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# **The impact of large lending on bank efficiency in U.S.A.**

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## **Abstract**

This paper investigates a rather neglected issue in the banking literature regarding the impact of large lending (LL) on the three banks' performance aspects (cost, profit and productive). Possible influences may arise in the context of banks' credit risk as trade credit, which is provided by large, creditworthy firms, and it is a method of monitoring and enforcing loan contracts to relatively riskier firms. Indeed, trade credit providers view payments beyond the discount period as a sign of financial difficulty while the option to cut off shipments for nonpayment is a potentially powerful means for a trade creditor to force repayment, especially if a supplier provides its customer with a product that has no close substitutes. A unique dataset was constructed concerning all USA banks collected from SDI (Statistics on Depository Institutions) report compiled by FDIC (Federal Deposit Insurance Corporation). Our sample contains 7960 banks and tracked yearly for the period 2010-2017, creating an unbalanced panel of year observations. An econometric framework based on nested non-neutral frontiers, was developed to estimate the influence and the decomposition of large lending on the three banks' performance aspects (cost, profit and productive). Moreover, different types of frontiers aiming at the cost, profit, and production side have been investigated. The empirical findings reveal that the large lending plays a crucial role on banks' technical efficiency. Significant variations among different frontier models, type of bank and size, banks' ownership structure and macroeconomic conditions appear to be present. By considering all CAMEL (Capital Adequacy Asset Quality Management Earnings Liquidity) parameters we notice that banks' financial strength affects banks' efficiency. Some policy implications are derived based on the empirical evidence supporting a safer and sounder banking system can be emerged as banks finance large firms, increasing the willingness of people to save and bank's attitude to finance profitable investments projects that rise firm's value and promote economic growth.

*JEL classifications:* C33; G21; G30

**Keywords:** Large lending, Trade credit, Bank efficiency, Stochastic frontier analysis, Cost and production function

## 1. Introduction

Trade credit remains the single largest source of short-term business credit in the United States and other nations around the world. The tendency of production firms to act as financial intermediaries—a role usually reserved for banks—has triggered the interest of policy makers and academics. The debate mainly focuses on (i) explanations that view trade credit as a method of monitoring and enforcing loan contracts to relatively risky firms, (ii) explanations in which a firm's long-term supply relationship helps it to make better credit decisions than a bank would, (iii) the relationship between bank credit and trade credit, and (v) the availability of credit to small- and medium-sized enterprises from suppliers and banks. Another, equally important topic, is the effects of large lending (LL) on bank efficiency provided that trade credit is mainly offered by large and old firms that have access to external finance. This paper contributes to the literature discussing this theme. We examine whether large lending has positive or negative effects on bank efficiency. To the best of our knowledge, this is the first paper that provides empirical evidence on this policy relevant topic. This paper examines the impact of large lending on bank efficiency by using stochastic frontier analysis for a broad sample of 7960 commercial and savings banks in USA. It explores the issue by addressing four related questions: (i) What is the effect of large lending on bank inefficiency? (ii) Large lending could be used as an input in production function? (iii) Large lending could be used as an output in cost function? (iv) Large lending could be used as an output in profit function?. We will show that large lending has a positive effect on bank efficiency. More importantly, we provide empirical evidence for the hypothesis that large lending increases bank efficiency, the bank efficiency increasing effects of a rise in large lending are observed for the three efficiency aspects (product, cost and profit). In

addition, we find that large lending could be used as output in cost function but not in profit function. Particularly, banks can reduce their total cost as lending large firms banks can avoid the cost that stem from monitoring and enforcing loan contracts to relatively risky firm. Finally, the estimation results support that large lending could be an input in product function which means that trade credit and bank credit can be considered as complements implying that banks lend those firms that have received trade credit reducing at the same time banks' credit risk.

The rest of the paper is structured as follows. In the next section we present the relevant literature review while in Section 3 we include the econometric methodology which will be followed. Section 4 we present the data used and the variables definition. Section 5 discusses the estimation results. Finally, Section 6 concludes the paper.

## **2. Trade credit, large lending and efficiency: A brief literature overview**

The widespread use of trade credit as a source of funding in modern economies has been highlighted by a considerable number of scholars (Elliehausen and Wolken, 1993, Rajan and Zingales, 1995, Kohler et al, 2000, Atanasova and Wilson, 2002, Bartholdy and Mateus, 2008, Wu et al, 2011.).

For instance, Rajan and Zingales (1995) mention that trade credit (measure it by using account payable) reaches to 15% of total assets in 1991 for a large sample of non-financial firms, listed US firms.

Moreover, trade credit is considered to be a very expensive means of external finance. Smith (1987) estimates an implicit interest rate of 44% per annum for those who do not take the discount which is 2% if costumers pay back within ten days, with net price charged for payments within 30 days.

Also, a firm may raise capital from a multitude of sources. According to the Financial Hierarchy doctrine, firms seek external finance when they exhaust their internal funds which top the hierarchy as being the least costly (Myers 1984; Myers and Majluf 1984).

Intuitively, bank loan is a cheaper source of funding compared to trade credit however bank loan procedure relates to credit risk as borrowers promise to lenders future uncertain payments which pay back the loan amount. Nevertheless, cash is relatively easy to divert from its intended purpose increasing the credit risk of a bank loan as these borrowed amounts are used to finance investments projects whose returns will repay the loan, instead under mounting financial pressure borrowers may use the loan for unprofitable purposes or fraud decreasing dramatically the likelihood of the repayment of loan (Burkart and Ellingsen, 2002).

Apart from large firms, banks lend SMEs, especially, in the development phase of their expansion, SMEs depend highly upon the banking sector to obtain funding (Boocock and Wahab, 2001). Although, large firms and SMEs create various positive externalities on economies and social benefit, because they make important contributions to investment, innovation, employment, and social stability (Carter and Jones-Evans, 2006 ; Edmiston, 2007), SMEs are thought as a group of firms for which informational asymmetries between lenders and borrowers are more pronounced due to their financial opacity (Berger and Udell, 1998), and therefore credit rationing is more likely to occur (Stiglitz and Weiss, 1981. Thus, financing gaps exist in SMEs (Cassar, 2004; Howorth 2001; Wingborg and Landström, 2000) which make not only banks unwilling to lend this kind of firms but also banks face a higher credit risk compared to large firms when they lend this kind of firms (Cassar, 2004; Howorth, 2001; Wingborg and Landstrom, 2000).

In addition, trade credit literature suggests that firms may extend credit to their customers for financial, operational, and commercial motives. In this section we review the implications of financial motives on bank efficiency. Borrowing goods instead of money permits firm to make a credible commitment not to divert the loan for unprofitable purposes. So, trade credit is a very important source of funding for those firms considered less creditworthy, especially when financial conditions are difficult and financial markets are tight (Burkart and Ellingsen, 2002).

In other words, the presence of supplier - customer relationship determines trade credit as a powerful tool that improves monitoring and enforcement since supplier can cut off shipments for nonpayment while at the same time trade creditors concern about the long term health of their costumers which ensures more sales in the future (Petersen and Rajan, 1997; Demirguc-Kunt and Maksimovic, 2001 ; Berlin,

2003). Indeed, Smith (1987) shows that firms which sell products to other firms have a screening motive to find out the default risk of their buyers.

Particularly, Smith (1987) supports that firms can manage nonsalvageables investments effectively if they have information about buyer's default risk. Therefore, he notices that selling firms can detect buyers' default risk offering cash discounts payments as buyers who do not exploit this opportunity might have experienced a deterioration in their creditworthiness. Therefore, selling firms, which offer trade credit, have more time to take steps in order to preserve nonsalvageables investments. In contrast to this, firms which claim net payments on cash do not have this opportunity. So, this kind of investments influences selling firms to use trade credit as a screening mechanism to acquire important information about buyer's default risk.

Similarly, trade credit providers view payments beyond the discount period as a sign of financial difficulty (Ng et al, 1999 ; Petersen and Rajan, 1994) while the option to cut off shipments for nonpayment is a potentially powerful means for a trade creditor to force repayment, especially if a supplier provides its customer with a product that has no close substitutes (Berlin, 2003).

Moreover, some scholars notice that larger and older firms typically have larger accounts receivable which means that they are large suppliers of trade credit (Petersen and Rajan, 1997; Berlin, 2003). Firm's age and firm's size reflect firm's creditworthiness a crucial characteristic that determines who is more likely to extend trade credit as reasonably creditworthy firms have an advantage monitoring riskier firms, which are typically smaller and younger (Petersen and Rajan, 1997; Nilsen, 2002; Berlin, 2003).

In addition, Schwartz (1974) developed the financial motives for the use of trade credit. He suggests that when credit is tight, financially stable firms will

increasingly offer more trade credit to maintain their relations with smaller customers, who are "rationed" from direct credit market participation. The seller firm acts as a financial intermediary to customers with limited access to capital markets, thus financing their customers' growth. Faulkender and Wang (2006), also observe that larger firms are thought to be better known and have better access to capital markets than smaller firms, in terms of availability and cost, and should therefore face fewer constraints when raising capital to finance their investments. Hence, the financial motive predicts a positive connection between extending trade credit and firm size (Schwartz 1974; Petersen and Rajan 1997; Mian and Smith 1992). Consequently, according to financial motive we establish the following hypothesis:

**H1: Large lending affects positively bank efficiency**

We investigate this association focusing not only on the cost efficiency, which is the most famous dimension of bank efficiency (Silva et al 2017), but also on profit efficiency and production efficiency two other dimensions of bank efficiency which need more exploration as banks may be cope with cost inefficient through higher revenue generation (Sensarma, 2005). In addition, profit function includes the same exogenous variables with cost function (a vector of outputs and a vector of input prices) (Sensarma, 2005).

Moreover, banks prefer to lend suppliers who extend trade credit to their customers (Berlin, 2003), ensuring their loans as suppliers have a monitoring and enforcing advantage over banks (Biais and Gollier, 1997). In addition, trade credit literature considers trade credit and bank credit as complements implying that banks lend those firms that have received trade credit (Cook, 1999; Omo, 2000; Love et al, 2007; Cunningham, 2005) as trade credit may represent a positive signal for banks (Marianosaria Agostino and Francesco Trivieri, 2014). Extending trade credit seller

faces the default risk of the buyer, which means that he has good information about the latter. Bank observes trade credit procedure and therefore it adjusts favorably its beliefs about the buyer deciding to lend him. In other words, bank credit rationing can be mitigated by the presence of trade credit as it permits the private information of the seller to be used in the lending relationship, (Biais and Gollier, 1997). Therefore, we create the below hypothesis:

### **H2: Large lending could be used as an input in production function**

In addition, larger and older firms have easier access to external finance; they, in turn, act as intermediaries and extend trade credit to other, riskier firms (Petersen and Rajan, 1997). Therefore, suppliers are financial intermediaries which means that banks can avoid the cost that stem from monitoring and enforcing loan contracts to relatively risky firm (Berlin, 2003). Obviously, banks cannot avoid costs that are related with efforts needed to monitoring and enforcing loans contract to large firms which are the main source of trade credit. Thus, we test the next hypothesis:

### **H3: Large lending could be used as an output in cost function**

Lastly, from a profit perspective, Stiglitz and Weiss, (1981) imply that banks' profitability can be affected negatively by increased interest rate because of information asymmetries issues that arise during bank loan procedure. Indeed, an increase in interest rate in credit markets where lenders are not able to distinguish bad borrowers from good borrowers, persuade low quality borrowers to apply for loans as they face higher probabilities of default on their loans and therefore, they are harmed less than good borrowers in case of an increase in interest rates. In other words, lenders are keen to offer low interest rates so as to create a less risky bank loan portfolio (Stiglitz and Weiss, 1981).

In addition, increased interest rates tend to diminish borrower's stake in the project while at the same time under limited liability borrowers are not harmed by a rise in interest rates when borrowers are declared insolvent. This moral hazard justification implies that this contraction in borrowers' profits convince them to undertake projects with high private benefits, or to abandon the initial project in favor of alternative activities, or get involved in fraud. Thus, the likelihood of compensation is negatively influenced by reduced performance (Stiglitz and Weiss, 1981). So, we test the next hypothesis

#### **H4: Large lending could be used as an output in profit function**

To investigate the above hypotheses, this research employs stochastic frontier analysis (SFA)<sup>1</sup> examining the uncertain relationship between the extent of large lending and the three different aspect of efficiency of USA banks. Based on Battese and Coelli (1995), we implement the maximum likelihood estimation method to simultaneously estimate the stochastic function and the inefficient model. Moreover, exploring the above hypothesis we contribute to the bank efficiency literature review which focus mainly lie in ownership structure (Bonin et al., 2005; Lensink et al., 2008; Berger et al., 2009), mergers and acquisitions (Lee et al., 2013; Montgomery et al., 2014) regulatory and supervisory measures on bank efficiency (Barth et al., 2010; Chortareas et al., 2012), and corporate governance on bank efficiency (Aebi et al., 2012; Beltratti and Stulz, 2012).

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<sup>1</sup> We use stochastic frontier analysis (SFA) rather than data envelopment analysis (DEA). The main advantage of SFA over DEA is that it allows us to distinguish between inefficiency and other stochastic shocks in the estimation of efficiency scores (Yildirim and Philippatos, 2007)

### 3. Methodological Issues

The most prominent and influential approach to firms' productive performance measurement is relied on the estimation of a parametric or non-parametric production frontier, which directly links productive efficiency notion to the notion of productive efficiency as it was introduced, by Farrell's seminal paper (1957). The popularity of the production frontiers approach to the productive performance measurement is mainly established on the grounds of its ability to decompose the overall productive efficiency in components, which are mainly oriented either to the production mix itself, either to exogenous factors which are accounted as productive inefficiency factors. In addition, it is not worthless to mention that the approach of the parametric, which include the so-called stochastic, production and cost frontiers, allows us to test the hypothesis that (i) the LL function affects the kernel of the frontier and thus are treated, in econometric terms, as an "additional input" in the production process or (ii) they are simply exogenous factors that may affect, in every possible direction, the firms' productive efficiency. Of course, both of the aforementioned hypotheses may not be accepted and thus no impact of LL on firm's productive performance is identified.

