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Information asymmetry and technical efficiency: Case of a panel of Tunisian insurance companies

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Abstract. *The problem of the information asymmetry affects all the insurance sectors namely the one that exists in Tunisia. This problem of asymmetry entails essentially two major problems, such as the adverse selection and the moral hazard. These problems of adverse selection and moral hazard cause perverse effects on the productivity of the insurance companies and consequently on their productive efficiency. The objective of this research work is, on the one hand, to theoretically analyze the effects of the information asymmetry on the insurance functioning and, on the other hand, to estimate the technical efficiency of the Tunisian companies while taking account this problem which remains up to now unsolved.*

Keywords: information asymmetric, technical efficiency, insurance companies, parametric approach.

JEL Classification: D82, D24, G22, C14.

1. Introduction

Several research studies analyzed the performance of financial institutions and mainly that of the assurance companies, because of their importance in the economy. In fact, the insurance sector is one of the driving forces of development and takes part directly or indirectly in the economic, social and financial development.

The insurance transaction involves two operators: the insurer and the insured. On concluding a contract, the insured must pay a premium, which is the price of the risk that the insurer assumes when purchasing an insurance policy. Therefore, in case of a disaster, the insurer grants a compensation to the affected policyholders. It should be noted that there the inverted production cycle, which is an insurance specificity, raises a problem of fixing the cost price considered an enigma for the insurer. Price is an information vector the main function of which is to notify us about the economic scarcity of a resource, namely its quality which is also complex information. However, an ambiguity appears in the insurance market since the information is not quite a property as the others. It is essentially an experience price, in other words, the information can be known only after being obtained.

Moreover, the information problems were a major focus in the economic analysis. The new microeconomic theory set forth recent studies which dealt in a relevant way with the debates related to the staff information problems in a contracting environment. The carried out studies showed that this problem arises when the available information is asymmetrically distributed between the contracting parties. Therefore, such an exchange seems difficult between two unequal parties. Such a problem may entail a cost for either of the two parties and even for both.

This information asymmetry leads to adverse selection and moral hazard problems. These latter ones start from a situation characterized by the information asymmetry. The difference between these two similar concepts is of a temporal nature. Adverse selection starts from a situation before the contract signing. This is to make the choice between goods or agents that will remain the same after signing the contract but don't reveal their true nature after the signature. In fact, the moral hazard occurs after signing such a contract. This situation is characterized by the fact that the agents can change their behavior after the signature of the contract. As a result, the insurer is called on to undertake the necessary measures to counterbalance these two phenomena of adverse selection and moral hazard, which can affect the firm’s productive efficiency.

It is therefore interesting to study the productivity and efficiency of the insurance companies and analyze the impact of the information asymmetry on them. However, in recent years, several studies have been conducted about the insurance companies’ productivity. These studies focused first on the estimation of the scale and scope economies and technical efficiency.

The aim of this research work is, on the one hand, to theoretically analyze the effects of the information asymmetry on the functioning of the insurance markets and, on the other hand, to estimate the technical efficiency of the Tunisian companies by taking into account this problem which remains unsolved up to now.

2. Theoretical framework

Studies about the information problems in the field of economics started in the early 1960s. The two most well known problems are the moral hazard and the adverse selection. Akerlof (1970) was the first author to deal with the problem of adverse selection which is sometimes referred to as anti-selection. According to this author, this concept refers to a situation where the goods buyers can observe only the average quality of the property. The sellers of a good quality property feel insufficiently rewarded through an average price and therefore, they withdraw from the market. In fact, only poor quality goods remain in the market that Akerlof calls “lemons”. He gives, among other things, the example of the used car market and thus explains the price difference between new and used cars. For Akerlof, informational asymmetry leads to the exclusion of the 'good' and in an extreme case the disappearance of the market. Akerlof demonstrated how this phenomenon can impede the functioning of the market. In this case, the insured provides better information on the risk that the insurer is committed to cover.

In an article dealing with the insurance sector for medical care, Arrow (1963) showed that the volume of medical care depends on the number of people who have health insurance. In other words, after the contract signature, people who signed contracts are more likely to consult their physicians, given the absence of costs of such an operation. Adverse selection and moral hazard are problematic for a decision maker. The latter might not know if he has chosen the good agents in the first situation and if the selected agents will change their behavior in the second situation. Therefore, most authors concluded that the information problems cause significant distortions in the economy. However, in some markets, effective mechanisms have been developed to reduce these distortions. These latter ones are more intense at the anti-selection level, which is explained by the fact that anti-selection is related to exogenous characteristics, whereas the moral hazard is explained by endogenous actions that can be modified at any time. For this reason, the present paper will be limited to the anti-selection problem.

