Corporate Governance Productivity Index in Banking Industry: Evidence from the European Banking Industry

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Practitioners and regulators increasingly rely on economic theory to measure bank efficiency and liken institutes with each other. These studies lean first on several methods that could be either stochastic or deterministic and second the input-output definition is based on a production or intermediation approach. This restraining modeling is unaware of several factors that can influence meaningfully banking efficiency such as banks' corporate governance. This paper aims to build a new model to measure bank efficiency. The goal of our model is to remedy existing model failings by the incorporation of the governance system. Our new model results imply contributions at both theoretical and empirical levels. From theoretical point of view, we develop an index to measure corporate governance productivity in the banking industry. This index is obtained by incorporating the governance variables in the usual expression of the directional technology distance function and a new development of the Luenberger productivity indicator. At empirical level, We apply this model on 146 banks dispersed in ten European countries. We show a significant effect of the governance variables on the construction of the technology frontier. In addition we find that the governance systems of Italy, Luxemburg and Netherlands are the more productive than the other systems.

JEL classification: G21; G34

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1. Introduction

To be effective is the central objective for all companies. Each organization looks for the performance in order to guarantee the survival. In fact, the manner whose company measure performance is crucial for their progress because the performance plays a very important role in the development of strategic plan, the assessment of organizational objective and the managers' remuneration.

With the quick development of efficiency frontier methods, the traditional performance measures became obsolete. Efficiency frontier methods are more objective than the financial ratios as Return on Equity (ROE) and Return on Assets (ROA) that are extensively used to measure company performance. These traditional methods estimate only a mean function whereas the goal of efficiency frontier methods is to measure the distance between each observation and the efficiency frontier. This new method has been widely used in regulatory analysis, the evaluation of the special effects of mergers and acquisitions, the capital regulations, deregulation of deposit rates, deletion of geographic restrictions on branching and holding company acquisitions, and on financial institution performance. The most important advantage of the efficiency frontier, comparing to the other indicators of performance, is a quantitative measure determined objectively that eliminates the special effects of market prices and other exogenous factors which can influence observed performance.

The pioneer of efficiency concept is attributed to Koopmans (1951), the first who proposes a measure of efficiency, and Debreu (1951) who computes it empirically and suggests the coefficient of using resources, essentially the measures of input-output ratio.

Farell (1957) shows that productive or economic efficiency has two components. The first one is the purely technical component defined as the ability of a production unit to generate as much output constraints permit. Thus, technical efficiency is defined as the maximum reduction of all inputs allowing a continual production of the same output quantities as before. The second is allocative efficiency or the price component: refers to a production unit ability to mix inputs and outputs in optimal proportions which should be adequate with their current prices.

Leibenstein (1966) has developed the concept of productive efficiency or X-efficiency, to assess the mass of company productivity through the use of inputs to generate outputs. Firms that exhibit X-inefficiency can be explained as follow: either wasting some of their inputs (technical inefficiency), or using the mistaken combination of inputs to produce outputs (allocative inefficiency), or the both. Management capacity as well as managerial preferences may be sources of X-inefficiency because, generally, manager's objectives differ from those of stockholders.

In the literature framework, two main methodologies are given to measure efficiency: the first one is the parametric approach which includes different methods such as: Stochastic Frontier Approach (SFA) (Aigner et al. (1977)); Tick Frontier Approach (TFA) and Distribution Free Approach (DFA). The second one is the nonparametric approach given by the most known methods: Data Envelopment Analyses (DEA) (Charnes, Cooper, and Rhodes (1978)) and Free Disposal Hull (FDH) (Deprins, Simar, and Tulkens (1984)). These two approaches allow us to estimate one common frontier shared by all companies. Every gap in the production level of any company compared with this estimated common frontier is assigned completely or partially to the inefficiency.

Before proceeding to measure efficiency, one must define inputs and outputs. For non banking industry, it is too simple to identify inputs and outputs. Services or products provided by the company are defined as outputs; raw materials used in the production process present the inputs. However, given the diversity of products and services offered by the banks, the identification of set-puts in this industry becomes a debated question. Literature review distinguishes between two main theoretical approaches to define banking production, either the production approach or the intermediation approach. The former, also called in volume approach, defines Capital and Labor as inputs to generate both loans and deposits as outputs. Since it is difficult to measure bank services, outputs are expressed as a stock of numbers of accounts (i.e. by the number of deposits and loans). This approach just incorporates operating costs in the deposits and loans services (Hancock (1984)). Although empirical applications illustrate that interest costs make up a greater part of bank costs, depending on the phase of the interest rate cycle and are integrated in the profit maximization plans of any efficient company (Berger and Humphrey, 1997). The production approach is favored if branch level efficiency is calculated to investigate a bank's operational efficiency. As branches mainly process customer documents for the institution and branch managers typically have a slight power over investment decisions and bank funding. The intermediation approach or in value approach, is attributed to Sealey and Lindley (1977) and focused on the financial value in accounts because the data of transaction service is usually unavailable (Berger and Humphrey, 1997). Capital, labor and the value of all deposits (purchased funds and financial equity capital) are considered as inputs that afford funds and cause costs. The value of all securities and loans, including loan monitoring services, are defined as outputs that exploit bank resources and generate revenues. This approach is also more suitable for evaluating entire banks as it includes total costs as opposed to the production approach which do not include interest expenses. Furthermore, the value approach is more appropriate when the principal goal of measuring bank efficiency is to assess among other: the implications of deregulation (or regulation) on the banking industry, the effects of integration into the entire financial architecture that accompanies financial liberalization and the influence of bank mergers and acquisitions on efficiency.

To estimate the frontier and measure efficiency we must specify an objective function. It exist essentially four principal functions that can be defined as references: cost, revenue, profit and the technology production function. These functions recognize an economic foundation for analyzing bank efficiency since they are focused on economic optimization in reaction to many business conditions such as: market prices, competition.etc. The measures of efficiency based on the production technology function knew an important theoretical evolution. Shephard (1953, 1974) pioneers radial distance functions as similar representations of a company's production technology and proposes some dual representations that have been extensively applied in empirical works. More recently, Luenberger (1992, 1995) develops some new production technology representations such as the benefit and the shortage functions. Chambers and al (1996, 1998) exploit these results and introduce the directional technology distance functions. This new technique becomes the center of research and application in the efficiency theory (Färe and al (2005, 2007); Fukuyama and Weber (2008)).

Several studies pointed the major impact of governance on the bank efficiency and performance. Nevertheless they don't introduce this factor as explanatory variables that can influence significantly the technology frontier.

Likewise the financial literature is in the center of a debate that treats the effect of corporate governance in the banking industry's efficiency. As for other business, banking governance is characterized by internal governance mechanisms that influence and supervise the manager's behavior opportunism. However, some more coercive external mechanisms exist in this sector. Booth et al. (2002), discuss the possibility to substitute these internal and external mechanisms in the case of bank governance. From their own opinion, the main internal mechanisms are reflected, first by the outside of the board of directors, second, by the capital manager's ownerships, and finally by the manager's statute as Chief Executive Officer and the Chairman in the same time.