#### 3.1. *LL affects the Frontier*

Following Kumbhakar and Lovell (2000, p.262) let  $(x_1, \dots, x_N) \geq 0$  be an input vector used to produce scalar output  $y \geq 0$ . The stochastic production frontier may be written as:

$$\ln y_{it} = \ln f(\mathbf{x}_{it}; \boldsymbol{\beta}) + v_{it} - u_{it}, \quad i = 1, \dots, I, \quad t = 1, \dots, T \quad (1)$$

where  $i$  indexes banks,  $t$  indexes time,  $\ln f(\mathbf{x}_{it}; \boldsymbol{\beta})$  is the deterministic kernel of the stochastic production frontier  $[\ln f(\mathbf{x}_{it}; \boldsymbol{\beta}) + v_{it}]$ ,  $v_i \sim iid N(0, \sigma_v^2)$  captures the effect of random noise on the production process,  $u_i \sim N(0, \sigma_u^2)$  captures the effect of technical inefficiency and  $\boldsymbol{\beta}$  is the parameter vector to be estimated. Hereafter the subscript  $t$  is suppressed and fixed effects panel data models are employed for simplicity reasons. Battese and Coelli (1992) show that the best predictor of the technical efficiency of each producer is  $TE_i = \exp(-\hat{u}_i)$ , where  $\hat{u}_i = E(u_i | (v_i - u_i))$ . In the above described model, the so-called Error Component Model (ECM), LL may influence the productive performance through their inclusion in the input mix. Such being the case, LL are econometrically treated as an additional input, and the corresponding stochastic production frontier can be written as:

$$\ln y_i = \ln f(\mathbf{x}_i, x_{LL}; \boldsymbol{\beta}, \boldsymbol{\beta}_{LL}) + v_i - u_i, \quad i = 1, \dots, I \quad (2)$$

where  $x_{LL}$  is the employed LL which operates as a shifter of the deterministic part of the production frontier,  $\boldsymbol{\beta}_{LL}$  is the vector of the additional parameters to be estimated and captures the alteration of the position and shape and the production frontier due to the inclusion of  $x_{LL}$ .

### 3.2. *LL as Inefficiency Factors*

In the next step we consider the case where a vector of exogenous variables  $(z_1, \dots, z_Q)$  influences the structure of the production process by which inputs  $\mathbf{x}$  is converted to output  $y$ . The elements of  $\mathbf{z}$  capture features of the environment in which the production takes place, and they are generally considered to be conditioning

variables beyond the control of those who manage the production process. In this case, as Huang and Liu (1994) proposed, the stochastic production frontier of equation (1) is accompanied by the technical inefficiency relationship

$$u_i = g(\mathbf{z}_i; \boldsymbol{\delta}) + \varepsilon_i \quad (3)$$

where  $\boldsymbol{\delta}$  is a vector of parameters which are associated to inefficiency factors, to be estimated. The requirement that  $u_i = [g(\mathbf{z}_i; \boldsymbol{\delta}) + \varepsilon_i] \geq 0$  is met by truncating  $\varepsilon_i$  from below such that  $\varepsilon_i \geq -g(\mathbf{z}_i; \boldsymbol{\delta})$ , and by assigning a distribution to  $\varepsilon_i$  such that  $\varepsilon_i \sim N(0, \sigma_\varepsilon^2)$ . This allows  $\varepsilon_i < 0$  but enforces  $u_i > 0$ . In the case in which the  $g$  function is a linear one, the above model is the so-called Technical Efficiency Effects Model (TEEM) which was introduced by Batesee and Coelli (1995). The technical efficiency of the  $i$ -th bank is given by  $TE = \exp\{-u_i\} = \exp\{-\boldsymbol{\delta}'\mathbf{z}_i - \varepsilon_i\}$ . In this paper we test the hypothesis that the LL may have the character of a  $z$  variable which we name it  $z_{LL}$ , and thus relationship (3) becomes:

$$u_i = g(\mathbf{z}_i; \mathbf{z}_{LL}; \boldsymbol{\delta}; \boldsymbol{\delta}_{LL}) + \varepsilon_i \quad (4)$$

where  $\boldsymbol{\delta}_{LL}$  are the additional parameters which have to be estimated since the LL have been included among the other inefficiency factors. According to equation (4) LL do not influence the structure of the production frontier, but they do influence the technical efficiency with which banks approach the production frontier.

### 3.3. *LL as an Input and an Inefficiency Factor*

In order to test the hypothesis that LL affects the production process through both the position and shape of the production frontier and the inefficiency term, equations (2) and (4) should be combined and the following model arises:

$$\begin{aligned}\ln y_i &= \ln f(\mathbf{x}_i; \mathbf{x}_{LL}; \boldsymbol{\beta}; \boldsymbol{\beta}_{LL}) + v_i - u_i \\ u_i &= g(\mathbf{z}_i; \mathbf{z}_{LL}; \boldsymbol{\delta}; \boldsymbol{\delta}_{LL}) + \varepsilon_i\end{aligned}\quad (5)$$

The essential novelty of the Huang and Liu (1994) approach is that the function  $g(\mathbf{z}_i; \boldsymbol{\delta})$  is allowed to include interactions between exogenous factors  $\mathbf{z}_i$  and production inputs  $\mathbf{x}_i$  (Batesse and Broca, 1997). The incorporation of non-neutral effects of LL in the production performance can be realized either through the consideration of LL as a factor that affects the production frontier itself, or through the consideration of LL as a technical efficiency factor. In the former case, the  $g(\mathbf{z}_i; \boldsymbol{\delta})$  function for the  $i$ -th bank can be written as:

$$g(\mathbf{z}_i, \mathbf{x}_{ni}, x_{LLi}; \boldsymbol{\delta}, \boldsymbol{\delta}_{LLqi}) = \sum_q \delta_q z_{qi} + \sum_q \sum_n \delta_{qn} z_{qi} \ln x_i + \sum_q \delta_{LLq} z_q \ln x_{LL} \quad (6)$$

The last term of the right-hand part of equation (6) depicts the non-neutral effects of the LL on the inefficiency terms when they affect productive performance through the kernel of the stochastic production frontier. In the case where LL are considered an inefficiency factor exhibiting non-neutral effects, the  $g(\mathbf{z}_i; \boldsymbol{\delta})$  function for the  $i$ -th bank can be written as:

$$g(\mathbf{z}_i, \mathbf{z}_{LLi}, \mathbf{x}_i; \boldsymbol{\delta}, \boldsymbol{\delta}_{LL}) = \sum_q \delta_q z_{qi} + \delta_{LL} z_{LL} + \sum_q \sum_n \delta_{qn} z_{qi} \ln x_{ni} + \sum_n \delta_{nLL} z_{LLi} \ln x_{ni} \quad (7)$$

The last term of the right-hand part of the above equation depicts the non-neutral effects of the LL on the inefficiency terms when LL are an inefficiency factor. The total effect of LL on the technical inefficiency of the  $i$ -th bank is the sum of the second and fourth term of the right-hand part of the above equation. Of course, combining equations (6) and (7) we can explore the case where non-neutral effects arise from both the LL as a factor that affects the production frontier as well as from LL as an inefficiency factor. Thus, the multifaceted character of LL, as regards

productive performance, may be based, in econometric terms, on the non-neutral effects that our model allows for.

In the current paper the production frontier of the banks is assumed to be described by the following translog functional form which is associated, through the inefficiency factor  $v$  to a linear inefficiency model. That is, we consider the following production frontier for the  $i$ -th bank with subscript  $t$  suppressed:

$$\begin{aligned} \ln y_i = & \beta_0 + \sum_n \beta_n \ln x_{ni} + \frac{1}{2} \sum_n \sum_m \beta_{nm} \ln x_{ni} \ln x_{mi} + \beta_T T + \\ & + \frac{1}{2} \beta_{TT} T^2 + \sum_n \beta_{Tn} T \ln x_{ni} + u_i - v_i \end{aligned} \quad (8)$$

where  $n, m = L, l, E, D, LL$  denote , labor, liabilities, total equity, deposits, and LL inputs respectively, while  $T$  is a time variable which captures technical change. The symmetry condition requires  $b_{nm} = b_{mn} \quad \forall n, m$ . As mentioned above in this paper, we consider the case whether LL affects productive performance through their inclusion in the input mix. In other words, the LL alters the position and the shape of the frontier itself.

#### 3.4. Cost and Profit Frontiers

In a similar vein we can test the hypothesis that LL affects the cost process through both the position and shape of the cost frontier and the inefficiency term, therefore the following model arises:

$$\begin{aligned} \ln tc_i = & \ln f(y_i, p_i; y_{LL}; \boldsymbol{\beta}; \boldsymbol{\beta}_{LL}) + v_i + u_i \\ u_i = & g(\mathbf{z}_i; \mathbf{z}_{LL}; \boldsymbol{\delta}; \boldsymbol{\delta}_{LL}) + \varepsilon_i \end{aligned} \quad (9)$$

Where  $(y_1, \dots, y_M) \geq 0$  be an output vector that requires total cost  $tc \geq 0$  given an vector of input prices  $(p_1, \dots, p_N) \geq 0$ . Moreover, the alternative profit specification employs the same set of exogenous variables as the cost function in equation 9 with

the only difference that profit replaces cost as the dependent variable in the frontier regression. Therefore, the alternative profit frontier, accompanying with the inefficiency model, is given by

$$\begin{aligned}\ln \pi_i &= \ln f(y_i, p_i; y_{LL}; \boldsymbol{\beta}; \boldsymbol{\beta}_{LL}) + v_i + u_i \\ u_i &= g(\mathbf{z}_i; \mathbf{z}_{LL}; \boldsymbol{\delta}; \boldsymbol{\delta}_{LL}) + \varepsilon_i\end{aligned}\quad (10)$$

where  $\pi$  is the profit of the bank and the other variables are as explained before

In that case the function  $g(\mathbf{z}_i; \boldsymbol{\delta})$  is allowed to include interactions between exogenous factors  $\mathbf{z}_i$  and outcomes  $y_i$  as well as between exogenous factors  $\mathbf{z}_i$  and input prices  $p_i$  (Batesse and Broca, 1997). The incorporation of non-neutral effects of LL in the cost(profit) performance can be realized either through the consideration of LL as a factor that affects the cost(profit) frontier itself, or through the consideration of LL as a technical efficiency factor. In the former case, the  $g(\mathbf{z}_i; \boldsymbol{\delta})$  function for the  $i$ -th bank can be written as:

$$g(\mathbf{z}_i, p_{mi}, y_{mi}, y_{LLi}; \boldsymbol{\delta}, \boldsymbol{\delta}_{LLqi}) = \sum_q \delta_q z_{qi} + \sum_q \sum_m \delta_{qm} z_{qi} \ln y_i + \sum_q \sum_n \delta_{qn} z_{qi} \ln p_i + \sum_q \delta_{LLq} z_q \ln y_{LL} \quad (11)$$

The last term of the right-hand part of equation (11) depicts the non-neutral effects of the LL on the inefficiency terms when they affect cost(profit) performance through the kernel of the stochastic cost(profit) frontier. In the case where LL are considered an inefficiency factor exhibiting non-neutral effects, the  $g(\mathbf{z}_i; \boldsymbol{\delta})$  function for the  $i$ -th bank can be written as:

$$g(\mathbf{z}_i, \mathbf{z}_{LLi}, p_{mi}, y_i; \boldsymbol{\delta}, \boldsymbol{\delta}_{LL}) = \sum_q \delta_q z_{qi} + \delta_{LL} z_{LL} + \sum_q \sum_n \delta_{qn} z_{qi} \ln y_{ni} + \sum_q \sum_n \delta_{qn} z_{qi} \ln p_i + \sum_m \delta_{mLL} z_{LLi} \ln y_{mi} \quad (12)$$

The last term of the right-hand part of the above equation depicts the non-neutral effects of the LL on the inefficiency terms when LL are an inefficiency factor.

The total effect of LL on the technical inefficiency of the  $i$ -th bank is the sum of the second and fourth term of the right-hand part of the above equation. Of course, combining equations (11) and (12) we can explore the case where non-neutral effects arise from both the LL as a factor that affects the total cost frontier as well as from LL as an inefficiency factor. Thus, the multifaceted character of LL, as regards cost and profit performance, may be based, in econometric terms, on the non-neutral effects that our model allows for.

Most studies on the determinants of banks' technical efficiency use data envelopment analysis (DEA) or stochastic frontier analysis (SFA). We use stochastic frontier analysis as it controls for measurement error and other random effects<sup>2</sup> We use Battese and Coelli(1995) SFA model henceforth the BC model. that provides estimates of efficiency in a single step in which firm effects are directly influenced by a number of variables. A first advantage of the BC model over the standard two-step SFA approach of Aigner et al. (1977), and Meeusen and van den Broeck (1977) is that the former estimates the cost frontier and the coefficients of the efficiency variables simultaneously<sup>3</sup>. Wang and Schmidt (2002) show that a two-step approach suffers from the assumption that the efficiency term is independent and identically half-normally distributed in the first step, while in the second step the efficiency terms are assumed to be normally distributed and dependent on the explanatory variables. This method inherently renders biased coefficients. A second advantage of the BC model is that it can be estimated for an unbalanced panel, which increases the amount

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<sup>2</sup> Non-parametric techniques do not allow for measurement error and luck factors. These techniques attribute any deviation from the best practice bank to technical inefficiency. For a more extensive review of the non-parametric and the parametric approach, see Matousek and Taci (2004).

<sup>3</sup> Kumbhakar and Lovell (2000) discuss other SFA models that also solve exogenous influences on efficiency simultaneously. Coelli (1996) has implemented the BC model into a statistical software package FRONTIER Version 4.1.

of observations. This study specifies the following stochastic translog cost function with three inputs and three outputs:

$$\begin{aligned} \ln tc_i = & \beta_0 + \sum_m \beta_m \ln y_{mi} + \sum_n \beta_n \ln p_{ni} + \frac{1}{2} \sum_m \sum_m \beta_{mm} \ln y_{mi} \ln y_{mi} + \frac{1}{2} \sum_n \sum_n \beta_{nn} \ln p_{ni} \ln p_{ni} + \frac{1}{2} \sum_m \sum_n \beta_{mp_n} \ln y_{mi} \ln p_{ni} + \beta_T T \\ & + \frac{1}{2} \beta_i T^2 + \sum_m \beta_{mT} T \ln y_{mi} + \sum_n \beta_{nT} T \ln p_{ni} + u_i + v_i \end{aligned} \quad (13)$$

where  $m = L, I, NI$ , and  $LL$  denote loans, investments, non-interest income and large lending respectively while  $n = L, C$  and  $F$  denote price of labor, price of capital and price of funding respectively,  $tc$  represents the total cost of the  $i$ -th bank with subscript  $t$  suppressed,  $\beta_m, \beta_n, \beta_{mm}, \beta_{nn}, \beta_{mp_n}, \beta_T, \beta_i, \beta_{mT}, \beta_{nT}$  are the parameters to be estimated. Cost and input prices are normalized by the price of labor before taking logarithms to impose linear input price homogeneity. This scaling implies an estimation of coefficients for  $p_C$  (price of capital) as well as  $p_F$  (price of funding) with the restriction that the sum of these coefficients is equal to one (see Kuenzle, 2005). The alternative profit function uses essentially the same specification as the cost function, but with one change. The dependent variable for the profit function replaces the logarithm of normalized total cost with  $\ln[\pi]$ , compared to the cost function, this the only change in specification, since the independent variables are identical to those in the cost function. The inefficiency term, of course, enters the frontier with a negative sign since now higher inefficiency is associated with lower profits as compared with best bank. As in the cost study, profit and input prices are normalized by the price of labor before taking logarithms to impose linear input price homogeneity.