Rothschild and Stiglitz (1976) examined the balance in a competitive market and showed that poor-risk individuals choose the same type of contract as the one chosen by low risk individuals. However, the premiums paid by the various groups are the same. The presence of this type of problem can prevent the low-risk insured from ensuring, or at least, he will be obliged to reduce his insurance purchases. This will certainly have an impact on the insurer’s portfolio, who in turn, will attempt to raise the fares so ad to compensate for the loss due to the departure of potential clients, which will cause a new start. Rothschild and Stiglitz made a bright analysis of the functioning of competitive insurance markets in the asymmetric information. Instead of offering a single insurance contract for all the individuals, the insurers offer a list of insurance contracts which organize a form of risk selection in the market. If the proportion of high-risk individuals is relatively high, a separator equilibrium is established and characterized by a full coverage of high and partial coverage of low risk. If the proportion of high-risk individuals goes beyond a certain threshold, there is no more equilibrium.

This theoretical prediction gave rise to many subsequent developments. Thus, a discussion was ensued about the possibility of a pooling equilibrium (mixing balance).

Wilson (1977) showed that the equilibrium is mixing when the proportion of high risk is relatively low. Other contributions focused on refinements of the equilibrium concept of the insurance markets (Riley, 1979; Miyazaki, 1977 and Spence, 1978).

These approaches, which may take into account or not, depending on the circumstances, the possibility of cross subsidies between the classes of risk, provide a very strong substantiation of the insurance deductibles. Indeed, the latter ones urge the insured individuals to get self-selected: high risk frequency agents prefer low or zero franchises, whereas low loss frequency agents accept high franchises. The insurance franchise is therefore a very relevant mechanism in the management of the risks subject to the anti-selection phenomenon. (Riahi and Pannequin, 2004). Therefore, it can be seen that if anti-selection can threaten the functioning of the insurance markets, insurers can, in some cases, overcome the barrier caused by the information asymmetry. They can get policyholders to reveal their risk level by offering contracts that can be distinguished by the amount of insurance.

As a result, the insurer is called to take the necessary measures to deal with this phenomenon of information asymmetry that can affect the firm's productive efficiency. In recent years, there have been several research studies dealing with the insurance productivity. These studies focused first on the estimation of economies of scale and scope and technical efficiency. Furthermore, several studies focused on the study of the insurance sector to assess its productive performance. In this context, we can mention the work of Fecher et al. (1993), Gardner and Grace (1993, 1998), Cummins and Zi (1997) and Cummins, Weiss and Tennyson (1999) and many others.

Cummins and Weiss (1993) presented an overview of the literature on research the efficiency and productivity of the insurance industry. These authors published several articles about the American insurance industry. Actually, he conducted some analyses in terms of allocative efficiency, at scale etc. Fecher et al. (1993) drew the same conclusion for the French industry. He explained this result by a heterogeneous and segmented market: firms are highly specialized and have specific customers to counteract the adverse selection. Furthermore, the prices paid by the insured depend on his characteristics; therefore, production technology may change from one company to another.

In another comparative study of fifteen countries of the OECD, Donni and Fécher (1997) showed that the productivity growth observed in all the surveyed countries is essentially attributed to technical progress. They also showed that both reinsurance and the monopolized share market have a positive effect on the level of efficiency. In fact, economic and financial liberalization will lead to more intense competition. As a consequence, the insurers are expected to improve their productive performance.

On the other hand, to measure performance, several approaches have been developed in the literature among the best known of them are those based on the ratios of total productivity (TFP) and the ratio of the partial productivity factors (PPF). These two ratios assume that firms operate on their production/cost border, which implies that these firms are efficient and that any productivity improvement is conceived as an improvement of the observed output. Nishimizu and Page (1982) showed that this improvement can be twofold: the technical progress on the one hand, and the change of efficiency, on the other hand. From here, it is clear that efficiency is a notable component that contributes to TFP growth. This suggests that this component may be considered as a performance indicator. Although they are of an undeniable value, these ratios (PTF, PPF) have become obsolete giving way to new techniques of performance measurement, such as mathematical programming techniques or non-parametric methods and econometric and parametric techniques or methods. For this reason, the major objective assigned to this work is to understand the productive efficiency of the different insurance companies by adopting technical efficiency as a performance criterion.

2.1. Information asymmetric in the insurance market: an anti-selection case

2.1.1. Insurance market equilibrium with anti-selection

Actually, in the model of Rothschild and Stiglitz, the game is a two-step procedure: in the first stage, and in the absence of information on the type of consumer, the insurance companies offer one or several contracts simultaneously and anticipate the characteristics of their customers by considering the rival companies as an input. In the second stage, the consumers make a choice among these contracts and reveal the type the ones specific to them.