Using Data Envelopment Analysis, Laeven (1999), examines the risk factors and Asian bank efficiency, applied to the period 1992-1996. His results show that state-owned and foreign-owned banks take slight risk relative to other banks, whereas family-owned and company-owned banks are among the highest risk takers. Many empirical studies focus on the relationship between the composition of the board of directors and the bank performance. These studies are mainly inspired from Jensen (1993). This author suggests that the board of directors is the crucial mechanism of the internal control system. This mechanism aims to discipline and to define the managerial discretion frame-work with the manager. Focusing on the board of director's size, Jensen (1993) suggests a board composed by a reduced number of administrator members. Gulamhussen and Guerreiro (2009) study the effect of foreign equity and board membership on the internal cost management and corporate strategy in Portuguese banks. They show that foreign equity reduces simultaneously total costs and operating costs, and also foreign board membership improves revenues generated from non-traditional areas of business as well as it reduces the dependence of domestic banks' revenues from traditional areas of business. Prowse (1995), on the basis of a simple of 234 banking holding companies over the period 1987-1997, studies the efficiency of the different control mechanisms within the banking sector. Among his results are the weakness of the board of directors to control the manager and the negative effect of the internal property on the bank performance. Simpson and Gleason (1999), investigate the relationship between the composition of the board of directors, the ownership structure and the probability of bankruptcy, for a simple of 287 banks in 1989. These authors find that the duality function for the manager (manager's statute as Chief Executive Officer and Chairman) deals with the limitation of the bankruptcy risk. On the other hand, they find that it doesn't exist any meaningful ties between the other components of the board of directors and bankruptcy risk. Using a simple of 260 commercial banks and saving banks, Belkhir (2009) proposes a synthesis features of the board of directors and the ownership structure that allow limited agency cost problems. He shows a substitution between these mechanisms of governance. Indeed banks being detained by interns have little need of independent administrators present in the board of directors. Besides, the Chief Executive Officer is less often president of the board of directors. Belkhir (2009) doesn't find any significant influence of these variables on the bank performance measured by the market to book proxy. Staikouras et al (2007) investigate banking efficiency in the South Eastern European region over the period 1998-2003. They show that banks with higher foreign ownership participation are costly most efficient with regard to other credit institution. Fries and Taci (2005) study the cost efficiency of 289 banks in the east European countries. They find that state-owned banks are less efficient than private banks. In addition, privatized banks with a majority domestic ownership are the least efficient and those with foreign ownership are the most efficient. Using a simple of 225 banks from 1996 to 2000 and by applying stochastic frontier approach, Bonin et al (2005) explore the effect of ownership on bank efficiency, for eleven transition countries. They show that the participation of international institutional investors have a considerable positive effect on profit efficiency. They find that cost bank efficiency increases with foreign-owned bank than other banks. Berger and al (2009) examine profit and cost efficiency of 38 commercial banks in china over the period 1994-2003with different majority ownership: Big-Four, non-Big-Four state owned, foreign and private domestic. They also study minority foreign ownership of some of private domestic Chinese institutions and non-Big-Four state owned banks. They show that reduction of state ownership and the increase of foreign ownership roles have a strong favorable effect on the Chinese banks. Berger and al (2009) conclude that Big-Four banks are the less efficient than the other banks. They suggest two reasons for this inefficiency: the poor revenue performance and the high non performing loans. Fuentes and Vergara (2003) use cost and profit function to estimate bank efficiency in Chile. They find two main results for these authors. Firstly, the offices of international banks are less efficient than banks that are established as open corporations in Chile. Lastly, banks that have higher ownership concentration are more efficient than other banks.

The aim of this paper is to study the influence of the governance variables on the technology frontier and to develop an index to measure governance system productivity. First we incorporate the governance variables in the directional technology distance function proposed by Chambers et al. (1996, 1998) to measure bank efficiency across-countries. Then we decompose the luenberger productivity indicator and express an indicator to measure governance system productivity. To valid empirically our work, we use a sample of 146 banks dispersed in ten European countries over the period 2002 - 2007.

Our research is organized as follows. The next section describes our methodology. The theoretical and empirical implications are developed in section three. Concluding remarks are given in the last section.

2. Methodology

2.1. Model

To measure productivity of governance system in the banking industry we use a directional technology distance function developed by Chambers et al. (1996, 1998), that is a particular form of the shortage function developed by Luenberger (1992) and a generalization of the input and output distance function introduced by shephard (1953). This function allows modeling the production process and measure efficiency by incorporating all inputs and outputs vectors.

Let (T) the technology set that defines all feasible input-output vectors for each bank, it can be presented as follow:

$$T \equiv \left\{(x,y) : x \text{ can produce } y\right\} \quad (1)$$

Where $x=(x_1,x_2...x_N)\in \Re_+^N$ denote the inputs vector, while $y=(y_1,y_2...y_M)\in \Re_+^M$ denote the outputs vector for each bank.

The directional technology distance function that allows completely characterizes the technology set T, generally defined as:

$$\vec{D}(x,y;g_x g_y)=\max\left\{\beta : (x-\beta g_x, y+\beta g_y)\in T\right\} \quad (2)$$

Where β gives the distance between the observation (x,y) and a point on the technology frontier, whiles the directional vector $g=(g_x g_y)$, $g_x=(g_x^1,g_x^2...g_x^N)\in \Re_+^N$ and $g_y=(g_y^1,g_y^2...g_y^M)\in \Re_+^M$ establishes the direction in which efficiency is measured. The directional distance function tries to find simultaneously the maximum contraction of inputs vector (x) and expansion of outputs vector (y) following the directional vector $(g_x g_y)$. When $\vec{D}(x,y;g_x g_y)=0$ the Bank is defined technically efficient and the vector (x,y) located at the technology frontier. On other hand, if $\vec{D}(x,y;g_x g_y) \geq 0$ then the bank is defined technically inefficient and the vector (x,y) located below the technology frontier.

Many proprieties of the directional distance function are described by Chambers et al. (1998) and Färe et al. (2007), but the most important is the translation property from which we define the restrictions imposed to the directional distance function:

$$\vec{D}(x,y;g_x g_y) - \beta = \vec{D}(x - \beta g_x, y + \beta g_y; g_x, g_y) \qquad \beta \in \Re \tag{3}$$

Färe et al. (2005) opt for a quadratic flexible functional form to parameterize the directional technology distance function and must satisfy the restrictions imposed by translation property and symmetry restrictions. This function is often expressed as follows:

$$\begin{aligned}\vec{D}(x,y;g_x,g_y,t,\theta) &= \alpha_0 + \sum_{n=1}^{N}\alpha_n x_n + \sum_{m=1}^{M}\beta_m y_m + 1/2\sum_{n=1}^{N}\sum_{n'=1}^{N}\alpha_{nn'}x_n x_{n'} + 1/2\sum_{m=1}^{M}\sum_{m'=1}^{M}\beta_{mm'}y_m y_{m'} \\ &+ \sum_{n=1}^{N}\sum_{m=1}^{M}\gamma_{mn}y_m x_n + \delta_1 t + 1/2\delta_2 t^2 + \sum_{n=1}^{N}\psi_n t x_n + \sum_{m=1}^{M}\eta_m t y_m\end{aligned} \tag{4}$$

To study the influence of governance system on the technology frontier we incorporate in expression (4) governance variables en interaction with inputs, outputs and time trend. Let $G = (G_1, G_2 ... G_K)$ the vector of governance mechanisms variables for each bank. Thus, the new directional technology distance function is parameterized as follows:

$$\begin{aligned}\vec{D}(x,y,G;g_x,g_y,t,\theta) &= \alpha_0 + \sum_{n=1}^{N}\alpha_n x_n + \sum_{m=1}^{M}\beta_m y_m + 1/2\sum_{n=1}^{N}\sum_{n'=1}^{N}\alpha_{nn'}x_n x_{n'} + 1/2\sum_{m=1}^{M}\sum_{m'=1}^{M}\beta_{mm'}y_m y_{m'} \\ &+ \sum_{n=1}^{N}\sum_{m=1}^{M}\gamma_{mn}y_m x_n + \sum_{k=1}^{K}\lambda_k G_k + \sum_{n=1}^{N}\sum_{k=1}^{K}\chi_{nk}x_n G_k + \sum_{m=1}^{M}\sum_{k=1}^{K}\phi_{mk}y_m G_k + 1/2\sum_{k=1}^{K}\sum_{k'=1}^{K}\tau_{kk'}G_k G_{k'} \\ &+ \delta_1 t + 1/2\delta_2 t^2 + \sum_{n=1}^{N}\psi_n t x_n + \sum_{m=1}^{M}\eta_m t y_m + \sum_{k=1}^{K}\varphi_k t G_k\end{aligned} \tag{5}$$