## 2.5. Testing Hypotheses Procedures

In order to provide a better illustration of our methodology, we devised figures 1,2, and 3, with four vertical flowcharts. Each of the first three charts depicts each of the three hypotheses regarding the impact of large lending may bear on the three banks' performance aspect (cost, profit and productive). More specifically: (i) it affects the deterministic part of the frontier, that is, the large lending operates as an "additional input" for the case of productive performance while it operates as "additional output" for the case of cost and profit performance; (ii) through the inefficiency term or in other words it has the character of an inefficiency factor; (iii) both ways. The final chart depicts the hypothesis that large lending has no effects. The full set of models that arise from these four distinct hypotheses for the case of cost, profit and productive performance is presented in the Fig 1,2, and 3 of the paper respectively.

To elaborate further, if we consider that large lending is an input (output for the case of cost and profit performance), the first vertical flow chart in figures 1,2 and 3 denote that this may be approximated by an ECM specification (see model B) or under a TEEM specification. The TEEM specification may be modeled with neutral (see model D) or with non-neutral (see model G) effects of inefficiency terms. The second from the left vertical flow chart indicates that large lending acts as an inefficiency factor that can be approached by a TEEM model specification with neutral (see model E) or non-neutral (see model F) effects of inefficiency terms. Accordingly, the third vertical flow chart reveals that the impact of the adoption can be approximated by only a TEEM model with neutral (see model H) or non-neutral (see model I) effects of inefficiency terms. Finally, the last vertical flow chart assumes that large lending has nothing to do with the efficiency of firms. In that case, the ECM

(see model A) specification and the two versions of the TEEM (see models C and J) specification are the ones that should be estimated<sup>4</sup>.

As we can observe from the formulation of our models, they are nested and their differences are in the number of restrictions employed in their estimation. Thus, we can use the generalized likelihood ratio to decide which identification is the most appropriate and thus to reveal the role of large lending on banks' cost, profit and productive efficiency.

**[Insert Figure 1 here]**

**[Insert Figure 2 here]**

**[Insert Figure 3 here]**

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<sup>4</sup> In the context of the non-neutral TEEM modeling procedure, two alternatives arise. The first alternative is the one which incorporates the non-neutral effects which are generated by the interaction of all the inputs (outputs in case of cost efficiency or profit efficiency) with all the inefficiency factors. The second alternative is the one which is restricted to the inclusion in the inefficiency model only of those terms which are generated by the interaction of only a subset of inputs (outputs in case of cost efficiency or profit efficiency) with the inefficiency factors. In the context of the present paper we have followed the second approach since the full version of the non-neutral TEEM approach incorporates thirty-two inefficiency factors and serious multicollinearity problems arise. Specifically, in all the cases where the modeling procedure considers LL an additional factor, the inefficiency model encompasses the non-neutral-effects of the  $\tilde{x}_E$  input (outputs in case of cost efficiency or profit efficiency) with all the inefficiency factors.

#### 4. Data and Variables Definition

The financial and accounting data used in this study were obtained from SDI (Statistics on Depository Institutions) report made by FDIC (Federal Deposit Insurance Corporation). This report provides banks' financial statements, ratios, types, ownership structure and information for USA banks. Therefore, it is the reference database for USA samples that both offers data on large and small business loans. In addition, SDI report is interested in what each bank considers a small business, so we can understand the full range of small business lending activity financed by banks. Rather than providing a definition, SDI report instead is asking each bank for its description of what it considers a small business. In this way, we will get a better sense of the differences in small business lending by different types of banks. Our sample contains 7960 banks and tracked quarterly for the period 2010 -2017, creating an unbalanced panel of bank year observations. We adopt an intermediation approach (Berger and Humphrey, 1991; Ellinger and Neff, 1993; Altumbas et al., 2000; Rezvanian and Mehdian, 2002) to define the factor input and output of banks.

For our estimations, we have three dependent variables, bank's total output ( $y$ ), is the sum of loans, investments and non-interest income, bank's total cost ( $tc$ ) is the sum of labor cost, capital cost and funding cost while bank's profit ( $\pi$ ) is the pre-tax operating income. We specify as inputs, the salaries and employee benefits ( $x_L$ ), the liabilities ( $x_I$ ), the total equity capital ( $x_E$ ), and deposits ( $x_D$ ) of banks. Moreover, We specify as outputs, the total loans ( $y_L$ ), the investments ( $y_I$ ), and the non-interest income ( $y_N$ ) of banks. In addition, we include in translog cost function, the price of capital ( $p_C$ ) derived as the ratio of operating expenses to net fixed assets, the

price of labor ( $p_L$ ) calculated as the ratio of employ salary to total employees and the price of funding ( $p_F$ ) determined as the ratio of interest payments to total liabilities. In the cases where the impact of LL on the deterministic part of the frontier is tested, and thus the LL is regarded as an additional input, the values of  $\tilde{x}_{LL}$  are derived from the difference between commercial and industrial loans minus commercial and industrial lending to small business divided by loans and lease financing receivables of the institution, including unearned income.

The variables which are incorporated in the inefficiency model may be grouped in two categories. The first category encompasses variables which are determined by the CAMEL model and therefore they depict the financial health of the bank and consequently its overall economic strength. Beginning with the first acronym of CAMEL model we have constructed the variable ( $CAP$ ), that represents bank's capital adequacy and it is defined as the ratio of the sum of Tier 1 (core) capital plus Tier 2 Risk-based capital divided by bank's total assets. Also, we have used variables that reflects bank's asset quality such as ( $NPLS3$ ), which is defined as the ratio of total assets past due 30 through 89 days and still accruing interest to the bank's total assets as well as the variable ( $NPLS3$ ), defined as the ratio of total assets past due 90 or more days and still accruing interest to the bank's total assets. Moreover, we have created the management capability variable ( $MAN$ ), defined as the ratio of net operating income to total not interest expenses. In addition, the variable ( $ROA$ ), net income after taxes and extraordinary items (annualized) as a percent of average total assets, reflects banks' profitability while the last acronym of the CAMEL model includes the variable ( $LIQ$ ) that represents banks' liquidity and it is defined as the ratio of loans and lease financing receivables of the institution,

including unearned income to total deposits. The second group of the inefficiency factors contains county-specific factors that expected to influence banks' efficiency. In this category we have included the Herfindahl index variable (*HHI*), as a proxy for the structural market conditions that entails in each county. In the same category of the inefficiency factors we have included the industry specific dummy variables (*COM*), and (*SAV*). Especially, (*COM*), variable takes the value of 1 for commercial banks and 0 for savings banks. Similarly, (*SAV*), variable takes the value of 1 for savings banks and 0 for commercial banks. Table 1,2 and 3 provide descriptive statistics for all variables used in the estimation of the cost, profit and production frontier and the inefficiency model respectively.

**[Insert Table 1 here]**

**[Insert Table 2 here]**

**[Insert Table 3 here]**

## 5. Results and discussion

### 5.1. Characteristics of the frontier and the inefficiency model

All the models which are analytically presented in figures 1,2 and 3 have been estimated using Frontier 4.1 software (Coelli, 1996). It should be noted, that in all the estimated models the relevant tests indicate that the null hypothesis of no technical inefficiency effects ( $\gamma = 0$ ) in the estimated production frontier is not accepted<sup>5</sup>. In addition, a range of specification tests was carried out for all the estimated frontiers aspects (cost, profit and production) including a test for the specification of the three frontiers aspects (cost, profit and production) as Cobb-Douglas (CRS). In all the cases the hypotheses that the functional form of three frontier aspects (cost, profit and production) is of the Cobb-Douglas type and that the technology exhibits Constant Returns to Scale were not accepted.

Models D, F and C are nested to Model I', and simple likelihood ratio tests indicate that the last is superior in econometric terms in case of banks' cost performance (Table 4). Thus, it can be argued that LL affects the banks' cost performance both through the position and shape of the frontier and the inefficiency term. Thus, and hereafter the discussion will be focused on the estimation results of Model I'. Similarly, the same analysis conducted in the case of banks' profit and productive performance (Table 5 and Table 6 respectively) concluding that Model I' is greater in econometrics terms and therefore the conversation will be focused on the estimation results of Model I'.

**[Insert Table 4 here]**

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<sup>5</sup> This test is carried out in the form of the likelihood ratio test. The critical value for testing the hypothesis  $\gamma = 0$  is derived from Kodde and Palm (1986) with degrees of freedom equal to the number of each time included inefficiency variables.

**[Insert Table 5 here]**

**[Insert Table 6 here]**

### *5.2 Cost Efficiency Results*

The estimates of the inefficiency model are summarized in the lower part of Table 7. The null hypothesis that the coefficients of the inefficiency factors are jointly zero is not accepted. Surprisingly, technical efficiency is negatively affected by the banks' financial strength as it is captured by the variable of capital adequacy. This result does not confirm the argument that higher capitalization contributes to alleviate agency problems between managers and shareholders. Shareholders in this case have greater incentives to monitor managements performance and ensure that the banks are run efficiently (Eisenbeis et al., 1999).

Similarly, non-performing loans past due 90 days or more affects negatively technical inefficiency contrary to financial theory that supports that non-value-added activities of bad assets incur a negative consequence on the operating performance (Tsai and Huang, 1999). In addition, market construction seems to influence negatively banks' technical inefficiency confirming the Efficient Structure Hypothesis, that most efficient banks are likely to survive competitive pressures and they will gain market share at the cost of less efficient banks (Demsetz, 1973). Finally, commercial banks firms are revealed to be more efficient compared to savings banks.

### *5.3. The Impact of large lending on Cost Efficiency*

Regarding the impact of large lending on the banks' cost performance, in model I', which as we have already mentioned is the one fitting best to the data, the

impact of large lending on banks' total cost performance is traced in both the deterministic kernel of the stochastic frontier and the inefficiency model.

Concerning the deterministic part of the model, it is evident that large lending influence the total cost since both the coefficient of the  $(\tilde{y}_{LL})$  variable and the coefficient of the  $(\tilde{y}_{LL})^2$  variable is negative. In addition, large lending affects negatively total cost when it interacts with non-interest income output and time trend variable which captures the technological change while it affects positively the total cost when it interacts with investments variable. The interaction of large lending with price of capital reveal a negative relationship between total cost and price of capital. Contrary, we notice a positive relationship between total cost and price of funding when large lending interacts with the price of funding. Apparently, a non-monotonic performing between the large lending and the banks' cost performance is in place. Further elaboration of this relationship is presented below in this section.

Turning to the inefficiency model, large lending reduces technical inefficiency when no non-neutral effects are taken into account. When the latter appear, we can identify the positive influence of large lending on the firms' technical efficiency, when they are combined with the price of capital variable and the variable that represent bank's investments and banks' non-interest income. In contrast, the interaction of the large lending with the price of funding reveals a negative influence on the banks' technical efficiency is rather expected.

Finally, the interaction of large lending with non-performing loans past due 90 or more days reveals the unexpected negative relationship between banks' inefficiency and non-performing loans.

**[Insert Table 7 here]**

#### 5.4. *Profit Efficiency Results*

As discussed earlier, it is important to look at the revenue side of bank operations. Accordingly, the estimates of profit efficiency are presented in Table 8. As in the cost case, we focus on model I'. The null hypothesis that the coefficients of the inefficiency factors are jointly zero is not accepted. The empirical results summarized in the lower part of Table 8 suggest that technical efficiency is positively affected by the bank's financial strength as it is captured by the non-performing loans variables. We find that non-performing loans have a positive relationship with banks profit inefficiency supporting the related literature that suggests that efficient banks are better at managing their credit risk (Berger and DeYoung, 1997).

Moreover, capital ratio influences negatively profit inefficiency implying that higher capital ratios are related with greater efficiency consisting with the argument that higher capitalization contributes to alleviate agency problems between managers and shareholders. Shareholders in this case have greater incentives to monitor managements performance and ensure that the banks are run efficiently (Eisenbeis et al., 1999). Finally, commercial banks firms are revealed to be more efficient compared to savings banks.

#### 5.5. *The Impact of large lending on Profit Efficiency*

Starting with the kernel of the stochastic frontier we notice that large lending influence positively banks' profits when interacts with investments output and time trend variable which captures technological change while this relationship turns to negative when large lending interacts with total loans output. Moreover, the interaction of large lending with price of funding and price of capital do not reveal any statistically significant influence on banks' profit. Obviously, the relationship between large between large lending and the banks' profit performance is not

monotonic. Additional amplification of this association is presented below in this section.

As far as the inefficiency model, large lending reduces technical inefficiency when no non-neutral effects are taken into account. When the latter appear, we can identify the positive influence of large lending on the firms' technical efficiency, when they are combined with total loans output and banks' investments output. However, the interaction of the large lending with the price of capital and the price of funding seems to not alter the negative relationship between technical inefficiency and large lending. Similarly, the above relationship does not change when large lending interacts with non-interest income output.

Moreover, we can identify the positive influence of large lending on the banks' technical inefficiency, when they are combined with the non-performing loans past due 90 days variable. Thus, we can argue that a poor asset quality are in general technical inefficiency increasing, as we have already seen above, in the case of large lending non-performing loans past due 90 days seems to not be affected by the ability of large lending to decrease banks credit risk alleviating the information asymmetry problems that arise during a loan procedure. In contrast, the interaction of large lending with market structure confirms the Efficient Structure Hypothesis that implies a negative relationship between banks' inefficiency and market power while the interaction of large lending with industry specific variable show the expected negative association between commercial bank and banks' inefficiency since this dummy capture banking technology that contains less credit risk.