The characteristics of the balance therefore depend on the reaction of an insurance company to the shares of its rivals. In a competitive environment, the retained equilibrium concept is the Nash equilibrium, which corresponds to a situation where each insurance company considers the other company' strategy as a parameter and does not anticipate the reaction of the rival insurers to the change of its own strategy. The insurance contracts available in the equilibrium will not be in deficit. Moreover, a contract cannot achieve positive profits because when an insurance company offers a profitable contract, another company will offer a less interesting contract, which increases the usefulness of the agent. Competition between companies generates void profits at equilibrium. The definition of RS equilibrium is as follows: "An RS equilibrium is a set of contracts defined in two dimensions (price, quantity) such as when different categories of consumers choose a particular contract so as to maximize their utility, each contract has a non-negative profit and there are no other contracts outside this equilibrium which, if offered, would realize a profit."

According to this definition, when there is perfect information, the competitive equilibrium is defined by the maximization of the utility function of each type under constraint of void profits. In the case of imperfect information, the insurance contracts of perfect information cannot be fulfilled; therefore, the insurers should take into account the behavior of this anti-selection in order not to suffer deficits. Therefore, two types of contracts correspond to the definition of RS equilibrium:

- Separator contracts (both types self-select and sign differentiated contracts),
- Pooling contract (a single contract is underwritten by both types of individuals).

Rothschild and Stiglitz (1976) showed that, in general, Nash equilibrium may not exist between insurance companies in competition when they use, as informative actions, a package of price and quantities. When there is no RS equilibrium, Wilson and Grossman (1979) showed preferred that the pooling equilibrium preferred by the low risks emerges, therefore, they proposed the following new definition for the equilibrium:

An equilibrium is a group of contracts, such as when the various categories of consumers choose a particular contract so as to maximize their usefulness, each contract has a non-negative profit and there are no other offered contracts which achieve a positive profit even when the existing initial contracts on the market are withdrawn.

According to Wilson and Grossman, the insurer has to anticipate the reaction of his competitors after his entry into the market and therefore should drop loss-making contracts. These expectations, at Wilson and ' the Grossman's way, helped the same equilibrium to emerge where the RS equilibrium did not exist. Rothschild and Stiglitz finally presented a more realistic view of the relationship between the insurer and the insured. By expressing their desires, the insured peoples reveal their risk level. Using this information, the insurer may deny a person to sign a contract intended for him.

Spence (1978) and Myazaki (1977) developed the analysis of Wilson (1977) and showed the possibility of the existence of stable equilibrium when the insurance company subsidized an insurance policy with the profits of another policy.

An equilibrium of Miyasaki-Spence-Wilson many contracts that globally realize a non-negative profit in the way that where different categories of consumers choose a particular contract so as to maximize their utility. There are no other offered contracts that achieve a positive profit even when the initial existing contracts on the market are removed.

Spence and Myazaki showed that an equilibrium contract for low risk individuals is identified by maximizing their expected utility under the following two constraints:

The insurer's expected profit is nil
- The members of the high risk group have no incentive to choose the contract offered to the low-risk group.

Finally, it should be noted that Wilson's equilibrium is sometimes called in the economic literature the Spence-Myazak's equilibrium. Wilson's equilibrium has the same characteristics as that of Nash. Actually, among both contract parties, the low-risk individuals are the ones who always suffer from the information asymmetry and who do not pay the premium corresponding to their real class of risk.

A new concept of the insurance market equilibrium, which is called "reactive equilibrium", was proposed by Riley (1979). After studying the model of Rothschild and Stiglitz (1976) and Wilson (1977), Riley distinguished two types of informational equilibrium:
- A series of informational contracts in which the company offers different contracts for each risk group. In such cases, the insurer may distinguish between the different types of individuals but the truth is a dominant strategy for at least the individuals of the high risk group.
- A group of low informational contracts in which a single contract is offered to all the risk groups. In this case, the discrimination between the different types of individuals

is therefore impossible and the truth is not the only dominant strategy for both groups of risks.

Riley showed that:

- The Nash's equilibrium satisfies, in general, neither the first set (Riley: 1979), nor the second set (Riley: 1979).
- Wilson's equilibrium satisfies the first set when two discriminating contracts are proposed and the second set when a uniform contract is proposed for both groups.

Therefore, compared with Wilson's equilibrium, the insurance companies have a "much more aggressive" behavior through a 'reactive equilibrium'. In fact, when the insurance companies are in a 'reactive equilibrium, no company has interest to react by offering a more advantageous contract on the market. If there is a reaction, the company will be a loser and may disappear from the market.

After presenting an overview of the information asymmetry in the insurance market and in particular on the presence of the anti-selection market, it can be concluded that if anti-selection threatens a priori the functioning of the insurance markets, insurers may, in certain circumstances, overcome the difficulty posed by the asymmetry of information. By offering contracts that differ by the amount of insurance, they bring the insured to disclose their risk level and they can quote actuarial premiums.

Therefore, the insurer has to take the necessary measures to counteract this information asymmetry that can affect the firm's productive efficiency. It therefore seems interesting to study the productivity and efficiency of the insurance companies and analyze the impact of information asymmetric on them.

