Innovation Behavior Patterns of Tunisian Firms : An Econometric Analysis Using Finite Mixture Approach

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(**Long Abstract**)

Abstract

The present work is oriented towards the study of the configuration of innovating process of tunisian firms, using available micro-data from a recently innovation survey provided by Ministry of Scientific Research, Technology and Competency Development (MSRTCD) in 2005. Firstly, we start by using macro level data to carry out a detailed descriptive analysis to provide an overall view of main characteristics of sectoral system of innovation and production in Tunisia. This, in turn, represent a first step to examine the feature of sectoral patterns of innovative activities. In fact, the innovation process differs across sectors in terms of various dimensions (Malerba, 2002) which underlie the existence of different patterns of innovation providing a taxonomy of innovative behavior.

Secondly, by providing an original methodology using latent class finite mixture regressions, we identify a taxonomy of innovation behavior among tunisian firms. Such an approach that distinguishes this work from the others and enables us to identify and describe the variety of patterns of innovation behavior of tunisian firms by the estimation of the effects of covariates on predicting latent class membership. This feature, helps us explain and describe the configurations of innovating process by classification of firms. We shall not only to try to explain similarities and differences among sectors in the sources, nature and impact of innovation, but we shall also to identify the configuration of innovation process among firms. We describe similarities and differences among firms, which

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are attractive for the explanation of divers components behind the technological behavior of firms and, thus, we try to provide a typology of tunisian firms in accordance with the concept of technological regime taking into account the national and sectoral innovation specificities of the country.

In empirical studies many difficulties lie in obtaining proper measures of elements combined to identify and describe different technological regimes. The classifications suffer from the absence of an econometric model of innovation behavior and still essentially descriptive. To avoid these difficulties, we used latent class models for polytomous outcome variables. We estimate the effects of covariates on predicting class membership using categorical dependent variables. We regroup firms that share common characteristics in their innovation behavior. This regroupment is important to innovation policy makers. Our approach distinguishes the present work from the others which use innovating firms as unit of analysis and classify sectors of innovating firms that perform R&D expenditures according to the sources of knowledge, the technological opportunities, the means of appropriations and the accumulative nature of innovations. In fact, in developing economies not all firms develop new and better products or production processes for the market and successfully commercialized them. Some innovations consist in introducing better products that are new only for the firm. Other firms make an effort and undertake R&D activities, but they fail in innovating. Thus, our analysis is not only restricted to the group of firms that undertake formal innovation activities. We use also information regarding the classification of non-innovating firms to provide guidance for policy measures to encourage firms to innovate. We account for various innovation indicators.

In the literature, the empirical studies take Pavitt's (1984) taxonomy as a starting point and investigate Pavitt's sectoral patterns of innovation. In his seminal paper, Keith Pavitt (1984) pointed out the existence of some major industry-specific characteristics of innovative firms and proposed a taxonomy of sectoral patterns of innovation (science-based, supplier-dominated, specialized-supplier and scale intensive sectors). His classification, which is the most useful for innovation policies, still constitute a fundamental starting point for investigating how innovations differ across sectors (Malerba, 2005). It is constructed more on a priori knowledge and assumptions about industry characteristics and interrelationships than on empirical findings regarding their innovative behavior (Raymond *et al.*, 2004). The Pavitt's conceptualization was based on an analysis of SPRU data-set containing information on various characteristics of innovative firms in Britain. This lead us to ask the question : How does the taxonomy perform when we consider the case of a developing country ?

This work constitutes a refinement for the case of a developing country. In fact, sectoral patterns and performance of innovative activities are related to country-specific factors and national system of innovation and research such as scientific and technological patterns, economic performance and nature of institutions. Then, we attempt to rely our finding and conceptualization to analyse the innovation policy in Tunisia.

Econometric Modeling

Latent class finite mixture models have become increasingly popular in the analysis of a wide range of data. In a finite mixture model the response variable is postulated as a draw from a superpopulation that is an additive mixture of C distincts proportions $p_1, p_2, ..., p_C$, where $\sum_{j=1}^{C} p_j = 1$; $p_j \geq 0 \quad (j = 1, ...C)$. The mixture density for observation i, $i = 1, ..., n$, is given by :

$$f(y_i/\theta) = \sum_{j=1}^{C} p_j f_j(y_i/\theta_j) \tag{1}$$

The mixing probabilities p_j can be interpreted as the unconditional probabilities that an individual belongs to class c, there are proportions of the sampled latent subpopulations parameterized using the logit function. The formulation of the component probability density is conditional upon subject i belonging to class c.

The underling theory of these models posits that individual behavior depends on observables attributes and on latent heterogeneity that varies with factors that are unobserved by the analyst (Greene H. W. and Hensher D. A., 2003). We propose to analyse this heterogeneity through latent class finite mixture regression models for polytomous outcome variables. The latent class model approximates the observed joint distribution of the manifest variables as the weighted sum of a finite number, C, of constituent cross-classification tables.

Suppose we observe J unordered polytomous categorical variables each of which contains K_j possible outcomes, for firms $i = 1, ..., N$. The observed values y_{ijk} of the categorical variables are given by $y_{ijk} = 1$ if the response is on category k of variable j, and $y_{ijk} = 0$ otherwise. The joint probability density is then :

$$f(y_i/\pi, p) = \sum_{c=1}^{C} p_c \prod_{j=1}^{J} \prod_{k=1}^{K_j} (\pi_{jkc})^{y_{ijk}} \tag{2}$$

where π_{jkc} denotes the probability that the response of a firm in class c is in category k of variable j.

Data

The data used in this paper are drawn from a survey provided by Ministry of Scientific Research, Technology and Competency Development (MSRTCD) for the period 2002-2005. The data covers 586 tunisian firms with at least 10 employees. This survey enables us to overcome the problems associated with the exclusive use of R&D (innovation input) or patents (innovation output) as a mesure of technological behvior. Indeed, Innovation behavior patterns may be characterized in terms of a set of the driving forces of innovation, and not only

of the balance between product and process innovation (Marsili and Verspagen, 2001).