**[Insert Table 8 here]**

#### 5.6. *Product Efficiency Results*

Based on model I' we explore banks technical efficiency in terms of product performance. The estimates of the inefficiency model summarized in Table 9. The null hypothesis that the coefficients of the inefficiency factors are jointly zero is not accepted. Technical efficiency is positively affected by the bank's financial strength as it captured by the variables of CAMEL model. Particularly, we find that non-performing loans have a negative relationship with banks efficiency confirming that a large proportion of non-performing loans may signal that banks use fewer resources than usual in their credit evaluation and loans monitoring process (Karim et al 2010). Similarly, capital ratio influences negatively technical inefficiency implying that higher capital ratios are related with greater efficiency consisting with the argument that higher capitalization contributes to alleviate agency problems between managers and shareholders (Eisenbeis et al., 1999). In a similar vein, the cost to income ratio influence positively product inefficiency suggesting that a poorer management's ability to control costs reduces cost inefficiency as higher expenses normally mean higher cost and vice versa.

Surprisingly, the liquidity ratio affects negatively the cost inefficiency indicating that banks inefficiency reduces as liquidity risk increases. As Golin (2001) In addition, market construction seems to influence positively banks' technical inefficiency confirming the "quiet-life" effect, postulating that the greater the market power, the lower the effort of managers to maximize operating efficiency. (Berger and Hannan, 1998). Finally, commercial banks firms are revealed to be more efficient compared to savings banks.

### *5.7. The Impact of large lending on Product Efficiency*

Concerning the kernel of the stochastic frontier, it is evident that large lending influences linearly the produced output since the coefficient of the ( $\tilde{x}_{LL}$ ) variable is

negative supporting the substitution hypothesis between bank credit and trade credit. In addition, large lending affects negatively the produced output when it interacts with liabilities input and total equity input while it affects positively the produced output when it interacts with labor input. Apparently, a non-monotonic performing between the large lending and the banks' product performance is in place. Further elaboration of this relationship is presented below in this section.

Regarding the inefficiency model, we notice that large lending reduces technical inefficiency when no non-neutral effects are taken into account. When the latter appear, we can identify the positive influence of large lending on the firms' technical efficiency, when they are combined with labor input and total deposits input.

In contrast, the interaction of the large lending with banks' liabilities input and total equity of capital input seems to not alter the negative relationship between technical inefficiency and large lending.

In addition, we can identify the positive influence of large lending on the banks' technical inefficiency, when large lending is combined with the non-performing loan variable. Thus, we can argue that an poor asset quality in general are technical inefficiency increasing, as we have already seen above, in the case of the large lending non-performing loans increase banks' inefficiency as a large proportion of non-performing loans may signal that banks use fewer resources than usual in their credit evaluation and loans monitoring process (Karim et al 2010). Similarly, the interaction of large lending with market structure confirms the "quiet-life" effect (Berger and Hannan, 1998). In addition, this relationship seems to alter when large lending interacts with capital adequacy variable implying that although banks use trade credit to reduce information asymmetry problems however it still contains credit risk.

Finally, the interaction of large lending with industry specific variable show the expected negative association between commercial bank and banks' inefficiency since this dummy capture banking technology that contains less credit risk.

**[Insert Table 9 here]**

## 6. Conclusions

Large firms (opaque firms) is particularly important for banks since an important part of lending to these kinds of firms is transported to trade credit provided to financially constrained firms (smaller and less liquid firms). Consequently, large lending could improve banks' technical efficiency significantly. Though the impact of large lending on banks' technical efficiency is highly important, no studies have been carried out to examine this relation. The objective of this article is to provide empirical evidence of the effect of large lending on the banks' technical efficiency for the three efficiency aspects (product, cost and profit) using a sample of USA banks during the period 2010-2017. We find a positive relationship between the investment in large lending and banks' technical efficiency for all measures derived from the fact that the benefits associated to trade credit surpass the costs of banks' credit risk. Further evidence supports the complements relationship between bank credit and trade credit, showing large lending enters positively and significantly in production function implying that banks provide credit to those firms that have been granted trade credit by suppliers. The findings also support the financial motive for trade credit. Actually, the use of large lending as output in cost function can decrease banks' cost. In this sense, large lending might be used to alleviate banks' credit risk, thus lowering operating costs and therefore enhancing bank profitability. However, we do not find evidence for the financial motive, when we focus on profit function as large lending does not enter significantly in our regression.

These results show the important role of large lending as a determinant of banks' technical efficiency and provide valuable insights for academics and bankers since the results suggest that by increasing their investment in large lending banks may enhance their technical efficiency. This article highlights the importance

of current assets management in the maximization of bank value and opens an important field for future research. However, this study is also relevant for other groups of stakeholders, such as central banks and policy makers since central banks play a key role in the monitor the banking system and policy makers, in view of the importance of large lending for banks' technical efficiency, should enforce loan contracts to combat late payment in large lending.

To finish, one possible limitation is that the study focuses on a period of economic recovery (2010-2017) for the USA banking system. From our point of view, the over-time robustness of the findings is interesting. It would be appropriate to replicate this study in a period of economic downturn, like the 2007 financial crises, when data are available, in order to compare the results and draw conclusions. Due to liquidity and financial constraints arising from the current financial crisis, the relations obtained could be different. Late payment or non- payment in commercial transactions has increased significantly and because of this the positive relation found between the investment in large lending, given that large lending transported to trade credit by larger firms, and banks' technical efficiency could differ. Therefore, this is an important step for future research.

## Tables

<b>Table 1. Descriptive statistics of cost frontier variables</b>													
	$tc$	$y_L$	$y_I$	$y_N$	$\tilde{y}_{LL}$	$p_L$	$p_F$	$p_C$	$CAP$	$NPLS3$	$NPLS9$	$HHI$	$COM$
Mean	13,990	376,626	526,095	5,307	0.048	65.07	0.007	0.298	0.108	0.007	1.649	0.029	0.911
Std.Dev	21,710.93	656,599.6	880,307.3	11,461	0.055	0.861	0.004	15.960	0.022	0.006	0.004	0.038	0.284
Min	305	6032	16,665	8	0.000	16.36	0.0002	0.001	0.034	0.000	2.600	0.005	0
Max	23,8367	7,718,297	8,792,214	203,291	0.874	235.461	0.032	50.070	0.410	0.080	0.165	0.695	1

<b>Table 2. Descriptive statistics of profit frontier variables</b>													
	$\pi$	$y_L$	$y_I$	$y_N$	$\tilde{y}_{LL}$	$p_L$	$p_F$	$p_C$	$CAP$	$NPLS3$	$NPLS9$	$HHI$	$COM$
Mean	7,047.533	384,409.2	540,272	5,567.803	0.049	65.4655	0.006	0.303	0.107	0.006	0.001	0.031	0.915
Std.Dev	13,967.47	688,564.4	920,396.4	12,499.04	0.057	16.065	0.004	0.817	0.025	0.006	0.004	0.041	0.278
Min	2	6,516	13,820	8	7.064	16.362	0.0002	0.001	0.023	5.035	2.594	0.005	0
Max	195,996	7,732,112	8,792,214	203,291	0.874	235.461	0.032	50.070	0.431	0.080	0.165	0.620	1

<b>Table 3. Descriptive statistics of product frontier variables</b>													
	$y$	$x_L$	$x_I$	$x_N$	$\tilde{x}_{LL}$	$CAP$	$NPLS3$	$NPLS9$	$MANAG$	$ROA$	$LIQ$	$HHI$	$COM$
Mean	892,409	504,004.3	61,188.64	135643.3	0.049	0.107	0.006	0.001	7.337	0.996	0.761	0.030	0.914
Std.Dev	1,524,122	848,903.4	111,714.7	193,670.1	0.056	0.025	0.006	0.004	67.093	0.509	0.180	0.040	0.279
Min	22,736	14,590	1,625	1,013	7.064	0.023	5.035	2.594	0.292	0.002	0.060	0.005	0
Max	16,592,708	8,503,653	1,437,022	2,817,174	0.874	0.431	0.080	0.165	5,769	3.472	1.912	0.620	1

<b>Table 4. Model selection decisions for cost frontier</b>									
$H_0$ hypothesis	Restricted model	Unrestricted model	$L(H_0)$	$L(H_1)$	$\lambda$	No of restriction	$X^2_{0.05}$	Decision	Preferable model
LL affects the kernel of the frontier The ECM is a valid assumption $\delta_{caprat} = \dots = \delta_{com} = 0$	(B)	(D)	2311.2	2504.6		5	386.67	Not accepted	(D)
The neutral TEEM is a valid assumption $\delta_{np1s3\_LL} = \dots = \delta_{com\_LL} = 0$	(D)	(G)	2504.6	2512.2		5	15.375	Not accepted	(G)
LL affects the inefficiency model The neutral TEEM is a valid assumption $\delta_{LLL} = \dots = \delta_{LLPF} = 0$	(E)	(F)	2476.4	2562.0		5	171.26	Not accepted	(F)
LL affects both the Kernel of the frontier and the inefficiency model The neutral TEEM is a valid assumption $\delta_{np1s3\_LL} = \dots = \delta_{com\_LL} = 0$	(H)	(I)	2504.8	2512.8		5	16.182	Not accepted	(I)
LL doesn't affect either the Kernel of the frontier or the inefficiency model The ECM is a valid	(A)	(C)	2259.6	2463.5		5	407.77	Not accepted	(C)

<b>assumption</b>									
$\delta_{caprat} = \dots = \delta_{com} = 0$									
<b>The neutral TEEM is a valid assumption</b>	<b>(C)</b>	<b>(J)</b>	<b>2463.5</b>	<b>4346.2</b>		<b>11</b>	<b>3765.4</b>	<b>Not accepted</b>	<b>(J)</b>
$\delta_{npls3\_LL} = \dots = \delta_{com\_LL} = 0$									
<b>Horizontal decisions</b>	<b>(D)</b>	<b>(I)</b>	<b>2504.6</b>	<b>2512.8</b>		<b>6</b>	<b>16.605</b>	<b>Not accepted</b>	<b>(I)</b>
$\delta_{LL} = \delta_{npls3\_LL} = \dots = \delta_{com\_LL} = 0$									
$\delta_{LL} = \delta_{npls3\_LL} = \dots = \delta_{com\_LL} = 0$	<b>(C)</b>	<b>(I)</b>	<b>2463.5</b>	<b>2512.8</b>		<b>14</b>	<b>98.658</b>	<b>Not accepted</b>	<b>(I)</b>
$\delta_{npls3\_LL} = \dots = \delta_{com\_LL} = 0$	<b>(F)</b>	<b>(I')</b>	<b>4562.1</b>	<b>2624.1</b>		<b>11</b>	<b>3875.5</b>	<b>Not accepted</b>	<b>(I')</b>
$\delta_{LLL} = \dots = \delta_{LLp_F} = 0$	<b>(I)</b>	<b>(I')</b>	<b>2512.8</b>	<b>2624.4</b>		<b>5</b>	<b>223.12</b>	<b>Not accepted</b>	<b>(I')</b>

<b>Table 5. Model selection decisions for profit frontier</b>									
$H_0$ hypothesis	Restricted model	Unrestricted model	$L(H_0)$	$L(H_1)$	$\lambda$	No of restriction	$X^2_{0.05}$	Decision	Preferable model
LL affects the kernel of the frontier The ECM is a valid assumption $\delta_{caprat} = \dots = \delta_{com} = 0$	(B)	(D)	No value	-9300.3	5	5	No value	Not accepted	(D)
The neutral TEEM is a valid assumption $\delta_{npls\_LL} = \dots = \delta_{com\_LL} = 0$	(D)	(G)	-9300.3	-9291.8		5	16.953	Not accepted	(G)
LL affects the inefficiency model The neutral TEEM is a valid assumption $\delta_{LLL} = \dots = \delta_{LLpF} = 0$	(E)	(F)	-9314.0	-9252.5		5	112.94	Not accepted	(F)
LL affects both the Kernel of the frontier and the inefficiency model The neutral TEEM is a valid assumption $\delta_{npls\_LL} = \dots = \delta_{com\_LL} = 0$	(H)	(I)	-9298.3	-9291.2		5	14.07	Not accepted	(I)
LL doesn't affect either the Kernel of the frontier or the inefficiency model The ECM is a valid assumption	(A)	(C)	No value	-9315.2		5	No value	Not accepted	(C)

$\delta_{caprat} = \dots = \delta_{com} = 0$									
<b>The neutral TEEM is a valid assumption</b>	(C)	(J)	-9315.2	-9308.4		5	13.508	Not accepted	(J)
$\delta_{npls3\_LL} = \dots = \delta_{com\_LL} = 0$									
<b>Horizontal decisions</b>	(D)	(I)	-9300.3	-9291.2		6	18.067	Not accepted	(I)
$\delta_{LL} = \delta_{npls3\_LL} = \dots = \delta_{com\_LL} = 0$									
$\delta_{LL} = \delta_{npls3\_LL} = \dots = \delta_{com\_LL} = 0$	(C)	(I)	-9315.2	-9291.2		14	47.918	Not accepted	(I)
$\delta_{npls3\_LL} = \dots = \delta_{com\_LL} = 0$	(F)	(I')	-9252.5	-92277		13	49.596	Not accepted	(I')
$\delta_{LLL} = \dots = \delta_{LLpF} = 0$	(I)	(I')	-9291.2	-9227.7		5	127.08	Not accepted	(I')

<b>Table 6. Model selection decisions for production frontier</b>									
$H_0$ hypothesis	Restricted model	Unrestricted model	$L(H_0)$	$L(H_1)$	$\lambda$	No of restriction	$X_{0.05}^2$	Decision	Preferable model
LL affects the kernel of the frontier The ECM is a valid assumption $\delta_{caprat} = \dots = \delta_{com} = 0$	(B)	(D)	11506	22831		8	22651	Not accepted	(D)
The neutral TEEM is a valid assumption $\delta_{npls3\_LL} = \dots = \delta_{com\_LL} = 0$	(D)	(G)	22831	22921		8	178.97	Not accepted	(G)
LL affects the inefficiency model The neutral TEEM is a valid assumption $\delta_{LLL} = \dots = \delta_{LLpF} = 0$	(E)	(F)	21429	21468		4	77.19	Not accepted	(F)
LL affects both the Kernel of the frontier and the inefficiency model The neutral TEEM is a valid assumption $\delta_{npls3\_LL} = \dots = \delta_{com\_LL} = 0$	(H)	(I)	22843	22862		8	37.899	Not accepted	(I)
LL doesn't affect either the Kernel of the frontier or the inefficiency model The ECM is a valid assumption	(A)	(C)	11472	22818		8	22691	Not accepted	(C)