2.2. Productivity and efficiency of the insurance companies

2.2.1. Productive performance concept

Productivity became a hot topic that unanimously interested the economists, the econometricians and the policy makers. Productivity for managers and economists is a means of improving competitiveness, production, revenues etc. Hence, it can, at the macro level, affect the quality of the provided services and can generate more resources.

Policyholders are increasingly seeking new ways of managing the risks they face. It is therefore appropriate to find, when necessary, unconventional solutions. In this respect, what distinguishes the insurers is the quality of their services. Actually, the offered services differentiate similar insurers. On the supply side, the insurer has to get adapted mainly to his customers' needs.

Both approaches seem to answer the measurement of production efficiency, namely, the traditional and the recent approaches. By referring to the firm's traditional economic theory on the evaluation of the productive performance, we have to look at the measurement of the partial and/or total factor productivity. Therefore, productivity connects production and the production factors which are necessarily used to achieve a certain level of production.

The various measures brought in by the traditional economic theory (partial labor productivity (PPL), total factor productivity (TFP)) are applicable to the field of insurance companies. Bernstein (1998) used the concept of total factor productivity when he studied the Canadian life insurance. Moreover, to carry out an analysis of the insurance companies' performance, the decision makers often opt for a calculation of the accounting or financial ratios.

Although these performance measures are the source of the evaluation of the productive performance of insurance companies, they have some limitations. First, these ratios do not take into account the quality of the services, besides they give only a facet of the companies' performance. In fact, a company can benefit from a solid financial structure; however, it may be technically inefficient. Moreover, these ratios do not enable us to conduct comparative analyzes at the international level. Similarly, these used accounting ratios are specific to each company, even within the insurance companies where the insurers do not adopt the same performance indicators.

However, with the rapid development of the recent methodologies of the efficiency frontiers, the traditional measures became obsolete. In fact, these methodologies represent, if it needs to be said, a multidimensional index through which the insurance companies' complex activities can be dealt with.

To cover the shortfalls caused by the traditional approaches in terms of the measurement of the firms' productive performance, some approaches have recently been developed. These approaches brought in some indicators of considerable importance because they can be applied to all the economic activities in any market structure (Pestieau and Picard, 1993).

The underlying logic of the frontier methodology helps measure the firms' performance in relation to a "Best practice" firm. Actually, every observed firm will be compared to firms operating in the same sector. In this context, several studies about the insurance companies' performance were conducted on the basis of a productive performance indicator, namely, technical efficiency. Besides technical efficiency, other indicators show the degree of the insurance companies' efficiency from another angle to find out allocative and scale efficiency.

2.2.1. The estimation techniques of productive efficiency

In a perspective of the efficiency analysis, the production function is not only interpreted as a relationship between the inputs and the outputs, but also as a frontier that has several production possibilities. For a company located on the border, this corresponds to the maximum amount that can be obtained from a given input vector, or in an equivalent manner the minimal amount of input required to achieve the level of the produced output. Each production activity belonging to the production frontier is defined as being efficient. Nevertheless, all the other firms located below the frontier are said to be inefficient.

Thus, the inefficiency level is measured by the distance that separates a firm of its efficiency frontier. In general, the production frontier is unknown, but it can be estimated from information about the companies' inputs and outputs which form all the selected production possibilities.

The most adopted techniques for the measurement of the degree of inefficiency are found in two main approaches:

- The nonparametric approaches, which are the "Data Envelopment Analysis" (DEA) and the "Free Disposal Hull" (FDH) methods.
- Parametric or econometric approach, which consists in estimating a production or distance function.

The focus on the nonparametric methods in estimating the production frontier lies in their capacity in several domains to take into account the specificity of the different sectors.

On the other hand, with the development of econometric tools, there was therefore the emergence of parametric techniques to measure the degree of inefficiency in most sectors. These techniques emerged mainly to correct the defects revealed by nonparametric techniques (non consideration of hazards, the need for a well defined functional form about the production technology etc.).

While the nonparametric approach builds the frontier using linear programming, the parametric approach builds the frontier using an econometric model. The main difference between the two approaches is that the second imposes a precise functional form on the specification of the frontier, whereas the first approach does not require this hypothesis.

Measuring the insurance output seems to be an enigma and actually raises several problems. If we resume the different insurance functions, we can conclude that it is an abstract product. In fact, the insurer sells security and protection that meet the need for security expressed by the insured. This feeling of security can be measured by the price that the insured is willing to pay. Therefore, measuring the output is a very difficult task. Furthermore, the offered services cause substantial difficulties when determining an aggregate measure for the firm's production. This topic has been widely debated by researchers. Besides, there are several studies dealing with the efficiency of insurance companies, although there is no consensus on a precise definition of measurement of the insurance output. Certainly, identifying the inputs and outputs is essential for the studying of the productive performance of insurance companies.

