the data in the estimation procedure parameters and their standard deviations.

The estimation results of the multi-level model show that financial barriers to innovation vary from one area to another. In other words, the lack of financial sources depends on individual characteristics (associated to the firm), but also on regional and sectorial characteristics (external factors to the firm).

Tunisia today goes through a transition phase, it is imperative seek is to reduce if not eliminate different types of barriers to innovation by assisting firms to reduce the economic and financial risk and making training programs to improve staff qualifications and skills, not forgetting to explore foreign markets.

To support innovation efforts in firms, the state has set up specialized structures throughout the country according to the specificities of each region: laboratories, technical centers, Upgrading Program (PMN), FOPRODEX (Exports Promotion Fund), FAMEX (Fund Access to Export Markets), but these incentives are still insufficient to mitigate the effects of difficulties in the process of internationalization of Tunisian companies.

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