$\delta_{caprat} = \dots = \delta_{com} = 0$									
<b>The neutral TEEM is a valid assumption</b>	(C)	(J)	22818	22833		8	30.535	Not accepted	(J)
$\delta_{npls3\_LL} = \dots = \delta_{com\_LL} = 0$									
<b>Horizontal decisions</b>	(D)	(I)	22831	22862		9	60.933	Not accepted	(I)
$\delta_{LL} = \delta_{npls3\_LL} = \dots = \delta_{com\_LL} = 0$									
$\delta_{LL} = \delta_{npls3\_LL} = \dots = \delta_{com\_LL} = 0$	(C)	(I)	22818	22862		16	88.547	Not accepted	(I)
$\delta_{npls3\_LL} = \dots = \delta_{com\_LL} = 0$	(F)	(I')	21468	22940		15	2944.8	Not accepted	(I')
$\delta_{LLL} = \dots = \delta_{LLpF} = 0$	(I)	(I')	22862	22940		4	156.25	Not accepted	(I')

Coef-Ficient	Variable	Model C	Model D	Model G	Model F	Model I'
$\beta_0$	Constant	-1.605 (-2.384)	-1.570** (-2.059)	-1.744** (-2.269)	-1.862*** (-2.728)	-1.942** (-2.368)
$\beta_L$	$\ln(y_L)$	-0.608** (-3.336)	-0.452** (-2.362)	-0.459** (-2.366)	-5.857*** (-3.189)	-4.400** (-2.266)
$\beta_I$	$\ln(y_I)$	1.440*** (6.932)	1.344*** (6.276)	1.377*** (6.341)	1.428*** (6.845)	1.304*** (5.948)
$\beta_N$	$\ln(y_N)$	0.248*** (3.717)	0.174** (2.501)	0.162** (2.303)	2.251*** (3.364)	1.680**
$\beta_{LL}$	$\ln y_{LL}$	-	-0.017 (-0.632)	-0.045 (-1.549)	-	-1.042*** (-3.340)
$\beta_{p_C}$	$\ln(p_C/p_L)$	-0.218*** (-3.425)	-0.210*** (-3.152)	-0.222*** (-3.287)	-2.111*** (-3.109)	-2.540*** (-3.435)
$\beta_{p_F}$	$\ln(p_F/p_L)$	0.838*** (9.186)	0.879*** (8.828)	0.885*** (8.763)	7.787*** (8.263)	7.802*** (7.217)
$\beta_{L^2}$	$(\ln y_L)^2$	-0.099*** (-3.719)	-0.113*** (-4.211)	-0.116*** (-4.249)	-1.079*** (-3.965)	-1.404*** (-5.060)
$\beta_{I^2}$	$(\ln y_I)^2$	-0.213*** (-5.417)	-0.198*** (-5.024)	-0.208*** (-5.166)	-2.184*** (-5.629)	-2.081*** (-5.292)
$\beta_{N^2}$	$(\ln y_N)^2$	0.077*** (18.085)	0.078*** (18.633)	-0.078*** (18.354)	7.898*** (17.762)	8.290*** (19.523)
$\beta_{LL^2}$	$(\ln y_{LL})^2$	-	-0.002*** (-3.988)	-0.002*** (-4.214)	-	-1.232* (-1.687)

$\beta_{p_C^2}$	$(\ln p_C/p_L)^2$	-0.071*** (-17.591)	-0.071*** (-17.498)	-0.071*** (-17.348)	-6.703*** (-15.988)	-6.462*** (-14.942)
$\beta_{p_F^2}$	$(\ln p_F/p_L)^2$	0.100*** (11.690)	0.105*** (12.025)	0.105*** (12.047)	1.154*** (12.432)	1.186*** (12.485)
$\beta_{LI}$	$(\ln y_L)(\ln y_I)$	0.197*** (6.647)	0.196*** (6.621)	0.202*** (6.683)	2.050*** (6.911)	2.207*** (7.364)
$\beta_{LN}$	$(\ln y_L)(\ln y_N)$	-0.070*** (-6.599)	-0.059*** (-5.464)	-0.060*** (-5.453)	-7.324*** (-6.806)	-5.895*** (-5.395)
$\beta_{IN}$	$(\ln y_I)(\ln y_N)$	-0.007 (-0.578)	-0.017 (-1.419)	-0.015 (-1.210)	-3.283 (-0.265)	-2.318* (-1.827)
$\beta_{LLL}$	$(\ln y_{LL})(\ln y_L)$	-	0.009** (2.244)	0.010** (2.281)	-	3.843 (0.790)
$\beta_{LLI}$	$(\ln y_{LL})(\ln y_I)$	-	-0.003 (-0.803)	-0.002 (-0.483)	-	1.286** (2.233)
$\beta_{LLN}$	$(\ln y_{LL})(\ln y_N)$	-	-0.006*** (-3.962)	-0.006*** (-4.354)	-	-8.750*** (-5.233)
$\beta_{p_C p_F}$	$\ln(p_C/p_L)\ln(p_F/p_L)$	0.010* (1.842)	0.010* (1.919)	0.010* (1.916)	8.792 (0.001)	-6.379 (-1.026)
$\beta_{Lp_C}$	$\ln(y_L)\ln(p_C/p_L)$	-0.024** (-2.141)	-0.024* (-2.136)	-0.022** (-1.966)	-3.380*** (-2.802)	-3.521*** (-2.918)
$\beta_{Lp_F}$	$\ln(y_L)\ln(p_F/p_L)$	0.025* (1.848)	0.025* (1.919)	0.027** (1.962)	2.738** (1.999)	3.388** (2.438)
$\beta_{Ip_C}$	$\ln(y_I)\ln(p_C/p_L)$	0.011 (0.903)	0.011 (0.877)	0.011 (0.873)	1.651 (1.245)	1.510 (1.125)
$\beta_{Ip_F}$	$\ln(y_I)\ln(p_F/p_L)$	0.043*** (2.910)	0.045*** (3.081)	0.043*** (2.938)	4.872*** (3.232)	5.019*** (3.299)
$\beta_{Np_C}$	$\ln(y_N)\ln(p_C/p_L)$	0.014*** (3.764)	0.014*** (3.862)	0.013*** (3.581)	-4.513*** (3.162)	1.325*** (3.315)

$\beta_{NPF}$	$\ln(y_N)\ln(p_F/p_L)$	-0.045*** (-8.170)	-0.050*** (-8.817)	-0.050*** (-8.705)	1.299*** (-7.426)	-5.382*** (-8.667)
$\beta_{LLPC}$	$\ln(y_{LL})\ln(p_C/p_L)$	-	0.0003 (0.241)	0.0003 (0.222)	-	-1.293*** (-4.397)
$\beta_{LLPF}$	$\ln(y_{LL})\ln(p_F/p_L)$	-	0.002 (1.226)	0.001 (0.798)	-	1.334*** (4.007)
$\beta_t$	$T$	-0.050 (-1.630)	-0.040 (-1.234)	-0.038 (-1.173)	-4.580 (-1.444)	-5.179 (-1.512)
$\beta_{t^2}$	$T^2$	-0.010*** (-6.973)	-0.009*** (-6.605)	-0.009*** (-6.374)	-1.024*** (-6.923)	-1.045*** (-6.712)
$\beta_{tL}$	$T \ln y_L$	0.002 (0.501)	0.001 (0.325)	0.001 (0.321)	1.467 (0.287)	2.766 (0.543)
$\beta_{tI}$	$T \ln y_I$	-0.005 (-1.037)	-0.004 (-0.854)	-0.004 (-0.852)	-4.608 (-0.827)	-4.785 (-0.860)
$\beta_{tN}$	$T \ln y_N$	0.002 (1.260)	0.002 (1.138)	0.002 (-1.140)	2.150 (1.072)	1.062 (0.524)
$\beta_{tLL}$	$T \ln y_{LL}$	-	-0.0001 (-0.261)	-0.0002 (-0.399)	-	-1.021* (-0.136)
$\beta_{tpC}$	$T\ln(p_C/p_L)$	0.002 (1.230)	0.002 (1.296)	0.002 (1.256)	4.045* (1.925)	4.181** (1.971)
$\beta_{tpF}$	$T\ln(p_F/p_L)$	-0.014*** (-5.083)	-0.012*** (-4.511)	-0.012*** (-4.401)	-1.446 (-5.093)	-1.470*** (-5.047)
<b>Inefficiency Model</b>						
$\delta_0$	Constant	0.124* (1.739)	0.203*** (2.764)	0.241*** (2.995)	3.761*** (5.127)	1.738 (1.197)
$\delta_{npls3}$	<i>NPLS3</i>	-0.101*** (-8.562)	0.496*** (-8.320)	-0.126*** (-7.464)	-8.554*** (-10.270)	-9.095*** (-8.231)

$\delta_{npls9}$	<i>NPLS9</i>	0.0002 (0.093)	0.0003 (0.141)	0.002 (0.458)	3.293 (0.116)	2.218 (0.037)
$\delta_{caprat}$	<i>CAP</i>	0.480*** (6.714)	0.496*** (6.463)	0.452*** (6.020)	3.969*** (8.917)	2.469*** (4.235)
$\delta_{hhi}$	<i>HHI</i>	-0.071*** (-7.164)	-0.063*** (-6.709)	-0.037** (-2.284)	-4.919*** (-6.265)	-2.834* (-1.892)
$\delta_{com}$	<i>COM</i>	-0.095*** (-4.515)	-0.112*** (-5.119)	-0.263*** (-4.878)	-1.493 (-6.277)	-1.505*** (-3.606)
$\delta_{LL}$	$y_{LL}$	-	-	-	4.640 (0.667)	-1.511*** (-2.703)
$\delta_{LLL}$	$y_{LL} \ln y_L$	-	-	-	-1.791** (-2.476)	-7.422 (-1.132)
$\delta_{LLI}$	$y_{LL} \ln y_I$	-	-	-	3.685*** (2.771)	3.321*** (3.974)
$\delta_{LLN}$	$y_{LL} \ln y_N$	-	-	-	3.836 (0.058)	-5.552* (-1.825)
$\delta_{LLp_C}$	$y_{LL} \ln(p_C/p_L)$	-	-	-	-2.803*** (-7.489)	-2.898*** (-9.261)
$\delta_{LLp_F}$	$y_{LL} \ln(p_F/p_L)$	-	-	-	4.264*** (7.326)	3.368*** (10.148)
$\delta_{npls3\_LL}$	$(NPLS3)(\ln y_{LL})$	-	-	-0.007*** (-2.947)	-	-8.546*** (-3.700)
$\delta_{npls9\_LL}$	$(NPLS9)(\ln y_{LL})$	-	-	0.0005 (0.342)	-	2.656 (0.019)
$\delta_{caprat\_LL}$	$(CAP)(\ln y_{LL})$	-	-	-0.011 (-1.176)	-	-2.119 (-0.174)
$\delta_{hhi\_LL}$	$(HHI)(\ln y_{LL})$	-	-	0.006* (1.799)	-	1.336 (0.395)

$\delta_{com\_LL}$	$(COM)(\ln y_{LL})$	-	-	-0.036*** (-3.590)	-	-1.379 (-1.581)
$LogL$	-	2463.521	2504,548	2512.236	2562.018	2624.41
$\sigma^2$	-	0.088*** (8.873)	0.089*** (8.753)	0.087*** (9.258)	8.954*** (11.769)	6.518***
$\gamma$	-	0.775*** (31.487)	0.778*** (31.662)	0.774*** (33.517)	7.984*** (51.042)	7.669***

**Notes:** (a) Numbers in parentheses are the ratios of estimated coefficients to their standard errors

\*\*\*Represent statistical significance at the 1% levels

\*\*Represent statistical significance at the 5% levels

\*Represent statistical significance at the 10% levels, respectively

**Table 8. Maximum Likelihood Estimators for Models C, D, G, F and I' for profit frontier<sup>a</sup>**

Coef-Ficient	Variable	Model C	Model D	Model G	Model F	Model I'
$\beta_0$	Constant	-2.770** (-1.972)	-1.307 (-0.807)	-1.145 (-0.688)	-0.419 (-0.267)	-0.335 (-0.200)
$\beta_L$	$\ln(y_L)$	1.557*** (3.957)	1.025** (2.426)	1.012** (2.426)	1.449*** (3.535)	1.058** (2.309)
$\beta_I$	$\ln(y_I)$	-4.379 (-0.974)	-4.737 (-0.100)	-4.746 (-0.100)	-0.486 (-1.034)	-0.145 (-0.284)
$\beta_N$	$\ln(y_N)$	4.103*** (2.818)	4.468*** (2.911)	4.505*** (2.865)	0.431*** (2.823)	0.459*** (2.951)
$\beta_{LL}$	$\ln y_{LL}$	-	1.263** (2.059)	1.543** (2.375)	-	0.011 (0.192)
$\beta_{p_C}$	$\ln(P_C/P_L)$	7.259*** (4.882)	7.460*** (4.674)	7.593*** (4.801)	0.803*** (5.143)	0.786*** (4.991)
$\beta_{p_F}$	$\ln(P_F/P_L)$	9.726*** (4.991)	1.081*** (5.067)	1.081*** (5.097)	1.170*** (1.650)	1.168*** (5.442)
$\beta_{L^2}$	$(\ln y_L)^2$	2.466*** (4.327)	2.807*** (5.319)	2.850*** (4.920)	0.272*** (4.563)	0.300*** (5.226)
$\beta_{I^2}$	$(\ln y_I)^2$	3.866*** (4.952)	3.666*** (4.974)	3.698*** (4.636)	0.403*** (5.034)	0.390*** (4.763)
$\beta_{N^2}$	$(\ln y_N)^2$	2.728*** (2.859)	2.518*** (2.640)	2.490** (2.512)	0.026*** (2.726)	0.023** (2.363)
$\beta_{LL^2}$	$(\ln y_{LL})^2$	-	2.019 (1.229)	2.339 (1.354)	-	0.002 (1.501)
$\beta_{p_C^2}$	$(\ln P_C/P_L)^2$	-6.496*** (-6.520)	-6.462*** (-6.449)	-6.456*** (-6.318)	-0.064*** (-6.248)	-0.064*** (-6.197)