In fact, the various approaches developed in the recent literature to measure the productive efficiency and mainly the technical efficiency are the non parametric DEA and the parametric methods. In the third section, these estimation techniques and the different already developed models are used to assess the performance of the Tunisian insurance companies.

3. Estimation technical efficiency of the Tunisian insurance companies

3.1. Data and variables

The available data are collected about 10 insurance companies observed over a 14 year period (1990-2003). Among the 22 companies resident, we have retained only 10 companies about which there is exhaustive information. For each company, the information is only available about the quantities of inputs (labor, physical and financial capital) and the quantity of outputs (claims paid out). The used database was developed from the balance sheets and the profit and loss accounts published by these companies. In order to estimate technical efficiency, we adopted the parametric approach by estimating a stochastic production function of translog type.

3.2. Estimation of technical efficiency using the parametric method

In the literature, there are two types of frontiers, a deterministic parametric frontier, which interprets any distance from the border as an indicator of inefficiency, and a stochastic frontier, which includes two types of errors, an asymmetrical one, which is used to capture inefficiency, and another symmetric or a common error term, which is assumed to be beyond the firm's control. Given the size of the temporal dimension of our sample (14 years), it seemed interesting to work on models that take into account the temporal variability of technical inefficiency (i.e., the model of Battese, 1992); Cornwell et al. (CSS, 1990); Lee and Schmidt, 1990 etc.). However, in this research study, our interest will be simply paid to the flexible functional form advanced by CSS, (1990). Moreover, we will take into account two types of stochastic frontiers with and without information asymmetry. In fact, the first is a standard stochastic production frontier without asymmetry, whereas the second tries to build a production frontier that incorporates the terms of the information asymmetry through two proxy variables, namely, the loss and reinsurance ratios.

- *The loss ratio:*

This ratio is the proportion of the sinister charges (payable claims + provisions for ongoing risk) to premiums. Nevertheless, it enables us to understand the proportion of the payable claims in the total of the net premiums received. However, this ratio gives us some information about the amount refunded in case of disaster. In practical terms, the policyholders' compensation is not done instantaneously, but it can, for several reasons (legal, administrative etc.), spread over a longer period. In this case, to ensure his future and present commitments to policyholders and beneficiaries of contracts, the insurer must set up provision funds for outstanding claims.

- *The reinsurance ratio:*

This ratio is calculated on the basis of the ratio of the ceded reinsurance and the deducted premiums. In fact, it reflects the level of uncertainty regarding some sold insurance policies. This implies that the insurer is unable either to adequately grasp the incurred risk regarding some insurance policies (e.g. automobile), or is unable to escape the problems related to the information asymmetry that represents the cornerstone in our research work. For this reason, sometimes the insurer chooses to insure himself to an insurance company to counteract any possible informational problems.

3.2.1. Estimation of the stochastic frontier without asymmetry

3.2.1.1. Selection of the functional form

Among the problems that arise in the context of the parameter estimates is the choice of the functional form. The question is to identify the most appropriate form which describes best the considered industry technology. However, we do not claim to study several functional forms, but we shall confine ourselves only to the Cobb-Douglas and translog production functions. However, our goal is to choose one among these two technologies. For this reason, we will conduct a Fisher test to choose the function which will be retained.

- ***The Cobb-Douglas form***

The Cobb-Douglas function can be written as follows:

$\log y = \alpha_0 + \alpha_1 \log L + \alpha_2 \log K$

- ***The Translog form***

The translog function can be written as follows:

$\log (Y_t) = \alpha_0 + \alpha_1 \log (K_t) + \beta_1 \log (L_t) + \alpha_2 \log (K_t)^2 + \beta_2 \log (L_t)^2 + \gamma \log (K_t) \log (L_t)$

It can be seen that these two models are nested. Indeed, if the β_{ij} (i=j=1,2) are nil, then the Cobb-Douglas form will be obtained. On this basis, a hypothesis test can be made on a subset of coefficients, which is in fact a Fisher's test.

As a consequence, our hypothesis can be formulated as follows

$\begin{cases} H_0: \beta_{12} = \beta_{11} = \beta_{22} = 0 \\ H_1: \beta ij \ (i = j = 1, 2) \neq 0 \end{cases}$ $\begin{cases} H_0: \text{Cobb-Douglas} \\ H_1: \text{Translog} \end{cases}$

The easiest and most appropriate method to carry out this test is to apply Fisher's test. Hence, the test statistics is defined as follows:

$$LR = \frac{(SCR(\textit{constrained model}) - (SCR\ (\textit{non constrained model})) / (dl(H_0) - dl(H_1))}{SCR\ (\textit{non constrained model}) / dl(H_1)}$$

With,
SCR: is the sum of the residual squares;
dl (H_0): is the degree of freedom under $H_{0;}$
dl (H_1): is the degree of freedom under $H_{1.}$

Table 1 shows the results of the conducted test:

Table 1. *The various test statistics*

	constrained model	non constrained model
SCR (H_0)	23.58	…….
DL (H_0)	136	…….
SCR (H_1)	…….	19.445
DL (H_1)	…….	130
F^c	4.609	…….
$F^T_{(5\%)}$	2.10	…….

