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WORKING PAPER[‡]

" Guatemala: Banking Technology and its Characteristics. A Scale Economies Model"

by

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May 2002

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[‡] The views expressed in this paper are those of the author and do not necessarily represent the views of Banco de Guatemala.

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ABSTRACT

This study examines the Guatemalan banking technology from 1995 to 2001, in order to provide some evidence about the existence of scale and scope economies. The approach used in this paper is known in the banking literature as the "production approach" where deposits and loans (measured in money amounts) are outputs, and capital and labor are the inputs. The model specification under the production approach consists of a conventional "translog" function, where operative costs are the dependent variable.

In this research, Guatemalan banks are classified in three groups according to their market shares. Additionally, panel data techniques are applied, using both a fixed effects model and a random effects model.

The paper ends with some interesting results providing statistical evidence on the existence of scale and scope economies in the Guatemalan banking sector.

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INTRODUCTION

Banking technology can be studied in order to measure efficiency by examining the existence and extent of scale and scope economies in the banking sector. As a firm expands its scale of operations, economies of scale occur if the firm is able to reduce costs per unit of output. Scope economies exist when the cost of one firm producing a given mix of products, is less than the cost of several specialized firms producing the same bundle of products, separately.

There is an enormous literature on the estimation of banks' costs and their production functions. However, that literature identifies basically three approaches: the "production approach", the "intermediation approach", and the "modern approach".

The first two approaches apply the classical microeconomic theory of the firm to the banking system; they differ only in the specification of banks' activities. The third approach modifies the classical theory of the firm by including some specific banks' activities, namely risk management and information processing. One important issue choosing one approach or the other is the availability of the information. In fact, many countries do not have enough data to implement any approach. Many other countries focus in the two first approaches, because data required, is usually available.

In the Guatemalan case, we use the "production approach". This approach describes banking activities as the production of services to depositors and borrowers. The "outputs" of the banks are typically named services to depositors and borrowers, and the inputs are labor and capital. Using the data from Superintendencia de Bancos (the Guatemalan financial supervision agency), we are able to estimate a cost function. Monthly data from January 1995 to December 2001 is used.

A major difficulty associated to the analysis of banking technology, is the definition of output. Many empirical studies have attempted to measure banking activity by broadly categorizing output in terms of deposits and loans. Deposits are classified as demand deposits, saving deposits and time deposits. Outputs are measured in terms of nominal monetary units.

This paper examines the Guatemalan banking technology from 1995 to 2001, in order to provide some evidence about the existence of scale and scope economies. The model specification under the production approach consists of a conventional "translog" function in which operative costs are the dependent variable.

In this research Guatemalan banks are classified in four groups according to their market shares in terms of deposits size. Additionally, panel data technique is applied, using both a fixed effect model and a random effect model.

The paper is divided in six parts as follows: a summary of the conceptual framework, a description of the costs of the Guatemalan banking system, a complete model specification, an explanation about the econometric technique, the empirical results and finally the conclusions.

I. THEORETICAL FRAMEWORK

1.1 Previous studies

There is a broad literature on banking costs around the world, in order to study bank technology and bank efficiency, but the most formal studies belong to USA. Initially these studies attempted to examine costs for banks of different size in ratios that relates bank costs and their output instead of using econometric methodologies to represent cost functions.

Subsequent research studies in the area of banking costs, are distinguished by the introduction of relatively sophisticated econometric methods. These methods have their roots in production theory and are based on modeling the cost functions. Formal studies starting with Benston (1965) who marked two principal changes in methodology: (a) detailed costs that were obtained from the Functional Cost Analysis (FCA) program of the Federal Reserve System in USA, and (b) marginal costs were calculated for specific bank output. This work concludes that those larger banks may offset slight cost inefficiencies by making large loans.