- ✓ Usual symmetric restrictions

$$\begin{aligned}&\alpha_{nn'} = \alpha_{n'n} && n \neq n' \\ &\beta_{mm'} = \beta_{m'm} && m \neq m' \\ &\tau_{kk'} = \tau_{k'k} && k \neq k'\end{aligned} \tag{6}$$

- ✓ Restrictions imposed by the translation property

$$\begin{aligned}&\sum_{m=1}^{M}\beta_m g_y - \sum_{n=1}^{N}\alpha_n g_x = -1 \\ &\sum_{m=1}^{M}\beta_m g_y - \sum_{n=1}^{N}\alpha_n g_x = -1 \\ &\sum_{m'=1}^{M}\beta_{mm'}g_{y'} - \sum_{n=1}^{N}\gamma_{nm}g_x = 0 \\ &\sum_{m=1}^{M}\phi_{km}g_{y'} - \sum_{n=1}^{N}\chi_{kn}g_x = 0 \\ &\sum_{m=1}^{M}\eta_m - \sum_{n=1}^{N}\psi_n = 0\end{aligned} \tag{7}$$

Where $\theta = (\alpha,\beta,\gamma,\lambda,\chi,\phi,\tau,\delta,\eta,\psi)$ is the parameters vector to be estimated whereas $G = (G_1, G_2 ... G_K)$ is the vector of governance mechanisms and finally the trend variable explains technical progress (Färe et al. (2005)).

To estimate the parameters of equation (5) we opt for a stochastic estimation methods used by Kumbhakar and Lovell (2000) and Färe et al. (2005). This stochastic specification takes the following form:

$$\vec{D}(x,y,G;g_x,g_y,t,\theta)+\varepsilon^k=0 \tag{8}$$

In a first step an objective function will be estimated $\min \varepsilon^k$ Subject to the translation and symmetric restrictions presented above, in addition to two other restrictions proposed by Färe et al. (2005)[18]:

$$\vec{D}(x,y,G;g_x,g_y)\geq 0 \tag{9}$$

$$\frac{\partial \vec{D}(x,y,G;g_x,g_y)}{\partial y_m}\leq 0 \qquad \forall m \tag{10}$$

Where the first restriction insures that, the directional technology distance function provides a complete characterization of the technology. The second restriction reflects the assumption of strong disposability of outputs imposed to the bank technology.

In a second step we estimate efficiency score of banks of each country by using a stochastic frontier approach introduced in academic literature by Aigner, Lovell and Schmidt (1977) and Meeusen and Vanden-Broek (1977). In this approach is considered as a compound error term and is depicted as follows:

$$\varepsilon=\mu_{it}+\upsilon_{it} \tag{11}$$

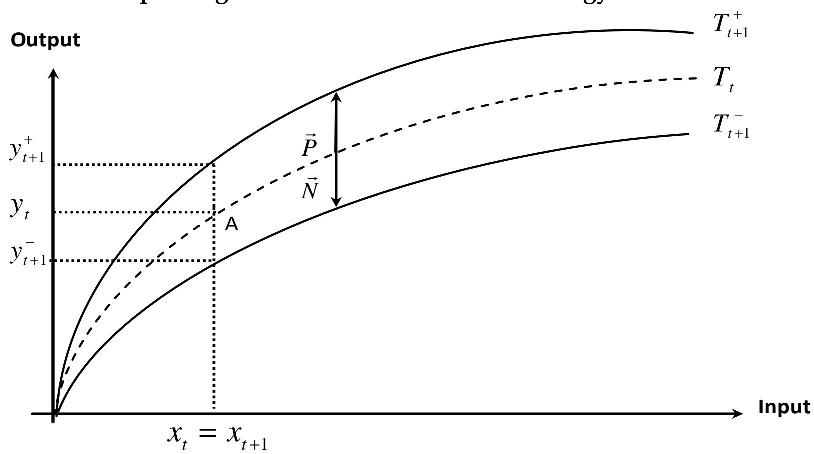
In equation (11), $\upsilon_{it}\overset{iid}{\mapsto}N(0,\sigma_\upsilon^2)$ denotes random noise term usually normally distributed, while $\mu_{it}\overset{iid}{\mapsto}\left|N(0,\sigma_\mu^2)\right|$ represents a positive efficiency component usually half-normally distributed and which allows explaining technical efficiency in production process.

Let's note that, we choose the directional vector $(g_x g_y)=(1,1)$, because that allows to gives the maximum unit contraction of input and unit expansion of output.

2.2. Corporate governance effect on the technology frontier

Between two consecutive periods t and t+1, corporate governance can influence negatively or positively the feasible space of input-output vectors. Figure 1 illustrates the two situations. When the corporate governance system has a positive influence, the technology frontier passes from T_t to T_{t+1}^{+}, grace to the force vector $\vec{P}$, the banks situated at the frontier in the period t will be more productive in the period t+1. For the same amount of input in the two period's t and t+1, i.e. $x_t=x_{t+1}$, the amount of output y_{t+1} produced in the period t+1 will be superior to the amount of output y_t produced in the period t. In other ways, for the same amount of output for the two period t and t+1, i.e. $y_t=y_{t+1}$, the amount of input x_{t+1} used in the period t+1 to produce this quantity of output is lower than the amount of input x_t used in the period t. In addition the feasible space of input-output vectors becomes more widen. Accordingly, where the corporate governance system has a negative influence, the technology frontier passes from T_t to T_{t+1}^{-}, caused by the force vector $\vec{N}$ .The banks situated at the frontier in the period t will be less productive in the period t+1. For the same amount of input, i.e. $x_t=x_{t+1}$, for the two period t and t+1 the bank produces an amount of output y_{t+1} for the period t+1 less than the amount of output y_t for the period t. In other ways, for the same amount of output for the two period t and t+1, i.e. $y_t=y_{t+1}$ the amount of input x_{t+1} used in the production process is lower than the quantity used in the period t+1. In addition the feasible space of input-output vectors becomes more restricted.

Figure I
Corporate governance effect on the technology frontier



Notes: Different notations used in the figure are defined as follows: T_t : technology frontier for the period t, T^{-}_{t+1} : technology frontier for the period t+1 with a negative effect of governance system, T^{+}_{t+1} : technology frontier for the period t+1 with a positive effect of governance system, $\vec{N}$: negative force vector, $\vec{P}$: positive force vector.

3. Theoretical and empirical implication

3.1. Theoretical implications

Referring to the new directional technology distance function, we observe that the technology is influenced by many factors among which the corporate governance system. The governance system of each country can influence positively or negatively her technology production. To attribute a measure of productivity for each country governance system we resort a new decomposition for the luenberger index.

Using the quadratic identity lemma proposed by Diewert (1976) we can write the changes in the directional technology distance function (4) between two time periods as follows:

$$\begin{aligned}\vec{D}^{t}-\vec{D}^{t+1} &= 0,5\sum_{n=1}^{N}\left[\frac{\partial\vec{D}^{t}}{\partial x_{n}}+\frac{\partial\vec{D}^{t+1}}{\partial x_{n}}\right](x_{n}^{t+1}-x_{n}^{t})+0,5\sum_{m=1}^{M}\left[\frac{\partial\vec{D}^{t}}{\partial y_{m}}+\frac{\partial\vec{D}^{t+1}}{\partial y_{m}}\right](y_{m}^{t+1}-y_{m}^{t})\\ &+0,5\sum_{k=1}^{K}\left[\frac{\partial\vec{D}^{t}}{\partial G_{k}}+\frac{\partial\vec{D}^{t+1}}{\partial G_{k}}\right](G_{k}^{t+1}-G_{k}^{t})+0,5\sum_{n=1}^{N}\left[\frac{\partial\vec{D}^{t}}{\partial t}+\frac{\partial\vec{D}^{t+1}}{\partial t}\right]\end{aligned} \tag{12}$$