From Table 1, it can be seen that Fisher's calculated statistics is higher than that of the table. This makes us conclude that the null hypothesis H_0can be rejected. In other words, the Cobb-Douglas functional form is rejected in favor of the Translog functional one. On the basis of this test, the technology of the Tunisian insurance industry can be represented by a Translog functional form, which will be retained later.

3.2.1.2. The model of Cornwell, Schmidt and Sickles: CSS

To assess the variability of technical efficiency over time, the specification proposed by CSS (1990) will be used. This choice can be validated using Fisher's test.

- ***Hypothesis test***

In the same vein, a statistical test will be carried out to justify the rejection of the deterministic fixed effect model in favor of the CSS model which describes the variability of technical efficiency. First of all, it should be noted that under the H_0 null hypothesis, the CSS model is equivalent to the deterministic fixed effect model. Hence, we have:

$$\begin{cases} H_0: \theta_{1i} = \theta_{2i} = 0 \\ H_1: \theta_{ji}\ (j = 1, 2) \text{ are different from zero} \end{cases}$$

- ***The test results***

The different test statistics are given in Table 2 below:

Table 2. *The various test statistics*

	constrained model	non constrained model
SCR (H_0)	7.822	…….
DL (H_0)	130	…….
SCR (H_1)	…….	4.6627
DL (H_1)	…….	110
F^c	3.7268	…….
$F^T_{(5\%)}$	1.75	…….

Therefore, the performed Fisher's test shows that H_0 is rejected in favor of H_1 hypothesis. As a result, this test rejects the constant efficiency model in favor of the variable efficiency model.

However, Cornwell, Schmidt and Sickles took a quadratic functional form which depends on time for efficiency.

This form can be written as:

$U_{it} = \theta_{0i} + \theta_{1i}\, t + \theta_{2i}\, t^2$

The type of translog production function is written as follows:

$\log y_{it} = \beta_1 \log K_{1it} + \beta_2 \log K_{2it} + \beta_3 \log L_{it} + \beta_{11it} (\log K_{1it})^2 + \beta_{22} (\log K_{2it})^2 + \beta_{33} (\log L_{it})^2 + \beta_{12} \log K_{1it} \operatorname{Log} K_{2it} + \beta_{13} \log K_{1it} \log L_{it} + \beta_{23} \log K_{2it} \log L_{it} + \varepsilon_{it} + V_{it}$

To estimate this model, we can also build dummy variables.

In fact, this model will be estimated by means of the so-called two-step method, which can be illustrated as follows:

- Estimate the production function by the OLS method.
- Recover the residues. $(\hat{\varepsilon}_{it})$.
- Regress the residues $(\hat{\varepsilon}_{it})$ on the V_{it} and $\theta_{0i} + \theta_{1i.t} + \theta_{2i.t}{}^2$, otherwise, the following model must be estimated by the OLS method.

Estimating the production function by the means of the OLS method

- Retrieve the residues $(\hat{\varepsilon}_{it})$.

Regress the $(\hat{\varepsilon}_{it})$ residues on V_{it} and $\theta_{0i} + \theta_{1i.t} + \theta_{2i.t}{}^2$, in other words, the following model should estimated using the OLS approach:

$\hat{\varepsilon}_{it} = \theta_{0i} + \theta_{1i}\, t + \theta_{2i}\, t^2 + V_{it}$.

Moreover, this estimation enables us to obtain the different elements of technical inefficiency θ_{ji} *(j = 1, 2, 3),* and therefore we can estimate the technical efficiency of the different companies. The efficiency scores can be obtained as follows:

$$TE = \exp\left(\hat{\theta}_{0i} + \hat{\theta}_{1i.t} + \hat{\theta}_{2i.t^2} - \max\left(\hat{\theta}_{0i} + \hat{\theta}_{1i.t} + \hat{\theta}_{2i.t^2}\right)\right)$$

i = 1,…, 10et t = 1,…, 14.

The following table shows the different technical efficiency scores obtained using this method.