$\beta_{p_F^2}$	$(\ln p_F / p_L)^2$	2.311 (1.201)	2.479 (1.271)	2.467*** (1.255)	0.031* (1.650)	0.028*** (1.463)
$\beta_{LI}$	$(\ln y_L)(\ln y_I)$	-3.320*** (-5.499)	-3.387*** (-6.117)	-3.426*** (-5.609)	-0.352*** (-5.619)	-0.361*** (-5.885)
$\beta_{LN}$	$(\ln y_L)(\ln y_N)$	-7.247*** (-3.375)	-7.457*** (-3.506)	-7.488*** (-3.393)	-0.072*** (-3.333)	-0.071*** (-3.204)
$\beta_{IN}$	$(\ln y_I)(\ln y_N)$	5.631** (2.291)	6.185** (2.548)	6.253** (2.458)	0.058** (2.336)	0.061** (2.407)
$\beta_{LLL}$	$(\ln y_{LL})(\ln y_L)$	-	-3.906*** (-4.250)	-4.053*** (-4.265)	-	-0.038*** (-4.042)
$\beta_{LLI}$	$(\ln y_{LL})(\ln y_I)$	-	2.794*** (2.703)	2.716*** (2.537)	-	0.030*** (2.929)
$\beta_{LLN}$	$(\ln y_{LL})(\ln y_N)$	-	2.146 (0.655)	2.953*** (0.853)	-	0.001 (0.601)
$\beta_{p_C p_F}$	$\ln(p_C / p_L) \ln(p_F / p_L)$	1.097*** (8.391)	1.111*** (8.442)	1.1132*** (8.366)	0.111*** (8.397)	0.113*** (8.525)
$\beta_{L p_C}$	$\ln(y_L) \ln(p_C / p_L)$	1.033*** (-4.179)	-1.051*** (-4.268)	-1.059*** (-4.144)	-0.100 (-3.996)	-0.100*** (-3.911)
$\beta_{L p_F}$	$\ln(y_L) \ln(p_F / p_L)$	5.099* (1.737)	4.253 (1.456)	4.208 (1.388)	0.042 (1.408)	0.041 (1.322)
$\beta_{I p_C}$	$\ln(y_I) \ln(p_C / p_L)$	8.453*** (3.094)	8.423*** (3.074)	8.373** (2.986)	0.078*** (2.825)	0.077*** (2.725)
$\beta_{I p_F}$	$\ln(y_I) \ln(p_F / p_L)$	-6.046** (-1.964)	-6.131** (-1.992)	-6.078* (-1.915)	-0.062** (-1.979)	-0.064** (-1.986)
$\beta_{N p_C}$	$\ln(y_N) \ln(p_C / p_L)$	1.927** (2.045)	2.122** (2.253)	2.174** (2.236)	0.019** (2.045)	0.022** (2.346)
$\beta_{N p_F}$	$\ln(y_N) \ln(p_F / p_L)$	1.938 (1.566)	2.393* (1.912)	2.393* (1.862)	0.024* (1.921)	0.026** (2.122)

$\beta_{LLp_C}$	$\ln(y_{LL})\ln(p_C/p_L)$	-	-1.046 (-0.254)	-9.854 (-0.234)	-	-0.005 (-1.375)
$\beta_{LLp_F}$	$\ln(y_{LL})\ln(p_F/p_L)$	-	3.270 (0.702)	3.822 (0.781)	-	-0.002 (-0.476)
$\beta_T$	$T$	1.576** (2.297)	1.985*** (2.735)	1.956*** (2.665)	0.162** (2.375)	0.194*** (2.668)
$\beta_{T^2}$	$T^2$	-1.596*** (-4.537)	-1.556*** (-4.460)	-1.562*** (-4.357)	-0.015*** (-4.337)	-0.015*** (-4.321)
$\beta_{iL}$	$T \ln y_L$	3.091*** (2.821)	3.225*** (2.956)	3.245*** (2.852)	0.029*** (2.613)	0.030*** (2.716)
$\beta_{iT}$	$T \ln y_i$	-1.996* (-1.665)	-2.257* (-1.887)	-2.254* (-1.801)	-0.019 (-1.627)	-0.022* (-1.791)
$\beta_{iN}$	$T \ln y_N$	-7.586* (-1.700)	-7.960* (-1.807)	-8.107* (-1.754)	-0.005 (-1.328)	-0.006 (-1.476)
$\beta_{iLL}$	$T \ln y_{LL}$	-	2.794* (1.691)	2.679 (1.523)	-	0.003* (1.939)
$\beta_{tp_C}$	$T \ln(p_C/p_L)$	1.977*** (4.360)	2.027*** (4.487)	2.030*** (4.343)	0.018*** (4.165)	0.019*** (4.155)
$\beta_{tp_F}$	$T \ln(p_F/p_L)$	3.245 (0.525)	4.378 (0.710)	4.263 (0.669)	0.003 (0.634)	0.003 (0.619)
<b>Inefficiency Model</b>						
$\delta_0$	Constant	-7.966*** (-3.492)	-7.146*** (-3.462)	-6.044*** (-3.588)	-41.391*** (-4.495)	-31.280*** (-4.325)
$\delta_{npls3}$	<i>NPLS3</i>	1.500*** (3.769)	1.385*** (3.498)	2.091*** (2.773)	0.530*** (4.082)	1.012*** (4.154)
$\delta_{npls9}$	<i>NPLS9</i>	8.822*** (3.421)	8.118*** (3.629)	5.549*** (2.629)	0.280*** (3.619)	0.276*** (3.241)

$\delta_{caprat}$	<i>CAP</i>	-3.246*** (-3.534)	-2.948*** (-3.559)	-2.332*** (-3.313)	-17.730*** (-4.791)	-13.289*** (-4.470)
$\delta_{hhi}$	<i>HHI</i>	5.871** (2.302)	5.934** (2.563)	-5.740*** (-2.577)	0.725*** (4.430)	-0.227 (-1.029)
$\delta_{com}$	<i>COM</i>	-2.050*** (-3.160)	-1.878** (-3.257)	-1.155*** (-3.122)	-11.348 (-4.326)	-6.505*** (-5.943)
$\delta_{LL}$	$y_{LL}$	-	-	-	-11.327*** (-5.250)	-9.749*** (-4.922)
$\delta_{LLL}$	$y_{LL} \ln y_L$	-	-	-	0.423*** (4.803)	0.233*** (4.624)
$\delta_{LLI}$	$y_{LL} \ln y_I$	-	-	-	0.007 (0.162)	0.153*** (3.615)
$\delta_{LLN}$	$y_{LL} \ln y_N$	-	-	-	-0.007 (-0.237)	-0.040** (-2.520)
$\delta_{LLP_C}$	$y_{LL} \ln(p_C/p_L)$	-	-	-	-0.298*** (-4.925)	-0.237*** (-6.200)
$\delta_{LLP_F}$	$y_{LL} \ln(p_F/p_L)$	-	-	-	-0.542*** (-4.639)	-0.499*** (-5.756)
$\delta_{npls3\_LL}$	$(NPLS3)(\ln y_{LL})$	-	-	2.393** (2.368)	-	0.157*** (4.092)
$\delta_{npls9\_LL}$	$(NPLS9)(\ln y_{LL})$	-	-	-2.307 (-1.267)	-	0.018 (1.272)
$\delta_{caprat\_LL}$	$(CAP)(\ln y_{LL})$	-	-	3.851* (1.683)	-	0.150 (1.378)
$\delta_{hhi\_LL}$	$(HHI)(\ln y_{LL})$	-	-	-2.788*** (-4.158)	-	-0.202*** (-3.723)
$\delta_{com\_LL}$	$(COM)(\ln y_{LL})$	-	-	9.556*** (3.991)	-	0.544*** (3.565)
<i>LogL</i>	-	-9,315.193	-9,300.268	-9,291.791	-9,252.493	-9,227.695

$\sigma^2$	-	2.495 <sup>***</sup> (3.342)	2.264 <sup>***</sup> (3.318)	1.890 <sup>***</sup> (5.444)	12.946 <sup>***</sup> (3.130)	9.941 <sup>***</sup>
$\gamma$	-	8.748 <sup>***</sup> (1139.725)	9.967 <sup>***</sup> (1013.579)	9.961 <sup>***</sup> (1.023)	0.994 <sup>***</sup> (0.001)	0.992 <sup>***</sup>

**Notes:** (a) Numbers in parentheses are the ratios of estimated coefficients to their standard errors

**\*\*\***Represent statistical significance at the 1% levels

**\*\***Represent statistical significance at the 5% levels

**\***Represent statistical significance at the 10% levels, respectively

Coef-Ficient	Variable	Model C	Model D	Model G	Model F	Model I'
$\beta_0$	Constant	1.025*** (7.805)	9.243*** (5.551)	1.158*** (14.798)	9.229*** (11.037)	7.333*** (9.490)
$\beta_L$	$\ln(x_L)$	9.150*** (24.423)	9.441*** (15.729)	7.160*** (18.598)	6.351*** (15.049)	9.211*** (24.693)
$\beta_I$	$\ln(x_I)$	-1.684 (-0.742)	-2.340 (-0.688)	2.159*** (8.670)	3.195*** (9.851)	-4.267 (-0.018)
$\beta_E$	$\ln(x_E)$	2.015 (1.081)	5.303 (0.257)	-8.529 (-0.577)	7.744*** (3.108)	-8.443 (-0.064)
$\beta_D$	$\ln(x_D)$	1.140*** (5.943)	1.173*** (4.301)	1.213*** (6.662)	-3.089 (-0.126)	1.216*** (6.721)
$\beta_{LL}$	$\ln \tilde{x}_{LL}$	-	-1.028** (-2.481)	-1.312*** (14.798)	-	-5.306*** (-5.715)
$\beta_L$	$(\ln x_L)^2$	4.059*** (3.122)	3.707** (2.071)	3.257*** (2.589)	1.072*** (6.840)	3.692*** (3.194)
$\beta_I$	$(\ln x_I)^2$	4.919*** (9.610)	4.949*** (7.428)	4.531*** (6.510)	7.551*** (7.562)	5.234*** (10.689)
$\beta_E$	$(\ln x_E)^2$	1.513*** (10.244)	1.501*** (8.128)	1.564*** (8.764)	-1.594 (-0.794)	1.590*** (10.743)
$\beta_D$	$(\ln x_D)^2$	4.344*** (14.878)	4.354*** (6.620)	4.479*** (13.201)	9.008* (1.776)	4.685*** (16.338)
$\beta_{LL}$	$(\ln \tilde{x}_{LL})^2$	-	-1.258 (-0.754)	-1.828 (-1.643)	-	-1.162 (-1.096)
$\beta_{LI}$	$(\ln x_L)(\ln x_I)$	-1.932*** (-2.663)	-1.873* (-2.028)	-1.702** (-2.046)	-8.441*** (-7.277)	-1.896*** (-2.742)

$\beta_{LE}$	$(\ln x_L)(\ln x_E)$	-1.570*** (-3.290)	-1.457*** (-2.608)	-9.834*** (-2.662)	-1.056** (-1.963)	-1.253*** (-3.673)
$\beta_{LD}$	$(\ln x_L)(\ln x_D)$	-9.629* (-1.656)	-9.355 (-0.950)	-8.012 (-1.533)	-3.273 (-0.475)	-1.088** (-2.120)
$\beta_{IE}$	$(\ln x_I)(\ln x_E)$	2.917 (0.983)	2.849 (0.710)	1.670 (0.061)	5.449 (1.383)	2.559 (0.096)
$\beta_{ID}$	$(\ln x_I)(\ln x_D)$	-3.224*** (-8.475)	-3.278*** (-7.941)	-3.210*** (-5.954)	-5.413 (-0.944)	-3.341*** (-9.098)
$\beta_{ED}$	$(\ln x_E)(\ln x_D)$	-1.522 (-0.549)	-1.601 (-0.415)	-4.405 (-1.616)	1.163 (0.315)	-1.976 (-0.941)
$\beta_{DLL}$	$(\ln x_D)(\ln \tilde{x}_{LL})$	-	2.593 (0.382)	9.895 (1.322)	-	1.671 (1.137)
$\beta_{LLL}$	$(\ln x_L)(\ln \tilde{x}_{LL})$	-	1.847* (1.849)	3.463*** (2.986)	-	2.586*** (9.104)
$\beta_{ILL}$	$(\ln x_I)(\ln \tilde{x}_{LL})$	-	-3.310 (-0.421)	-2.766*** (-3.834)	-	-2.234*** (-12.512)
$\beta_{ELL}$	$(\ln x_E)(\ln \tilde{x}_{LL})$	-	-9.930* (-1.782)	-8.390* (-1.869)	-	-4.785*** (-4.574)
$\beta_t$	$T$	-6.263 (-1.218)	-7.935 (-1.644)	-9.305* (-1.727)	1.371** (2.232)	-9.544*** (-3.039)
$\beta_{tt}$	$T^2$	2.212 (1.254)	2.081 (0.599)	3.305 (1.413)	4.793 (1.239)	2.982* (1.717)
$\beta_{iL}$	$T \ln x_L$	1.470 (0.947)	1.600 (1.497)	1.884 (1.174)	-4.187** (-2.505)	1.820* (2.010)
$\beta_{it}$	$T \ln x_I$	-2.050 (-0.193)	-1.585 (-0.237)	-2.248 (-0.301)	3.784 (0.429)	-7.390 (-1.150)
$\beta_{iE}$	$T \ln x_E$	-6.515 (-1.003)	-7.177 (-1.519)	-6.774 (-1.571)	1.039** (1.976)	-3.941 (-1.055)