The productivity change can be generally expressed as the difference between the weighted average rates of change in outputs and inputs. The weights are derivatives of the directional technology distance function with respect to the outputs and inputs:

$$PC = 0,5\sum_{n=1}^{N}\left[\frac{\partial\vec{D}^{t}}{\partial x_{n}}+\frac{\partial\vec{D}^{t+1}}{\partial x_{n}}\right](x_{n}^{t+1}-x_{n}^{t})+0,5\sum_{m=1}^{M}\left[\frac{\partial\vec{D}^{t}}{\partial y_{m}}+\frac{\partial\vec{D}^{t+1}}{\partial y_{m}}\right](y_{m}^{t+1}-y_{m}^{t}) \tag{13}$$

While taking account of the two equations (12) and (13) we get the new expression of the productivity change as follows:

$$PC = \underbrace{\vec{D}^{t}-\vec{D}^{t+1}}_{EC}\;\underbrace{\underbrace{-\,0,5\sum_{k=1}^{K}\left[\frac{\partial\vec{D}^{t}}{\partial G_{k}}+\frac{\partial\vec{D}^{t+1}}{\partial G_{k}}\right](G_{k}^{t+1}-G_{k}^{t})}_{GTC}\;\underbrace{-\,0,5\sum_{n=1}^{N}\left[\frac{\partial\vec{D}^{t}}{\partial t}+\frac{\partial\vec{D}^{t+1}}{\partial t}\right]}_{TTC}}_{TC} \tag{14}$$

The Luenberger productivity change index (LPC) initially developed by Chambers et al (1996) that allows computing productivity growth. It is presented as follows:

$$LPC = \frac{1}{2}\Big[\vec{D}^{t}(x^{t}, y^{t}, G^{t}; g) - \vec{D}^{t+1}(x^{t+1}, y^{t+1}, G^{t+1}; g) + \vec{D}^{t+1}(x^{t}, y^{t}, G^{t}; g) - \vec{D}^{t}(x^{t+1}, y^{t+1}, G^{t+1}; g)\Big] \quad (15)$$

This indicator is the sum of technical change (LTC) and efficiency change (LEC)

$$LPC = LEC + LTC \quad (16)$$

The efficiency change index (LEC) indicates the difference of the directional technology distance function between two periods:

$$LEC = \Big[\vec{D}^{t}(x^{t}, y^{t}, G^{t}; g) - \vec{D}^{t+1}(x^{t+1}, y^{t+1}, G^{t+1}; g)\Big] \quad (17)$$

This indicator measures changes in the position of a production unit relative to the industry's best-practice frontier over time and represents the so-called 'catching up' term, that is, the convergence towards or divergence from best practice.

The technical efficiency change (LTC) is presented by the average shift in the frontier and is expressed as:

$$LPC = \frac{1}{2}\Big[\vec{D}^{t+1}(x^{t+1}, y^{t+1}, G^{t+1}; g) - \vec{D}^{t}(x^{t+1}, y^{t+1}, G^{t+1}; g) + \vec{D}^{t+1}(x^{t}, y^{t}, G^{t}; g) - \vec{D}^{t}(x^{t}, y^{t}, G^{t}; g)\Big] \quad (18)$$

The LTC indicator equals the average "shift" in the best-practice frontier from period to period and reflects improvement or deterioration in the performance of best-practice production units. If the shift in the technological frontier is parallel then technological change is neutral.

Many factors can influence the technical efficiency change among which we can identify governance technical change (GTC) and the other factors are incorporated in the time trend (TTC).

$$TC = GTC + TTC \quad (19)$$

Thus we can decompose luenberger technology change (LTC) to luenberger governance technical change index (LGTC) and the luenberger time trend efficiency change index (LTTC).

$$LGTC = \frac{1}{2}\Big[\vec{D}^{t+1}(x^{t+1}, y^{t+1}, G^{t+1}; g) - \vec{D}^{t+1}(x^{t+1}, y^{t+1}, G^{t}; g) + \vec{D}^{t}(x^{t}, y^{t}, G^{t+1}; g) - \vec{D}^{t}(x^{t}, y^{t}, G^{t}; g)\Big] \quad (20)$$

$$LTTC = \frac{1}{2}\Big[\vec{D}^{t+1}(x^{t+1}, y^{t+1}, G^{t}; g) - \vec{D}^{t}(x^{t}, y^{t}, G^{t+1}; g) + \vec{D}^{t+1}(x^{t}, y^{t}, G^{t}; g) - \vec{D}^{t}(x^{t+1}, y^{t+1}, G^{t+1}; g)\Big] \quad (21)$$

For each country we can calculate a luenberger governance technical change index (LGTC): If this index has a positive value then we conclude that governance system of this country is more productive, in the case of a negative value of this index that indicates a negative influence of the governance system in this country and is classified as the least productive. In addition, this index can help in order to classify the productivity of governance system between countries. The country which has the largest index (LGTC), her governance system is classified as the most productive system.

3.2. Empirical implications

In this section we will present in the first time our dataset and sources of information. Second, we define variables used in this study. Finally, we will present the empirical results.

3.2.1. Dataset

For the empirical validation of our model and studying the influence of the governance on the efficiency frontier and assess the luenberger indexes of productivity and governance, we use a sample of 146 banks dispersed in 10 European countries (Belgium, Denmark, Germany, Greece, France, Italy, Luxemburg, Netherlands, Sweden, United Kingdom) over the period 2002-2007. First we construct our sample referring to a list of European banks, classified by country, published by the European Central Bank (ECB) in her official web site. Then needed information for our data base is established referring to the annual reports published by banks in their official web sites. To be included in our sample, banks must have all variables, defined in our model, accessible at least for four years.

3.2.2. Variable definitions

To estimate efficiency frontier we need measures of inputs and outputs and also those of governance variables.

A. Input-output variables

Regarding previous literature, there is no compromise about specification of inputs and outputs for a banking firm. There are two main approaches to this measurement question. In the production approach, banks are concerned to produce generally deposit accounts and loan accounts maintained with them. It is the number of accounts of various types that are taken as measures of output, produced by using capital and labor. Berger and Humphrey (1992) describe this approach as value added approach. On the other hand, in the case of intermediation approach also named asset approach, a bank has as a principal task that transforming maturity profile and risk of received funds, to loan portfolio or investment of a different maturity profile and risk, by using capital and labor. In this paper we use the intermediation approach since, in our time, banks operate in a potential manner on the stock exchange and are not anymore considered as a simple producer of deposit accounts and loan accounts.

Following the pioneers of the intermediation approach Sealey and Lindley (1977) we specify three inputs, fixed assets as a proxy of physical capital, personnel expenses as a measure of labor and borrowed funds. These inputs are used to produce three outputs, interbank loans, commercial loans and securities.

B. Governance variables

Like other firms, banking governance is characterized by internal mechanisms having for objective to influence and to supervise the manger behavior. Among these mechanisms, one distinguishes notably the disciplinary role assumed by the board of directors and the ownership structure.

The size of the board of directors

Following Fama and Jensen (1983) the board of directors is not an effective device for decision control unless but it limits decisions discretions of individual top managers. Booth et al. (2002) and Adams and Mehran (2003) find that the size of the board of directors in the banking industry is greater than firms of other industries.

We expect that banks having a large board of directors can prove her productivity and the bank will be more efficient. In our study, this variable is assessed by the total number of directors present in the board.

Duality

Duality is an indicator of the power structure in the board of directors when the Chief Executive Officer is simultaneously the chairman (e.g. the chief of the board of directors). In this case, he will have a strong power to influence the choice of other directors, the strategic planning process and decisions.

Pi and Timme (1993) show that in presence of duality, banks are least efficient than other banks which separate this two functions. Thus we estimate that duality influence negatively productivity and, in this situation, banks will be least productive and consequently least efficient. In this paper, this variable is assuming to be a binary variable, which takes the value one in presence of duality, and zero in the other case.

Majority ownership

The effect of ownership concentration on the banking performance is theoretically complex and empirically ambiguous. In fact numerous studies found a positive influence of the majority ownership on the performance, whereas others concluded that it doesn't exist any relation between them.