Table 3. *The different technical efficiency scores obtained by the means of the CSS model (without asymmetry)*

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
90	0.6643	1	0.3388	0.3243	0.4311	0.6035	0.8337	0.9775	0.8961	0.6867
91	0.609	1	0.3486	0.394	0.4032	0.5984	0.7169	0.9609	0.7282	0.6751
92	0.5677	1	0.3587	0.4655	0.3813	0.5938	0.6308	0.9437	0.6073	0.6632
93	0.5379	1	0.369	0.5349	0.3645	0.5899	0.568	0.926	0.5196	0.6509
94	0.5182	1	0.3796	0.5977	0.3524	0.5864	0.5233	0.9076	0.4563	0.6383
95	0.5076	1	0.3904	0.6495	0.3445	0.5835	0.4933	0.8888	0.4111	0.6255
96	0.5054	1	0.4014	0.6864	0.3405	0.5812	0.4758	0.8695	0.3801	0.6124
97	0.5116	1	0.4126	0.7055	0.3403	0.5793	0.4696	0.8498	0.3606	0.5991
98	0.5265	1	0.4241	0.7051	0.3439	0.578	0.4743	0.8298	0.351	0.5857
99	0.5509	1	0.4358	0.6854	0.3514	0.5772	0.4901	0.8094	0.3506	0.572
00	0.586	1	0.4478	0.6478	0.363	0.5769	0.5183	0.7888	0.3594	0.5582
01	0.6337	1	0.4601	0.5955	0.3792	0.5771	0.5608	0.768	0.378	0.5443
02	0.6968	1	0.4725	0.5324	0.4005	0.5778	0.6209	0.747	0.408	0.5303
03	0.7788	1	0.4853	0.4629	0.4278	0.5791	0.7034	0.7258	0.4518	0.5163
Moy	0.5853	1	0.4089	0.5705	0.3731	0.5844	0.5771	0.8566	0.4756	0.6041
Rang	4	1	9	7	10	5	6	2	8	3
Min	0.5054	1	0.3388	0.3243	0.3403	0.5769	0.4696	0.7258	0.3506	0.5163
Max	0.7788	1	0.4853	0.7055	0.4311	0.6035	0.8337	0.9775	0.8961	0.6867

By looking at Table 3, it can be noticed that on the basis the different scores, a ranking of the different companies could be achieved. In the first group, we find companies C2, C8 and C10 which are classified respectively in the 1st, 2nd and 3rd place, with respective technical efficiency scores of the order of 1; 0.8566 and 0.6041. A second group includes companies C1, C6, C7 and C4 the efficiency scores of which are too close to one another, that is 0.5853; 0.5844; 0.5771 and 0.5705. Finally, a third group consists of C9, C3 and C5 companies which have low efficiency scores, that is 0.4756; 0.4089 and 0.3731.

Besides, on the basis of the various obtained scores, it can be concluded that C3 company recorded an efficiency improved over the 1990-2003 period, whereas C8 company knew a decline of efficiency over the whole studied period. The same applies to company 9, except for the last two years.

3.2.2. Estimation of a stochastic frontier with asymmetry

In this section, the information asymmetry will be taken account for its contribution to the production frontier since it could hamper the functioning of the insurance market or even threaten its existence. In fact, in the face of an insurer who, due the lack of sufficient information on the risk of its customers, practices uniform rates, only the individuals who anticipate high costs (high risk) will be interested in ensuring themselves, which results in an incomplete coverage of low risk and a deficit for the insurer. In practice, this anti-selection phenomenon consists of the insurers' strategies in selecting the low risks so much so that, unlike the theoretical predictions of adverse selection, in systems where a real competition between insurers prevails, there is rather a difficulty of high risks that should be ensured (Henriet and Rochet, 1998;Couffinhal, 2000). This incentive to the high risk selection is so high for the insurers that it is more immediately profitable and much easier to implement than the risk management. Risk management can be defined as the insurer's ability to create incentives towards the policyholders seeking a greater productive efficiency.

In this section, there is an attempt to build a production frontier that incorporates the terms of the information asymmetry through two proxy variables, which are the loss and the reinsurance ratios. Actually, a Fisher's test will be conducted to justify the introduction of the terms of the information asymmetry in the production function. Then, the temporal variability of technical efficiency will be tested in the presence of both ratios. Finally, an estimation of the technical efficiency of different companies could be achieved.

- ***The test results***

The various test statistics are presented in Table 4 below:

Table 4. *The various test statistics*

	constrained model	non constrained model
SCR (H_0)	19.4459	…….
DL (H_0)	130	…….
SCR (H_1)	…….	115.8228
DL (H_1)	…….	27
F^c	120.5229	…….
$F^T_{(5\%)}$	2.67	…….

On the basis of this table, it can be noticed that the calculated Fisher's statistics is greater than that of the table. This makes us conclude that the null H_0 hypothesis is rejected in favor of H_1 hypothesis. As a consequence, this test shows the relevance of the introduction of the information asymmetry terms in the production function.

The translog production function is written as follows:

$\log y_{it} = \beta_1 \log K_{1it} + \beta_2 \log K_{2it} + \beta_3 \log L_{it} + \beta_{11it} (\log K_{1it})^2 + \beta_{22} (\log K_{2it})^2 + \beta_{33} (\log L_{it})^2 + \beta_{12} \log K_{1it} \operatorname{Log} K_{2it} + \beta_{13} \log K_{1it} \log L_{it} + \beta_{23} \log K_{2it} \log L_{it} + \varepsilon_{it} + V_{it} + \delta 1 \text{ Sinisit}_{it} \delta 2 \text{ Réass}_{it}$.