$\beta_{iD}$	$T \ln x_D$	-1.509 (-0.260)	-1.763 (-0.232)	-3.998 (-0.430)	2.583*** (2.585)	-6.628 (-0.126)
$\beta_{iLL}$	$T \ln \tilde{x}_{LL}$	-	-1.549 (-1.564)	-1.456 (-1.054)	-	-1.234 (-1.390)
<b>Inefficiency Model</b>						
$\delta_0$	Constant	-1.409 (1.223)	1.319 (0.966)	4.363*** (2.190)	2.302*** (21.003)	-7.302*** (-4.326)
$\delta_{npls3}$	<i>NPLS3</i>	-1.197*** (4.006)	1.173*** (3.811)	1.577** (2.341)	2.600 (0.518)	1.304** (2.024)
$\delta_{npls9}$	<i>NPLS9</i>	-1.568 (0.098)	9.874 (0.059)	1.191*** (3.265)	1.058*** (4.072)	9.779*** (2.748)
$\delta_{roa}$	<i>ROA</i>	-2.310 (-0.172)	-3.096 (-0.207)	9.175 (0.296)	-1.631 (-0.777)	-5.078 (-0.171)
$\delta_{liq}$	<i>LIQ</i>	-3.201*** (-256.568)	-3.198 (-235.662)	-3.229*** (-123.511)	2.374*** (127.637)	-3.206*** (-128.835)
$\delta_{caprat}$	<i>CAP</i>	-7.465*** (-22.028)	-7.428*** (-20.775)	1.579*** (16.366)	-7.793*** (-16.552)	-6.202*** (-8.985)
$\delta_{manag}$	<i>MAN</i>	7.394*** (1.212)	7.370*** (5.766)	9.189*** (3.436)	1.229*** (7.210)	7.922*** (3.040)
$\delta_{hhi}$	<i>HHI</i>	1.240*** (3.313)	1.142*** (2.914)	3.502*** (3.784)	2.531*** (6.649)	4.092*** (4.724)
$\delta_{com}$	<i>COM</i>	-4.452*** (1.661)	-4.042*** (-3.522)	-8.641*** (-3.429)	4.833*** (2.584)	-9.671*** (-3.827)
$\delta_{LL}$	$\tilde{x}_{LL}$	-	-	-	-1.174*** (-2.910)	-4.076*** (-4.454)
$\delta_{LLLL}$	$\tilde{x}_{LL} \ln x_L$	-	-	-	6.116*** (5.257)	2.854*** (10.604)

$\delta_{LLI}$	$\tilde{x}_{LL} \ln x_I$	-	-	-	-6.165*** (-7.903)	-2.536*** (-13.996)
$\delta_{LLE}$	$\tilde{x}_{LL} \ln x_E$	-	-	-	-4.112 (-0.896)	-4.114*** (-4.245)
$\delta_{LLD}$	$\tilde{x}_{LL} \ln x_D$	-	-	-	4.702 (0.725)	5.619*** (0.425)
$\delta_{npls3\_LL}$	$(NPLS3)(\ln \tilde{x}_{LL})$	-	-	1.402 (0.873)	-	3.295 (0.219)
$\delta_{npls9\_LL}$	$(NPLS9)(\ln \tilde{x}_{LL})$	-	-	2.813*** (3.277)	-	2.424*** (2.864)
$\delta_{roa\_LL}$	$(ROA)(\ln \tilde{x}_{LL})$	-	-	-3.874 (-0.537)	-	-1.016 (-0.144)
$\delta_{liq\_LL}$	$(LIQ)(\ln \tilde{x}_{LL})$	-	-	2.790 (0.475)	-	4.179 (0.757)
$\delta_{caprat\_LL}$	$(CAP)(\ln \tilde{x}_{LL})$	-	-	-3.643*** (-5.438)	-	2.820* (1.672)
$\delta_{manag\_E}$	$(MAN)(\ln \tilde{x}_{LL})$	-	-	-2.669 (-0.422)	-	5.054 (0.080)
$\delta_{hhi\_LL}$	$(HHI)(\ln \tilde{x}_{LL})$	-	-	8.234*** (3.668)	-	8.212*** (3.935)
$\delta_{com\_LL}$	$(COM)(\ln \tilde{x}_{LL})$	-	-	-1.494*** (-2.683)	-	-1.475*** (-2.730)
$LogL$	-	22817.55	22831.35	22714.3	21467.52	22939.95
$\sigma^2$	-	9.424*** (76.927)	9.401*** (73.275)	9.602*** (73.943)	1.438*** (55.550)	9.218*** (76.867)
$\gamma$	-	6.833*** (10.085)	5.838*** (9.912)	2.575*** (59.634)	5.287*** (27.326)	3.294*** (1441.602)

**Notes:** (a) Numbers in parentheses are the ratios of estimated coefficients to their standard errors

\*\*\*Represent statistical significance at the 1% levels

\*\*Represent statistical significance at the 5% levels  
\*Represent statistical significance at the 10% levels, respectively

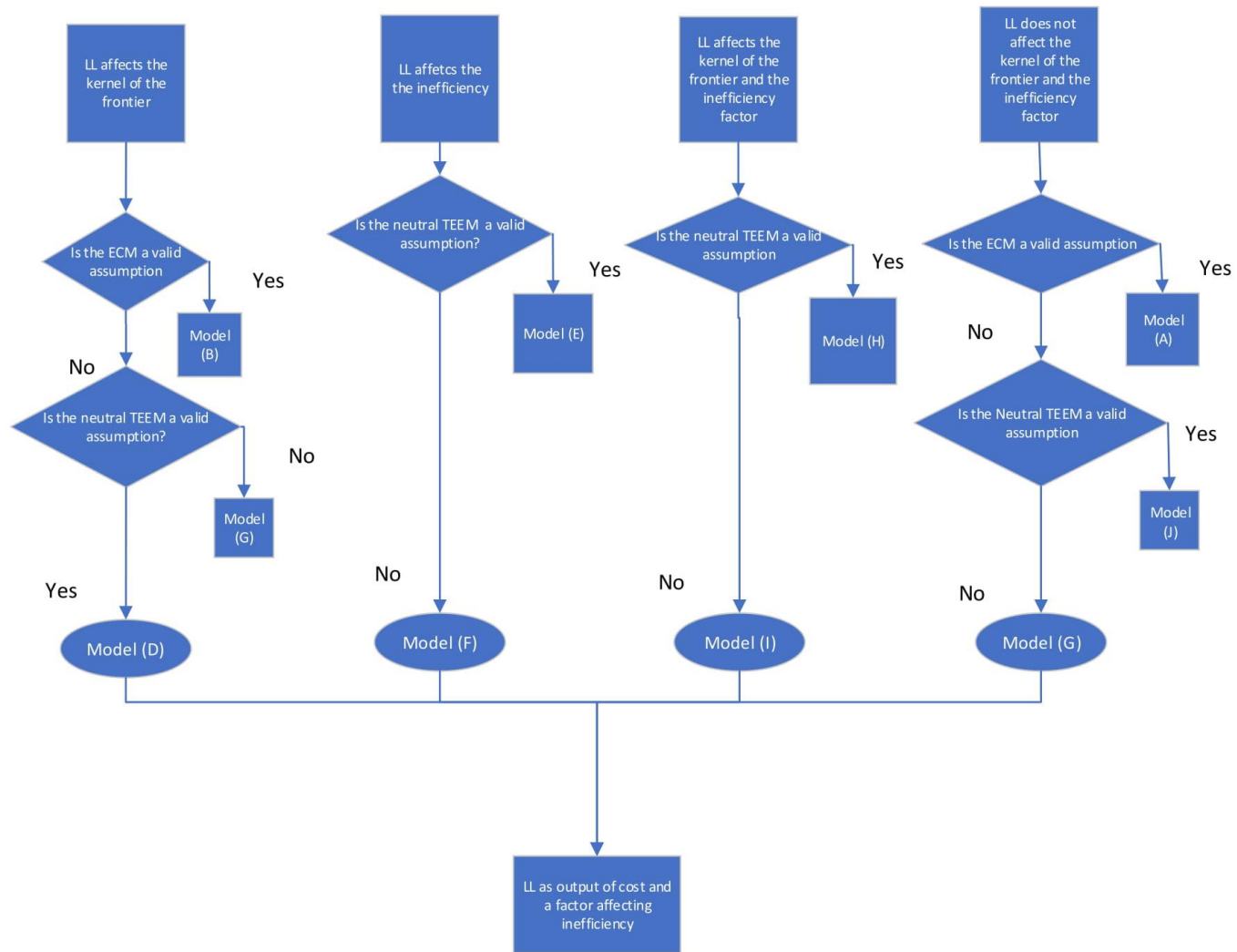


Fig 1. Model selection decision process for cost efficiency

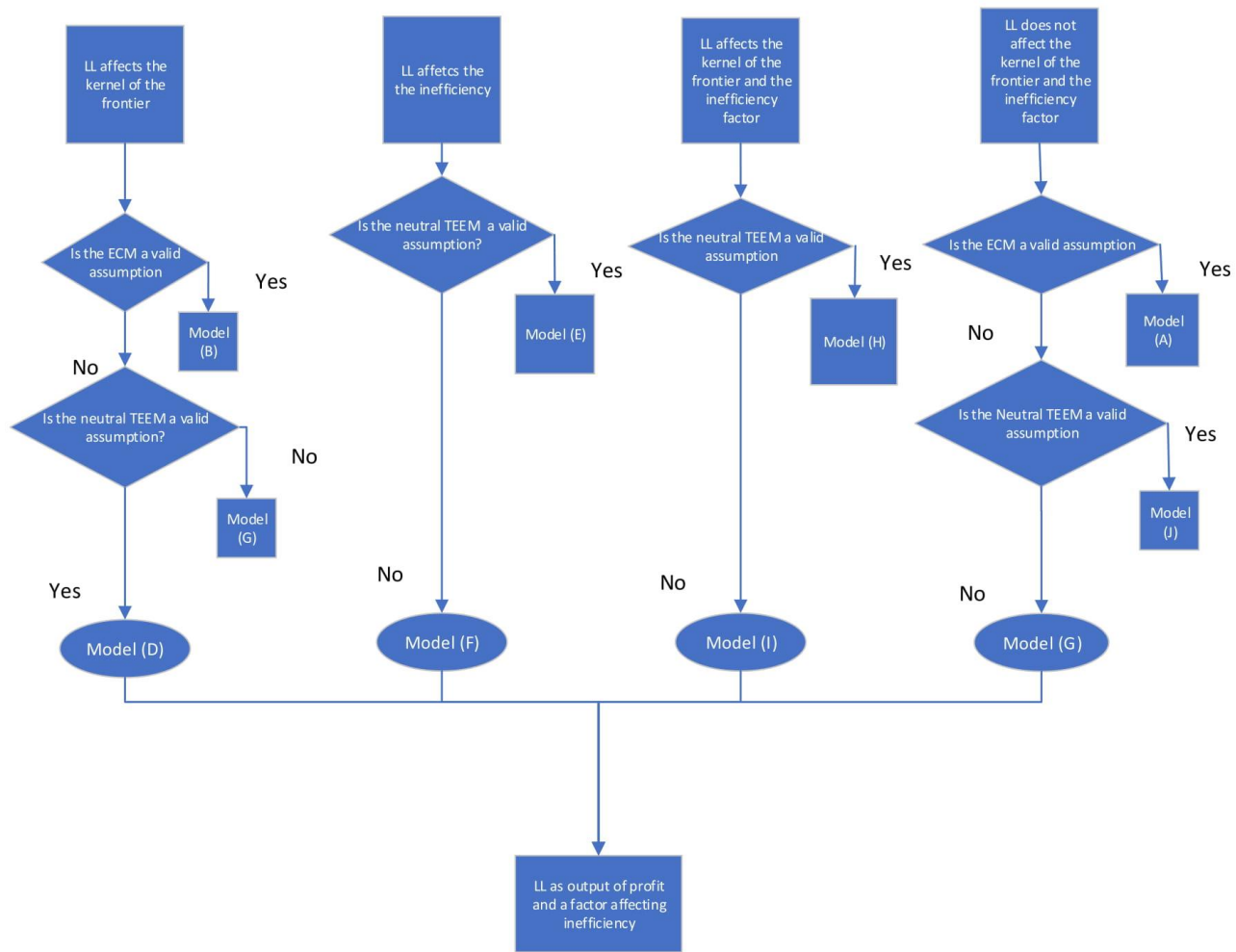


Fig 2. Model selection decision process for profit efficiency.

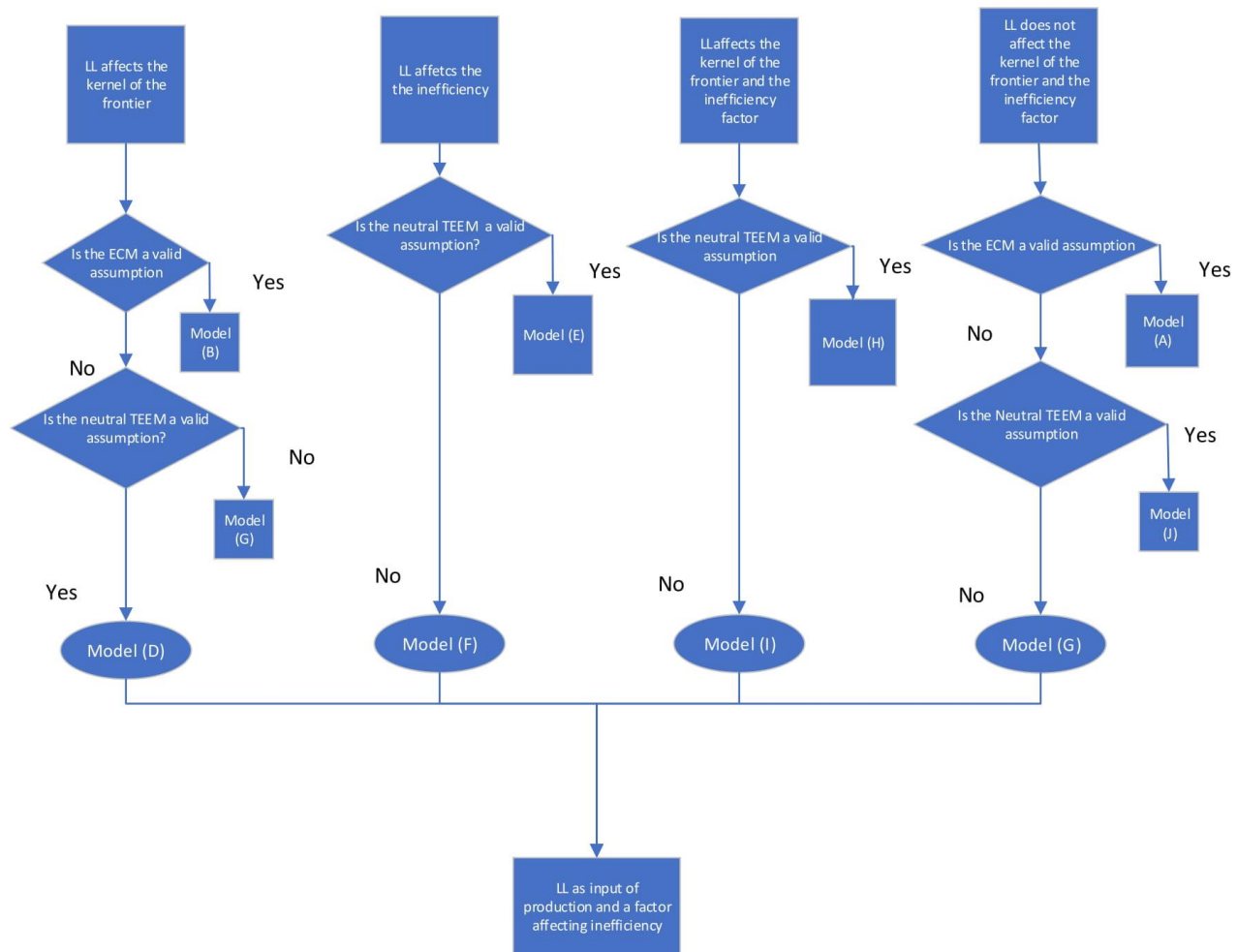


Fig 3. Model selection decision process for product efficiency.