Spong et al. (1996) conclude for a simple of 143 American banks that ownership concentration influence positively banking performance. In the same way, Crespi et al. (2004) and Caprio et al. (2007) reveal that majority ownership has a positive effect on banking performance.

We expect a positive effect of ownership concentration in banking efficiency and productivity. We define two stapes to calculate this variable for each bank. In the first we search shareholders that detain more than five percent of the total of shares. In the second step we sum the total of these percentages.

Institutional investor-owned

Today, institutional investors are actors that detain the largest fraction of titles quoted in the most stock exchanges in the world. This type of investors has a particular influence on corporate governance and company performance Gillian and Starks (2003).

Stable institutional investors can improve company performance Elyasiani and Jia (2008), and allow firms to reduce agency cost and information asymmetry problems (Jensen and Meckling, 1976; Myers and Majluf, 1984).

We expect that institutional investors influence positively performance. In other words, the presence of this type of investors has a positive effect on banks efficiency and productivity. This governance variable is assessed as the percentage of stocks for each bank detained by the institutional investors.

Table 1, provides descriptive statistics (the mean and the standard deviation) of the variables used in this study by country over the period 2002-2007. There are substantial variations across countries relating to bank outputs, inputs and governance variables. Denmark has the smallest banking sector in the sample with the lowest mean values of fixed assets, labor, borrowed funds, interbank loans, commercial loans, and securities (all expressed in millions of Euros). Conversely, the banking systems of the France and United-Kingdom are the largest in our sample, as showed by the mean values of bank inputs and outputs.

Luxemburg has the highest percentages of the Institutional owners and the Majority ownership. On the other hand, Denmark has the smallest percentage of these two variables. The duality percentage ranges from 22% in Luxemburg to 45% in Belgium and Greece. The size of the board of directors is relatively high in Germany approximately with an average of 20 members.

Table 1
Descriptive statistics of variables by country

Panel A: Inputs

Inputs	x_1		x_2		x_3	
	Mean	SD	Mean	SD	Mean	SD
Germany	1,556.57	2,092.74	652.17	835.59	84,395.89	88,327.55
France	10,857.59	15,094.19	2,009.13	2,600.15	126,932.20	156,274.70
UK	8,076.65	13,379.97	1,471.40	2,229.23	116,074.10	170,359.60
Belgium	293.57	815.42	197.72	516.31	15,051.90	40,553.80
Italy	770.01	960.19	184.62	200.74	9,188.17	9,277.24
Netherlands	5,206.21	7,703.78	2,242.75	3,305.72	142,228.50	207,420.50
Luxemburg	880.19	1,278.33	247.73	322.23	45,138.79	57,635.76
Sweden	2,790.32	3,415.19	618.22	702.54	63,464.41	56,982.95
Denmark	493.25	649.03	73.01	83.92	6,530.38	6,382.58
Greece	786.48	897.59	258.88	268.66	11,909.70	12,784.60

Panel B: Outputs

Outputs	y_1		y_2		y_3	
	Mean	SD	Mean	SD	Mean	SD
Germany	18,453.67	20,588.23	39,835.54	40,758.04	31,392.92	37,500.64
France	24,052.65	29,637.74	52,086.00	63,138.78	76,248.05	106,038.30
UK	13,322.80	20,329.70	70,056.41	102,431.50	31,974.88	50,533.30
Belgium	2,714.15	7,175.72	6,285.02	16,531.22	7,914.48	22,506.63
Italy	1,647.25	1,976.59	6,282.93	6,403.23	1,346.05	1,959.53
Netherlands	19,956.03	28,865.79	78,187.98	115,081.35	47,106.32	67,188.92
Luxemburg	15,163.28	19,026.03	14,481.94	18,846.36	18,373.90	24,520.39
Sweden	10,433.81	8,719.73	41,772.51	35,266.02	12,627.94	15,909.86
Denmark	955.26	1,151.62	4,342.65	4,210.97	1,236.64	1,266.88
Greece	1,548.49	1,602.70	7,598.66	7,967.48	2,669.30	3,303.45

Panel C: Governance variables

Governance variables	G_1		G_2		G_3		G_4	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Germany	71.34	23.50	0.24	0.37	19.63	4.43	69.43	23.50
France	74.61	28.67	0.39	0.48	15.39	4.21	70.76	28.67
UK	68.61	28.06	0.32	0.43	12.42	4.09	65.61	28.06
Belgium	73.87	23.25	0.45	0.50	12.85	3.10	68.57	23.25
Italy	79.56	22.87	0.31	0.43	10.27	2.63	75.56	22.87
Netherlands	84.04	16.72	0.23	0.36	9.48	1.63	79.47	16.72
Luxemburg	91.64	11.47	0.22	0.34	12.93	4.96	85.94	13.47
Sweden	64.36	30.18	0.44	0.49	11.56	1.92	63.27	30.18
Denmark	53.76	20.19	0.31	0.43	13.21	1.77	45.87	20.19
Greece	60.76	30.13	0.45	0.49	10.97	1.84	58.76	30.13

Notes: The table reports the mean and the cross-sectional standard deviation (SD) of each variable by country, different notations used in the table are defined as follows : x_1 = Fixed assets; x_2 = Labor; x_3 = Borrowed funds; y_1 = Interbank loans; y_2 = Commercial loans; y_3 = Securities; G_1 = Institutional owners; G_2 = Duality; G_3 = Board of directors size; G_4 = Majority ownership. Inputs and outputs variables are expressed on € million, the governance variables are expressed in percentage except the board of directors is measured by the number of directors who constitute the board.

3.2.3. Results and interpretation

- Efficiency estimate and models comparison

In order to investigate the sensitivity of our model, we use the test of likelihood ratio (LR) that allows us to verify if the model is globally significant. The robustness of our model increases with the LR value. In our study the likelihood ratio increases from 785 in the first model to 1576 in our second model, a thing that proves the importance of governance variables in the construction of the technology frontier and their considerable effect to define the production space.

We note that in the second model the majority of variables are significant at the 1 to 10% levels. Concerning the governance variables except their interaction with the other variables are significant at the level of 1 to 5%. Again this result proves the significant effect of governance variables on the construction of the technology frontier. It is also remarkable that the standard deviation of the estimated parameters decreases for the majority of the considered variables comparing to the previous model.