Table 5 shows the results of the conducted test:

Table 5. *The various test statistics*

	constrained model	non constrained model
SCR (H_0)	3.2818	…….
DL (H_0)	110	…….
SCR (H_1)	…….	2.2292
DL (H_1)	…….	130
F^c	2.59726	…….
$F^T_{(5\%)}$	1.67	…….

Therefore, the performed Fisher's test shows that hypothesis H_0should be rejected in favor of H_1. As a result, this test rejects the model of constant efficiency in favor of that of the variable efficiency.

The following table shows the different technical efficiency scores obtained in the case of the information asymmetry.

Table 6. *The different technical efficiency scores obtained using the CSS model (with asymmetry)*

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
90	0.4252	0.7488	0.7151	0.9352	0.6802	0.4912	0.4912	0.7936	1	0.8533
91	0.3726	0.6387	0.8333	09891	0.2745	0.3502	0.8266	0.9603	1	0.819
92	0.4742	0.7423	0.6895	1	0.2863	0.4285	0.6083	0.6855	0.969	0.6273
93	0.6373	0.3842	0.5367	1	0.2539	0.3845	0.5055	0.528	0.8788	0.5535
94	0.3226	0.4041	0.5044	1	0.316	0.3306	0.6603	0.5457	0.8939	0.5196
95	0.357	0.3973	0.6267	1	0.2561	0.2618	0.5506	0.2626	0.8014	0.2761
96	0.6266	0.3832	0.3326	1	0.2767	0.2391	0.4175	0.2525	0.6359	0.2365
97	0.8582	0.4982	0.5753	1	0.5584	0.3189	0.5382	0.5283	0.8093	0.3305
98	0.7904	0.4547	0.5184	1	0.416	0.2826	0.363	0.4554	0.6329	0.3073
99	0.8791	0.7633	1	0.7002	0.6877	0.4632	0.7333	0.6625	0.9635	0.4256
00	0.8062	0.802	0.7994	1	0.7269	0.4289	0.688	0.7202	0.9142	0.4737
01	0.6461	0.827	0.5075	0.8932	0.51	0.5018	0.7429	0.8081	1	0.5126
02	0.5069	0.6147	0.4582	1	0.3845	0.3901	0.5307	0.6034	0.703	0.3661
03	0.2922	0.4797	0.3678	1	0.28	0.2727	0.4256	0.3775	0.5075	0.2981
Moy	0.5710	0.5813	0.6046	0.9655	0.4219	0.3674	0.5773	0.5845	0.8364	0.4714
Rang	7	5	3	1	9	10	6	4	2	8
Min	0.2922	0.3832	0.3326	0.7002	0.2539	0.2391	0.363	0.2525	0.5075	0.2365
Max	0.8791	0.827	1	1	0.7269	0.5018	0.8266	0.9603	1	0.8533

By referring to the table, we can draw the following results:

A first group includes C4, C9 and C3 companies classified respectively in the 1st, 2nd and 3rd place and which have respective technical efficiency scores of 0.9655; 0.8364 and 0.6046. A second group includes C8, C2, C1 and C7 companies which have efficiency scores too close to one another, that is, 0.5845; 0.5813; 0.5773 and 0.5710. Finally, a third group includes C10, C5 and C6 companies which have somewhat low efficiency scores, that is, 0.4714; 0.4219 and 0.3674.

Furthermore, from the obtained different scores, it can be concluded that the C4 company recorded an efficiency improvement of 0.9352 in 1990 to 1 in 2003, whereas C2 company saw a decline of its efficiency score which passes from 0.7488 in 1990 to 0.5813 in 2003. On the basis of this table, it can be noticed that the different efficiency scores for most insurance companies recorded a development compared to the technical efficiency scores achieved when the information asymmetry is not taken into account. Therefore, it can be concluded from this analysis that, when insurance companies take into account the information asymmetry, their efficiency scores generally improve. This implies that these companies need to better manage risk so as to overcome the problem of the information asymmetry.

Conclusion

To analyze the technical efficiency of the Tunisian insurance companies, we applied in this work the parametric approach embodied in the translog stochastic frontier production. The main obtained results firstly lead, through the model of Cornwell, Schmidt and Sickles (CSS), to the determination of technical efficiency scores, while ignoring the problem of the information asymmetry, as well as companies' classification, and secondly to the determinations of the efficiency scores while taking into account the problem of the information asymmetry. These results show that the different technical efficiency scores for most of the insurance companies recorded an improvement compared to the technical efficiency scores recorded by these companies when the information asymmetry is not taken into account. However, the new companies' classification obtained from the estimation of a production frontier with asymmetry shows that on average, most of the companies recorded greater efficiency scores when taking into account the information asymmetry. Finally, the Tunisian insurance companies are required to take into account the information asymmetry to improve their productive performance.

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