Bell and Murphy (1967) followed finding evidence of scale economies. Studies made in the 1970's, principally from Murphy, Schweitzer, Longbrake's and others, observed scale economies studying bank costs in the same line.[1]

The most famous study about economies of scale in USA banking is awarded to Benston, Berger, Hanweck and Humphrey (hereafter BBHH) in 1982. This work has published a study that tests jointness in the production on bank services using a "translog model" that uses data from USA for each of the following outputs: demand deposits, time and saving deposits, real state loans, commercial loans, and installment loans. They observed that economies of scale prevailed for all the sizes of branches except the largest. Many authors followed BBHH methodology, however, recent

[1] See Kollari and Zardkoohi (1987)

studies have changed econometric methods to allow for multiple product output and potential jointness cost.

Related to studies about banking technology in Latin America stand out some works, principally in Argentina and Chile. All of these have used many cost functions in the last years. In Argentina, Baraschi (1971) and Santibañes (1975) were the first authors to study scale economies in Argentinean banking system, measuring a total product function of banks according to "lending product" j of bank i and "not lending product" k of bank i with different interest rates.[2] Rivas (1984) studied banking costs through two functional forms of costs: Cobb-Douglas and Translog forms that included variables like size of accounts and branches using Ordinary Least Squares (OLS) method. He concluded that size of account variable explains the presence of scale economies. Recent studies for Argentina show important economies of scale in banking, these results belong principally to Burdisso's work (1997) that used a data panel methodology to estimate a translog cost function.

Scale economies in Chilean banking system were measured recently by Dagnino and Zúñiga (2001) and Budnevich, Franken and Paredes (hereafter BFP) in 2001. Both included two variants of translog function. Dagnino and Zúñiga's work included a conventional translog function while BFP's work adopted a Fourier-Flexible functional form that contains two parts: a translog functional part and a Fourier truncated part. Both works found scale economies in all banks except for big ones (Dagnino and Zúñiga) and for foreigner banks (BFP).

There are no previous studies for Guatemalan banking system in order to explore the presence of scale and/or scope economies.

[2] See Feldman (1977).

1.2 Banking technology

A bank is an institution whose current operations consist in granting loans and receiving deposits from the public, the typical activities of commercial banks. This is the definition that regulators use to prevail prudential regulation for banks. On the other hand, fragility of the banks justifies banking regulations because that combination of lending and borrowing. In fact, the existence of banks is justified by their role in the process of capital allocation.

Actually, banking theory classifies banking function into four main categories: (1) offering access to a payment system, (2) transforming assets, (3) managing risk, and (4) processing information and monitoring borrowers. Universal banks will do this, but specialized banks won't.

According to Kim (1986) "...a fundamental difficulty associated to the study of banking technology and its characteristics (e.g. scale and scope economies) is the specification of an appropriate measure of output". Since banks produce several and different services (outputs) it is very difficult to allocate banking costs to all those services. As a result, researchers have identified three basic approaches: (a) production approach, (b) intermediation approach, and (c) modern approach. Each one targets a specific segment of the bank's activity.

The first approach relates to the role played by the banks as asset transformers (production approach). The second approach refers to the nature of the liabilities issued and their central function in a monetary economy (intermediation approach). Finally, the third approach views banks like risk takers and their costs are in function of it.

The cost function must be estimated to study banking technology. When a firm is maximizing its benefits, it must at the same time, be efficiently related with costs; it means, a firm should operate with minimum average costs and an optimal combination of products.[3]

1.3 Costs and scale economies

Assuming a cost minimizing behavior, econometrically this allows the estimation of the cost structure and characteristics of the underlying production structure.

The short run multi-product variable cost function can be written as follows:

$$C = C(z,w,f)$$

where C is a minimal short run variable cost, z is a vector of outputs, w is a vector of variable input, and f is a vector of fixed input, exemplified by capital.[4]

In banking, the operative costs are very important since their target to minimizing costs is, at the same time, maximizing benefits. On the other hand, it is convenient to show that operative costs are only related with banks like producers of different services, while the financial cost seems related to the analysis of profitability and credit allocation policies. From this point of view, the operative costs are important for a banking firm like multi-service producers.