Table 2
Empirical results of the two models of frontier estimation

	Par.	Model1	Model2		Par.	Model1	Model2		Par.	Model1	Model2
C	α_0	0.0615 (0.0445)	-0.4004 (0.0860)	x_1G_1	χ_{11}		-0.3423 (0.0214)	y_2G_1	ϕ_{21}		-0.3448 (0.0173)
x_1	α_1	0.0206 (0.0048)	-0.2659 (0.0038)	x_1G_2	χ_{12}		-0.3820 (0.0136)	y_2G_2	ϕ_{22}		-0.3772 (0.0103)
x_2	α_2	-0.0784 (0.0046)	-0.2706 (0.0044)	x_1G_3	χ_{13}		-0.2119 (0.0017)	y_2G_3	ϕ_{23}		-0.1868 (0.0013)
x_3	α_3	0.5258 (0.0031)	-0.2462 (0.0032)	x_1G_4	χ_{14}		-0.1231 (0.0012)	y_2G_4	ϕ_{24}		-0.0748 (0.0010)
y_1	β_1 α_1	-0.0821 (0.0035)	-0.3906 (0.0035)	x_2x_3	α_{23}	0.0858 (0.0003)	0.9516 (0.0001)	y_3G_1	ϕ_{31}		-0.3510 (0.0192)
y_2	β_2	-0.3494 (0.0033)	.5006E-8 (0.0032)	x_2y_1	γ_{21}	-0.0297 (0.0004)	0.4385 (0.0001)	y_3G_2	ϕ_{32}		-0.3795 (0.0109)
y_3	β_3	-0.1005 (0.0092)	-0.3922 (0.0035)	x_2y_2	γ_{22}	-0.0543 (0.0004)	0.5967 (0.0001)	y_3G_3	ϕ_{33}		-0.2062 (0.0016)
G_1	λ_1		-0.4016 (0.2122)	x_2y_3	γ_{23}	-0.0089 (0.0008)	0.4260 (0.0002)	y_3G_4	ϕ_{34}		-0.1079 (0.0011)
G_2	λ_2		-0.4042 (0.1783)	x_2G_1	χ_{21}		-0.3460 (0.0225)	G_1G_2	τ_{12}		-0.4048 (0.6873)
G_3	λ_3		-0.3920 (0.0330)	x_2G_2	χ_{22}		-0.3838 (0.0136)	G_1G_3	τ_{13}		-0.3952 (0.1152)
G_4	λ_4		-0.3846 (0.0242)	x_2G_3	χ_{23}		-0.2242 (0.0019)	G_1G_4	τ_{14}		-0.3888 (0.0810)
x_1^2	α_{11}	-0.0021 (0.0006)	0.7835 (0.0004)	x_2G_4	χ_{24}		-0.1405 (0.0014)	G_2G_3	τ_{23}		-0.4014 (0.0716)
x_2^2	α_{22}	-0.0013 (0.0005)	0.6532 (0.0003)	x_3y_1	γ_{31}	-0.0036 (0.0003)	0.8059 (0.0001)	G_2G_4	τ_{24}		-0.4000 (0.0558)
x_3^2	α_{33}	-0.0952 (0.0002)	1.3634 (0.0001)	x_3y_2	γ_{32}	0.0769 (0.0003)	0.9130 (0.0001)	G_3G_4	τ_{34}		-0.3527 (0.0092)
y_1^2	β_{11}	0.0100 (0.0003)	0.8626 (0.0002)	x_3y_3	γ_{33}	0.0289 (0.0022)	0.7880 (0.0001)	t	δ_1	0.0013 (0.0203)	-0.3869 (0.0704)
y_2^2	β_{22}	-0.0137 (0.0003)	1.0588 (0.0001)	x_3G_1	χ_{31}		-0.3269 (0.0168)	t^2	δ_2	-0.0006 (0.0338)	-0.3653 (0.1489)
y_3^2	β_{33}	-0.0018 (0.0009)	0.8469 (0.0006)	x_3G_2	χ_{32}		-0.3762 (0.0099)	tx_1	ψ_1	-0.0032 (0.0021)	-0.1441 (0.0054)
G_1^2	τ_{11}		-0.4022 (0.9383)	x_3G_3	χ_{33}		-0.1627 (0.0013)	tx_2	ψ_2	0.0022 (0.0021)	-0.1594 (0.0058)
G_2^2	τ_{22}		-0.4042 (0.1783)	x_3G_4	χ_{34}		-0.0459 (0.0010)	tx_3	ψ_3	0.0009 (0.0014)	-0.0751 (0.0041)
G_3^2	τ_{33}		-0.3699 (0.0157)	y_1y_2	β_{12}	0.0159 (0.0003)	0.9520 (0.0001)	ty_1	η_1	0.0014 (0.0017)	-0.1322 (0.0046)
G_4^2	τ_{44}		-0.3152 (0.0084)	y_1y_3	β_{13}	-0.0039 (0.0005)	0.8451 (0.0002)	ty_2	η_2	0.00005 (0.0016)	-0.1096 (0.0044)
x_1x_2	α_{12}	0.0088 (0.0005)	0.7131 (0.0003)	y_1G_1	ϕ_{11}		-0.3496 (0.0191)	ty_3	η_3	-0.0015 (0.0019)	-0.1368 (0.0050)
x_1x_3	α_{13}	0.0046 (0.0003)	1.0347 (0.0001)	y_1G_2	ϕ_{12}		-0.3794 (0.0111)	tG_1	φ_1		-0.3910 (0.1717)
x_1y_1	γ_{11}	-0.0010 (0.0004)	0.5130 (0.0002)	y_1G_3	ϕ_{13}		-0.2029 (0.0014)	tG_2	φ_2		-0.4000 (0.0903)
x_1y_2	γ_{12}	-0.0018 (0.0004)	0.5967 (0.0002)	y_1G_4	ϕ_{14}		-0.0995 (0.0011)	tG_3	φ_3		-0.3579 (0.0283)
x_1y_3	γ_{13}	-0.0059 (0.0006)	0.5011 (0.0002)	y_2y_3	β_{23}	-0.0058 (0.0005)	0.9342 (0.0001)	tG_4	φ_4		-0.3324 (0.0182)

$LR_{model1} = 785$ $LR_{model2} = 1576$

Notes: This table presents the estimated parameters and the standard deviation for each one enter parenthesis of the two models 1 and 2 (see appendix1). The model 1 expresses the previous model used in the literature review. In this model only the inputs, outputs and trend time considered as principal variables. Model 2 incorporates the governance variables in the directional technology distance function to estimate the technology frontier. Different notations used in the table are defined as follows : x_1 = Fixed assets; x_2 = Labor; x_3 = Borrowed funds; y_1 = Interbank loans; y_2 = Commercial loans; y_3 = Securities; G_1 = Institutional owners; G_2 = Duality; G_3 = Board of directors size; G_4 = Majority ownership; t = trend time variable that explains technical progress; LR: the Likelihood Ratio; Par.: estimated parameters.

From an economic point of view, a good governance system takes places to widen the feasible space of input-output vectors, and allows banks to be more productive and more competitive. Ownership concentration, duality, the size of the board of directors and institutional investors can influence this space of production for each bank as well as the overall banking sector. This finding is due to the desperate concurrence between banks. Any technical evolution of any bank motivates other banks at least to follow this technology and try to develop it.

In the last decade, we observe that banks invest more and more in the research and development function. This investment has for principal aim to search a new opportunities and ameliorate the productivity of the relative bank and ensure its survival.

The incorporation of governance variables in the directional distance function has a considerable effect on the building of the technology frontier and the space of feasible input-output vectors. From table 3 we note a substantial variation of inefficiency scores between the model 1 and model 2 that proves the considerable effect of governance variables on the construction of the technology frontier. Referring to the first model the most efficient banking system is this of Denmark as with an average of inefficiency score of 0.1477, whereas the most inefficient banking system is that of Luxemburg with an average of inefficiency score of 0.3550. But referring to the second model, we note that all the scores of inefficiency have increased except those of Belgium, Luxemburg and the United Kingdom that marked a slight reduction of their inefficiency scores.

Table 3
Inefficiency scores by country

		2002	2003	2004	2005	2006	2007	2002-07
Belgium	Model1	0.2597	0.3507	0.3449	0.2539	0.2242	0.3073	0.2901
	Model2	0.2261	0.2256	0.2301	0.2333	0.2348	0.2170	0.2278
Denmark	Model1	0.1734	0.1697	0.1357	0.1510	0.1094	0.1468	0.1477
	Model2	0.2564	0.2550	0.2515	0.2593	0.2757	0.2809	0.2631
France	Model1	0.3661	0.2692	0.2645	0.2703	0.2814	0.2468	0.2830
	Model2	0.3422	0.3409	0.3462	0.3496	0.3582	0.3592	0.3494
Germany	Model1	0.2706	0.3011	0.2813	0.4095	0.3326	0.2723	0.3112
	Model2	0.3412	0.3422	0.3455	0.3513	0.3509	0.3540	0.3475
Greece	Model1	0.1635	0.1629	0.1592	0.3239	0.1702	0.1734	0.1922
	Model2	0.2848	0.2844	0.2741	0.2797	0.2939	0.3010	0.2863
Italy	Model1	0.3236	0.2870	0.2295	0.3094	0.2674	0.2337	0.2751
	Model2	0.2670	0.2631	0.2603	0.2608	0.2602	0.2664	0.2630
Luxemburg	Model1	0.2421	0.3397	0.3429	0.3808	0.4327	0.3918	0.3550
	Model2	0.3036	0.3002	0.2996	0.3038	0.3020	0.2979	0.3012
Netherlands	Model1	0.1385	0.1428	0.2526	0.2847	0.1749	0.1758	0.1949
	Model2	0.3410	0.3233	0.3266	0.3201	0.3308	0.3323	0.3290
Sweden	Model1	0.2550	0.1881	0.2907	0.2613	0.3926	0.3832	0.2952
	Model2	0.3523	0.3538	0.3347	0.3378	0.3409	0.3455	0.3441
UK	Model1	0.2697	0.3124	0.2617	0.3969	0.3296	0.3260	0.3161
	Model2	0.2854	0.2853	0.2903	0.2955	0.3026	0.3005	0.2933

Notes: This table reports a comparison of the average annual inefficiency scores estimated by the model 1 and model 2 (see appendix1) for each country reported by year and for all the period.