## References

- Adedeji, Abimbola, and Richard C. Stapleton. 1996. Leases, debt and taxable capacity. *Applied Financial Economics* 6.1, 71-83.
- Aebi, V., Sabato, G., & Schmid, M., 2012. Risk management, corporate governance, and bank performance in the financial crisis. *Journal of Banking & Finance*, 36(12), 3213-3226.
- Aigner, D., Lovell, C. K., & Schmidt, P., 1977. Formulation and estimation of stochastic frontier production function models. *Journal of econometrics*, 6(1), 21-37.
- Allen, J., Rai, A., 1996. Operational efficiency in banking: an international comparison. *Journal of Banking and Finance*, 20, 665-672.
- Altunbas, Y., Liu, M.H., Molyneux, P., Seth, R., 2000. Efficiency and risk in Japanese banking. *Journal of Banking and Finance*. 24(10), 1605-1628.
- Ang, J., Peterson, P., 1984. The leasing puzzle. *Journal of Finance* 39 (4), 1055-65.
- Atanasova, C. and Wilson, N. 2001. Borrowing constraints and the demand for trade credit: Evidence from UK panel data. Mimeograph, Credit Management Research Centre, University of Leeds.
- Bartholdy, J. and Mateus, C. 2008. Taxes and corporate debt policy: Evidence for unlisted firms of sixteen European countries. Working paper, <http://ssrn.com/abstract=1098370>.
- Battese, G.E., and Broca, S.S., 1997. Functional forms of stochastic frontier production functions and models for technical inefficiency effects: a comparative study for wheat farmers in Pakistan. *Journal of Productivity Analysis* 8, 395-414.
- Battese, G.E. Coelli, T., 1995. A model for technical inefficiency effects in a stochastic frontier production function for panel data. *Empirical Economics* 20, 325-32.
- Berger, A. N., Hasan, I., & Zhou, M., 2009. Bank ownership and efficiency in China: What will happen in the world's largest nation?. *Journal of Banking & Finance*, 33(1), 113-130.
- Berger, Allen N., and Timothy H. Hannan., 1998. The efficiency cost of market power in the banking industry: A test of the "quiet life" and related hypotheses. *Review of Economics and Statistics* 80.3, 454-465
- Berger, A.N., and G.F. Udell, 1998. The economics of small business finance: The roles of private equity and debt markets in the financial growth cycle, *Journal of Banking and Finance*, 22,(6-8), 613-673.

- Berger, A. N., & DeYoung, R., 1997. Problem loans and cost efficiency in commercial banks. *Journal of Banking & Finance*, 21(6), 849-870.
- Berger, Allen N., and David B. Humphrey. 1991. The dominance of inefficiencies over scale and product mix economies in banking. *Journal of Monetary Economics* 28.1 , 117-148.
- Berlin, M., 2003. Trade credit: why do production firms act as financial intermediaries?. *Business Review*, (Q3), 21-28.
- Biais, B., & Gollier, C., 1997. Trade credit and credit rationing. *The Review of Financial Studies*, 10(4), 903-937.
- Boocock, G., & Wahab, I., 2001. The financing of small firms: different continents, the same problems?.
- Bonin, J. P., Hasan, I., & Wachtel, P., 2005. Privatization matters: Bank efficiency in transition countries. *Journal of Banking & Finance*, 29(8-9), 2155-2178.
- Boot, Arnoud WA., 2003. Restructuring in the banking industry with implications for Europe. *EIB papers* 8.1, 109-129
- Bowman, Robert G., 1980. The debt equivalence of leases: An empirical investigation. *Accounting Review*, 237-253.
- Burkart, Mike, and Tore Ellingsen., 2002. In-kind finance. *Financial Markets Group, London School of Economics, Discussion Paper* 421.
- Carter, S., & Jones-Evans, D. (Eds.), 2006. *Enterprise and small business: Principles, practice and policy*. Pearson Education.
- Cassar, G., 2004. The financing of business start-ups. *Journal of business venturing*, 19(2), 261-283.
- Chortareas, Georgios E., Claudia Girardone, and Alexia Ventouri., 2012. Bank supervision, regulation, and efficiency: Evidence from the European Union. *Journal of Financial Stability* 8.4, 292-302.
- Coelli, Tim J., 1996. *A Guide to FRONTIER Version 4.1: A Computer Program for Stochastic Frontier Production and Cost Function Estimation*. Armidale, NSW, Australia: Department of Econometrics, University of New England.
- Cook, L. D., 1999. Trade credit and bank finance: Financing small firms in Russia. *Journal of Business venturing*, 14(5-6), 493-518.
- Cunningham, R.C., 2005. Trade credit and credit rationing in Canadian firms, *Economic Analysis (EA) Research paper series catalogue* no11ff0027MIE-No.036.

Deloof, Marc, Istvan Lagaert, and Ilse Verschueren., 2007. Leases and debt: complements or substitutes? Evidence from Belgian SMEs. *Journal of Small Business Management* 45.4: 491-500.

Demsetz, H., 1973. Industry structure, market rivalry, and public policy. *The Journal of Law and Economics*, 16(1), 1-9.

Edmiston, B., 2007. *Forming ethical identities in early childhood play*. Routledge.

Eisenbeis, Robert Eisenbeis, Gary D. Ferrier, and Simon H. Kwan., 1999. "The informativeness of stochastic frontier and programming frontier efficiency scores: Cost efficiency and other measures of bank holding company performance.

Elliehausen, G. and Walken, J., 1993. An empirical investigation into motives for demand for trade credit, Federal Reserve Board Staff Study no.165

Farrell, M.J., 1957. The Measurement of Productive Efficiency. *Journal of the Royal Statistical Society Series A*, 1957, 120, 253-90.

Faulkender, M., & Wang, R., 2006. Corporate financial policy and the value of cash. *The Journal of Finance*, 61(4), 1957-1990.

Finucane, Thomas J., 1988. Some empirical evidence on the use of financial leases. *Journal of Financial Research* 11.4, 321-333.

Gilligan, Michael J., 2004. Is there a broader-deeper trade-off in international multilateral agreements?. *International Organization* 58.3, 459-484.

Golin, J., 2001. *The Bank Credit Analysis Handbook: A Guide for Analysts, Bankers and Investors*, John Wiley & Sons (Asia) Pre Ltd

Howorth, C. A., 2001. Small firms' demand for finance: A research note. *International Small Business Journal*, 19(4), 78-86.

Huang, C.J. Liu, J.T., 1994. Estimation of a non neutral stochastic frontier function, *Journal of Productivity Analysis* 15, 171-180.

Jaffe, D. and Russel, T., 1976. Imperfect information, uncertainty, and credit rationing, *Quarterly Journal of Economics* 90 (4), 651-666.

Karim, M. Z. A., Chan, S. G., & Hassan, S., 2010. Bank efficiency and non-performing loans: Evidence from Malaysia and Singapore. *Prague Economic Papers*, 2(1), 118-132.

Keeton, W.R. ,1979. *Equilibrium credit rationing*. New York and London:Garland.

Klein, Benjamin, Robert G. Crawford, and Armen A. Alchian., 1978. Vertical integration, appropriable rents, and the competitive contracting process. *The journal of Law and Economics* 21.2, 297-326.

- Klemperer, Paul., 1995. Competition when consumers have switching costs: An overview with applications to industrial organization, macroeconomics, and international trade. *The review of economic studies* 62.4, 515-539.
- Kodde, D. A., & Palm, F. C., 1986. Wald criteria for jointly testing equality and inequality restrictions. *Econometrica: journal of the Econometric Society*, 1243-1248.
- Kohler, M., Briton, E. and Yates, T., 2000. Trade Credit and the monetary transmission mechanisms, Discussion Paper, Bank of England.
- Kosmidou, Kyriaki, Sailesh Tanna, and Fotios Pasiouras., 2005. Determinants of profitability of domestic UK commercial banks: panel evidence from the period 1995-2002. *Money Macro and Finance (MMF) Research Group Conference*. Vol. 45.
- Krishnan, V. Sivarama, and R. Charles Moyer., 1994. Bankruptcy costs and the financial leasing decision. *Financial Management*, 31-42.
- Kuenzle, M., 2005. Cost Efficiency in Network Industries: Application of Stochastic Frontier Analysis. Universität Zurich.
- Kumbhakar S. C., Knox Lovell, C. A., 2000. *Stochastic Frontier Analysis*, Cambridge University Press.
- Lee, T. H., Liang, L. W., & Huang, B. Y., 2013. Do mergers improve the efficiency of banks in Taiwan?: evidence from stochastic frontier approach. *The Journal of Developing Areas*, 47(1), 395-416.
- Lensink, R., Meesters, A., & Naaborg, I., 2008. Bank efficiency and foreign ownership: Do good institutions matter?. *Journal of Banking & Finance*, 32(5), 834-844.
- Lewellen, Wilbur G., Michael S. Long, and John J. McConnell., 1976. Asset leasing in competitive capital markets. *The Journal of Finance* 31.3, 787-798.
- Love, I. Preve, L. and Sarria-Allende, V.C., 2007. Trade credit and bank credit : Evidence from recent financial crises, *Journal of Financial Economics*, 83, (2), 453-469.
- Matoušek, R., & Taci, A., 2004. Efficiency in banking: Empirical evidence from the Czech Republic. *Economics of Planning*, 37(3-4), 225-244.
- Meeusen, W., & van Den Broeck, J., 1977. Efficiency estimation from Cobb-Douglas production functions with composed error. *International economic review*, 435-444.
- Mian, S. L., & Smith Jr, C. W., 1992. Accounts receivable management policy: theory and evidence. *The Journal of Finance*, 47(1), 169-200.

Montgomery, H., Harimaya, K., & Takahashi, Y., 2014. Too big to succeed? Banking sector consolidation and efficiency. *Journal of International Financial Markets, Institutions and Money*, 32, 86-106.

Myers, S., 1984. Presidential address: The capital structure puzzle, *Journal of Finance*, 39(3), 575-92.

Myers, S.C., and Majuf, N.S., 1984. Corporate financing and investment decisions when firms have information that investors do not have, *Journal of Financial Economics*, 13(2), 187-221.

Neff, David L., et al., 1993. Measuring Inefficiencies of Individual Agricultural Banks. No. 1280-2016-102136.

Ng CK, Smith JK, Smith RL, 1999. Evidence on the determinants of credit terms used in interfirm trade. *Journal of Finance* 54, 1109–1129

Nilsen, J. H., 2002. Trade credit and the bank lending channel. *Journal of Money, credit and Banking*, 226-253.

Pilloff, Steven J., and Stephen A. Rhoades., 2002. Structure and profitability in banking markets. *Review of Industrial Organization* 20.1, 81-98.

Petersen, M. A., & Rajan, R. G., 1994. The benefits of lending relationships: Evidence from small business data. *The journal of finance*, 49(1), 3-37.

Omo, M., 2000. Determinants of trade credit in the Japanese Manufacturing sector, *Journal of the Japanese and International Economies*, 15, 160-177.

Petersen, M. A., & Rajan, R. G., 1997. Trade credit: theories and evidence. *The review of financial studies*, 10(3), 661-691.

Rajan, R. and Zingales, L., 1995. What do we know about capital structure? Some evidence from international data, *Journal of Finance*, 50, 1421-1460.

Rezvanian, Rasoul, and Seyed Mehdian., 2002. An examination of cost structure and production performance of commercial banks in Singapore. *Journal of Banking & Finance* 26.1, 79-98.

Schwartz, R. A., 1974. An economic model of trade credit. *Journal of financial and quantitative analysis*, 9(4), 643-657.

Semih Yildirim, H., and George C. Philippatos., 2007. Efficiency of banks: Recent evidence from the transition economies of Europe, 1993–2000. *European Journal of Finance* 13.2, 123-143.

Sensarma, R., 2005. Cost and profit efficiency of Indian banks during 1986-2003: a stochastic frontier analysis. *Economic and Political Weekly*, 1198-1209.

Sharpe, Steven A., and Hien H. Nguyen., 1995. Capital market imperfections and the incentive to lease. *Journal of Financial Economics* 39.2-3, 271-294.

Silva, T. C., Tabak, B. M., Cajueiro, D. O., & Dias, M. V. B., 2017. A comparison of DEA and SFA using micro-and macro-level perspectives: Efficiency of Chinese local banks. *Physica A: Statistical Mechanics and its Applications*, 469, 216-223.

Smith, J. K., 1987. Trade credit and informational asymmetry, *The Journal of Finance*, 42, (4), 863-872.

Stulz, RenéM, and Herb Johnson., 1958. An analysis of secured debt. *Journal of financial Economics* 14.4, 501-521.

Stiglitz, J.H., and Weiss A., 1981. Credit rationing in markets with imperfect information, *American Economic Review*, 71, (3), 393-410.

Tsai, D.H. and Huang, F.W., 1999. Management quality and bank efficiency: empirical evidence for Taiwanese banks, *Management Review*, Vol. 18, No. 3, pp.35–55.

Wang, H. J., & Schmidt, P., 2002. One-step and two-step estimation of the effects of exogenous variables on technical efficiency levels. *journal of Productivity Analysis*, 18(2), 129-144.

Wingborg, J., & Landstrom, H., 2000. Financial bootstrapping in small business: examining small business managers' resource acquisition behaviour. *Journal of Business Venturing*, 16(1), 235-254

Wu,W.,Rui,O.M. and Wu,C., 2011. Trade credit, cash holding and financial deepening: Evidence from a transition economy, *Journal of Banking and Finance*, 36, (11), 2668-2883.