Finally we note that order countries changed referring to the new scores of inefficiency. The Belgium banking system becomes the most efficient with an average score of inefficiency of 0.2278 whereas the most inefficient banking system is that of France with an average score of inefficiency of 0.3494.

From this table we see, also, that not only inefficiency scores have been changed but the order of banking systems based in inefficiency score has also changed. This table shows that, the inefficiency scores nearly have all increased. That means that the estimated feasible space of input-output vectors becomes more widen. Thus, the technology frontier of the model 1 is at least partially below then technology frontier of the second model since the observed input-output vectors of our sample is the same for the two models. Governance mechanisms have for principal role to control manager and their decision. The manager is remunerated according to the attained results. When he reaches a good result, his remuneration increase and his work will be appreciated. But in the case of a bad results he will be punished and he will may' lose his work. For this reason, the manager will be more averse to risk and his work will be limited only on the free risk opportunities. He deserts the input-output vectors which have a high risk and a high return in the same time. In contrast he investigates in the input-output vectors which guaranteed a certain return with a minimum level of risk.

From the discussion presented above we can conclude that the excess of the control exerted by the governance mechanisms on the decisions space of the manager can be considered as a negative that can guide a bank to sub-optimal decisions.

- Luenberger productivity indexes

Table 4 shows a positive growth of productivity in the beginning of the period survey precisely for the periods 2002-2003 and 2003-2004. Then the change of productivity becomes negative for the remainder period. The negative evolution of productivity owed to an unfavorable economic conjuncture and more precisely the crisis that assails the European banking system for this period.

Table 4
Decomposition of the Luenberger productivity indexes by year

Years	LPC	LEC	LTC	LGTC	LTTC
2002-2003	0.4544	0.7954	-0.3410	-0.0371	-0.3039
2003-2004	0.1420	-0.0919	0.2339	-0.0521	0.2860
2004-2005	-0.4981	-0.0850	-0.4131	-0.0402	-0.3729
2005-2006	-0.7065	-0.3476	-0.3589	-0.0498	-0.3091
2006-2007	-0.3201	-0.4114	0.0913	-0.0285	0.1198

Notes: This table presents the productivity change (LPC) of the banking sector for our sample of European countries and its decomposition in efficiency change (LEC) and technical change (LTC). Technical change is also decomposed in governance technical change (LGTC) and trend time change (LTTC).

We note the existence of a negative change in the technical productivity during the periods 2004-2005 and 2005-2006. In unfavorable conjuncture, the uncertainty increase and as a consequence, each bank must decrease the incurred risk. For this reason, banks either remain steady or decrease the quantities of input and output. In fact, any decision to increase productivity is followed generally by an increase in the quantities of production factors and systematically an increase of running risk. However, the positive change of the technical productivity for the period 2006-2007 can be explained by the intervention of monetary and governmental authorities to pass such situation.

The negative change of technical governance productivity over our period of study, indicates that the governance system in the most European countries have a negative effect on the productivity of the banks and restrict the feasible space of input-output vectors.

Table 5 details the individual country information of banking sector productivity in our sample and more precisely concerning the change of productivity related to the governance system. We note a positive productivity change for almost all countries except Sweden (-0.0622) for the period

2002-2003 and then many countries start registering a negative productivity change for the remaindered periods. Concerning the technical change we view also a negative change in productivity in almost all countries since the start of the period survey. From this table we detect different models of productivity change between countries. All the countries faced a decline in productivity at least for two periods, except Luxemburg shows an increase in productivity growth over the entire period of survey. The principal features for this country is that more than 90% of the capital of banking sector is detained by institutional investors with the little standard error for this variable comparing to the other countries. We reserve the same results for the majority ownership variable. We note also, little percentage of duality for this country. Finally the average size of the board of directors is among the least size in our sample.

Table 5
Decomposition of the luenberger productivity by country

2002-2003	**LPC**	**LEC**	**LTC**	**LGTC**	**LTTC**
Belgium	0.2141	0.2218	-0.0077	-0.0017	-0.0060
Denmark	0.3592	0.8705	-0.5113	-0.0375	-0.4738
France	0.3635	0.3813	-0.0178	-0.0031	-0.0147
Germany	0.0215	0.6599	-0.6384	-0.0018	-0.6366
Greece	0.1558	0.5127	-0.3569	-0.0639	-0.2930
Italy	0.6468	0.5298	0.1170	0.0126	0.1044
Luxemburg	0.6324	0.5974	0.0350	0.0019	0.0331
Netherlands	2.6339	0.8458	1.7881	0.0657	1.7224
Sweden	-0.0622	0.6106	-0.6728	-0.0309	-0.6419
UK	0.1365	0.5145	-0.3780	-0.0118	-0.3662
2003-2004	**LPC**	**LEC**	**LTC**	**LGTC**	**LTTC**
Belgium	-0.5909	-0.4581	-0.1328	-0.0056	-0.1272
Denmark	0.5833	0.5646	0.0187	-0.0347	0.0534
France	-0.6845	0.0421	-0.7266	-0.0006	-0.7260
Germany	-0.3986	-0.0622	-0.3364	-0.0043	-0.3321
Greece	0.1532	-0.0033	0.1565	-0.0127	0.1692
Italy	0.4887	0.1939	0.2948	0.0441	0.2507
Luxemburg	0,1631	0,0056	0,1575	0,0087	0,1488
Netherlands	-0.3919	-0.4397	0.0478	0.0093	0.0385
Sweden	0.2901	-0.0233	0.3134	-0.0272	0.3406
UK	-0.6534	-0.5544	-0.0990	-0.0245	-0.0745
2004-2005	**LPC**	**LEC**	**LTC**	**LGTC**	**LTTC**
Belgium	-0.4768	-0.3254	-0.1514	-0.0065	-0.1449
Denmark	-1.1388	0.0062	-1.1450	-0.0215	-1.1235
France	-0.4934	0.0280	-0.5214	-0.0022	-0.5192
Germany	-0.8552	-0.0476	-0.8076	-0.0078	-0.7998
Greece	-0.8232	-0.3616	-0.4616	-0.0913	-0.3703
Italy	0.0755	0.4135	-0.3380	-0,0017	-0,3363
Luxemburg	0,0961	-0,4257	0,5218	0,0053	0,5165
Netherlands	0.9403	0.0617	0.8786	0.0517	0.8269
Sweden	-0.4558	-0.1941	-0.2617	-0.0482	-0.2135
UK	-0.7584	-0.3902	-0.3682	-0.0497	-0.3185

2005-2006	**LPC**	**LEC**	**LTC**	**LGTC**	**LTTC**
Belgium	-0.2917	-0.1243	-0.1674	-0.0096	-0.1578
Denmark	-2.4028	-0.8275	-1.5753	-0.0356	-1.5397
France	-0.1324	-0.1846	0.0522	0.0016	0.0506
Germany	-0.3476	-0.2436	-0.1040	-0.0067	-0.0973
Greece	-0.2749	-0.0659	-0.2090	-0.0711	-0.1379
Italy	-0.5964	-0.2357	-0.3607	-0.0024	-0.3583
Luxemburg	0.0151	-0.2577	0.2728	0.0007	0.2721
Netherlands	-0.1601	-0.4519	0.2918	0.0468	0.2450
Sweden	-0.0539	-0.3582	0.3043	-0.0006	0.3049
UK	-0.1046	-0.0785	-0.0261	-0.0354	0.0093
2006-2007	**LPC**	**LEC**	**LTC**	**LGTC**	**LTTC**
Belgium	0.2648	-0.0834	0.3482	0.0009	0.3473
Denmark	-0.0881	-0.0968	0.0087	-0.0034	0.0121
France	-0.0351	-0.1633	0.1282	0.0029	0.1253
Germany	-0.0679	-0.0899	0.0220	0.0042	0.0178
Greece	-0.1275	-0.5764	0.4489	-0.0833	0.5322
Italy	-0.0954	-0.1888	0.0934	0.0092	0.0842
Luxemburg	0.0478	-0.4076	0.4554	0.0037	0.4517
Netherlands	-0.0396	-0.0539	0.0143	0.0117	0.0026
Sweden	-0.0902	-0.0604	-0.0298	-0.0269	-0.0029
UK	0.1419	-0.0446	0.1865	-0.0483	0.2348

Notes: This table presents a more detailed productivity by country, to show the difference of productivity change between European countries and more precisely concerning the change of productivity related to the governance system. Different notations used in the table are defined as follows: LPC = Luenberger productivity change index; LEC = Luenberger efficiency change index; LTC= Luenberger technical change index; LGTC = Luenberger governance technical change index; LTTC = Luenberger trend time change index.

These results are coherent with some empirical studies. Pi and Timme (1993) show that in presence of duality, banks are less efficient than other banks which separate these two functions. Spong et al. (1996), Crespi et al. (2004) and Caprio et al. (2007) suggest that the majority ownership has a positive effect on banking performance. Finally Elyasiani and Jia (2008) show that stable institutional investors can improve company performance

The sign of the governance productivity indicator is negative during nearly all the period of survey except for next three countries: Italy, Luxemburg and the Netherlands. These countries have some specific governance conception: first these countries are doted by a high level of institutional ownership. Second, the average size of the board of directors is the least. Finally, the average percentage of duality is the least and it is nearest to zero for the banking sector of these countries. Our results confirm the empirical results the results of previous literatures Elyasiani and Jia (2008) for the positive influence of the institutional investors, Pi and Timme (1993) for the negative effect of the presence of duality. But for the size of the board of directors, we note that, when a bank has the smallest size of the board of directors operates more efficiently and it is more productive than the other banks. This last result collaborate these of Jensen (1993).

4. Conclusion

Using a stochastic directional technology distance function model, this paper has proved the effect of the governance variables on the technology frontier for a sample of 146 banks dispersed in ten European countries for 2002-2007. The Likelihood Ratio has been progressed from 785 for the traditional model to 1,576 in our new model that holds account of governance factors to construct the technology frontier. The model becomes globally more significant. The estimated average inefficiency scores and the ranks of the banking systems have been changed from the first model to the second. From the traditional model, the Denmark banking system appears to be the most efficient with an average inefficiency level of 14.77%, respectively, at an average inefficiency level of 35.5% the banking system of Luxemburg has been identified as the least efficient. On the other hand, drawing on the estimated average inefficiency scores of our new model, the Belgium banking system is the most efficient with an average inefficiency level of 22.78% and the banking system of France least efficient with an inefficiency score of 34.94%.

The incorporation of the governance variables on the quadratic directional technology distance function brings us to a new development of the luenberger productivity indicator and to clear an index to measure governance productivity. This index is very useful to detect the most efficient governance system. The results of our empirical study show that governance productivity indicator is positive and loftier in the case of Italy, Luxemburg and the Netherlands. As a consequence the governance systems of these countries are classified as the most efficient. From this result we can define the principal features of the ideal corporate governance system: first, more the percentage and the stability of the institutional ownership increase more the bank productivity increases. Secondly, the separation between the functions of decisions (the Chief Executive Officer) and control (chairman) should be pronounced. Finally, the size of the board of directors must be minimized to avoid the control costs and increase its effectiveness.

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Appendix 1:

Model1: based on the development suggested by Färe et al. (2005))

$$\vec{D}(x,y;g_x,g_y,t,\theta)=\alpha_0+\sum_{n=1}^{N}\alpha_n x_n+\sum_{m=1}^{M}\beta_m y_m+1/2\sum_{n=1}^{N}\sum_{n'=1}^{N}\alpha_{nn'}x_n x_{n'}+1/2\sum_{m=1}^{M}\sum_{m'=1}^{M}\beta_{mm'}y_m y_{m'}$$

$$+\sum_{n=1}^{N}\sum_{m=1}^{M}\gamma_{mn}y_m x_n+\delta_1 t+1/2\delta_2 t^2+\sum_{n=1}^{N}\psi_n t x_n+\sum_{m=1}^{M}\eta_m t y_m$$

✓ Usual symmetric restrictions

$\alpha_{nn'}=\alpha_{n'n}$ $\quad n\neq n'$;

$\beta_{mm'}=\beta_{m'm}$ $\quad m\neq m'$

✓ Restrictions imposed by the translation property

$$\sum_{m=1}^{M}\beta_m g_y-\sum_{n=1}^{N}\alpha_n g_x=-1 \qquad \sum_{m=1}^{M}\beta_m g_y-\sum_{n=1}^{N}\alpha_n g_x=-1$$

$$\sum_{m'=1}^{M}\beta_{mm'}g_{y'}-\sum_{n=1}^{N}\gamma_{nm}g_x=0 \qquad \sum_{m=1}^{M}\eta_m-\sum_{n=1}^{N}\psi_n=0$$

Model2: In which we incorporate governance variables

$$\vec{D}(x,y,G;g_x,g_y,t,\theta)=\alpha_0+\sum_{n=1}^{N}\alpha_n x_n+\sum_{m=1}^{M}\beta_m y_m+1/2\sum_{n=1}^{N}\sum_{n'=1}^{N}\alpha_{nn'}x_n x_{n'}+1/2\sum_{m=1}^{M}\sum_{m'=1}^{M}\beta_{mm'}y_m y_{m'}$$

$$+\sum_{n=1}^{N}\sum_{m=1}^{M}\gamma_{mn}y_m x_n+\sum_{k=1}^{K}\lambda_k G_k+\sum_{n=1}^{N}\sum_{k=1}^{K}\chi_{nk}x_n G_k+\sum_{m=1}^{M}\sum_{k=1}^{K}\phi_{mk}y_m G_k+1/2\sum_{k=1}^{K}\sum_{k'=1}^{K}\tau_{kk'}G_k G_{k'}$$

$$+\delta_1 t+1/2\delta_2 t^2+\sum_{n=1}^{N}\psi_n t x_n+\sum_{m=1}^{M}\eta_m t y_m+\sum_{k=1}^{K}\varphi_k t G_k$$

✓ Usual symmetric restrictions

$\alpha_{nn'}=\alpha_{n'n}$ $\quad n\neq n'$;

$\beta_{mm'}=\beta_{m'm}$ $\quad m\neq m'$;

$\tau_{kk'}=\tau_{k'k}$ $\quad k\neq k'$

✓ Restrictions imposed by the translation property

$$\sum_{m=1}^{M}\beta_m g_y-\sum_{n=1}^{N}\alpha_n g_x=-1\ ; \qquad \sum_{m=1}^{M}\beta_m g_y-\sum_{n=1}^{N}\alpha_n g_x=-1$$

$$\sum_{m'=1}^{M} \beta_{mm'} g_{y'} - \sum_{n=1}^{N} \gamma_{nm} g_x = 0 \;;\quad \sum_{m=1}^{M} \phi_{km} g_{y'} - \sum_{n=1}^{N} \chi_{kn} g_x = 0$$

$$\sum_{m=1}^{M} \eta_m - \sum_{n=1}^{N} \psi_n = 0$$