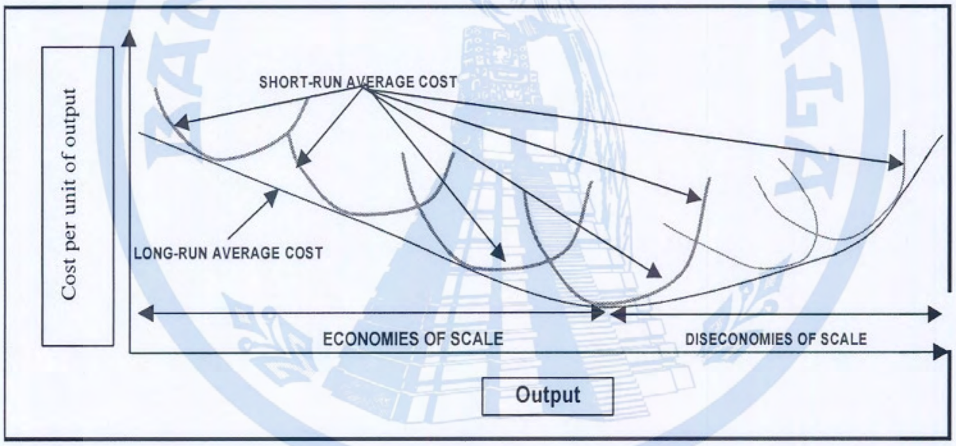
A simple way to justify the existence of banks, is to emphasize the difference between their inputs and their outputs. According to production approach, inputs like labor (number of employees) and capital (size of the plant), are necessary to produce banking products (outputs). Clearly it needs to minimize costs while maximizes benefits. In this context, the distinction between flow and stock variables is very important. In that sense, capital is a stock variable while labor is a flow variable, in the short-run, but in the long-run both inputs are variable. Because of this, when a

[3] See Burdisso (1997)
[4] See Hancock D. (1991).

banking firm is expanding its plant size and increasing production, cost average must fall. This is directly associated with scale economies.

Scale economies in production for a firm, imply that average cost falls as output and/or size of the plant is increased. This is shown by a fall in the long-run average cost curve (LRAC) of the firm (figure 1.3.1). The curve of long-run average cost is the encircling of the curves of average short-term cost. The short-term average costs are at least as high as the average long-term costs and both are same in the production level in which the long-term demand of fixed input is similar to the quantity that we have of this factor.[5]

Figure 1.3.1
Economies and diseconomies of scale



Scale economies are attributable to technological efficiencies resulting from increasing the plant size and are associated to greater specialization and labor division.[6]

[5] See Varian H. (1992)
[6] See Standford (2001)

The success of scale economies is to achieve the lower minimum point in the short-run average cost curve (SRAC) as the firms expand the range of their operating capacities and trace out a tangential minimum LRAC. LRAC is, in its ideal form, a broadly U-Shaped curve,[7] but may exhibit a variety wide on this theme.

"Economies of scope" are economies due to multi-product or multi-service production. For example, if a bank produces two goods, Q1 and Q2, scope economies are present if the average cost of producing goods jointly, is less than the average cost of producing them separately. Technological changes can either provide greater or lesser potential for economies of scope.

[7] It means that we can observe in a curve economies of scale, constant economies of scale, and diseconomies of scale.

II. AVERAGE COSTS IN GUATEMALAN BANKING SYSTEM

2.1 Banking structure in Guatemala

The formal financial sector (regulated) in Guatemala is conformed by institutions whose authorization is of state character, in a case by case approach, and it is subject to the supervision of the Superintendencia de Bancos. This sector embraces a bank system and non-banking institutions. The first one includes commercial banks and financial societies; these last ones, defined by law as institutions specialized in operations of banking investment (they do not capture deposits and their active operations are of long-term). On the other hand, the non-banking system is ruled by specific laws and it is conformed by the general warehouses of deposit, insurance companies and foreign exchange offices (bureau of exchange).

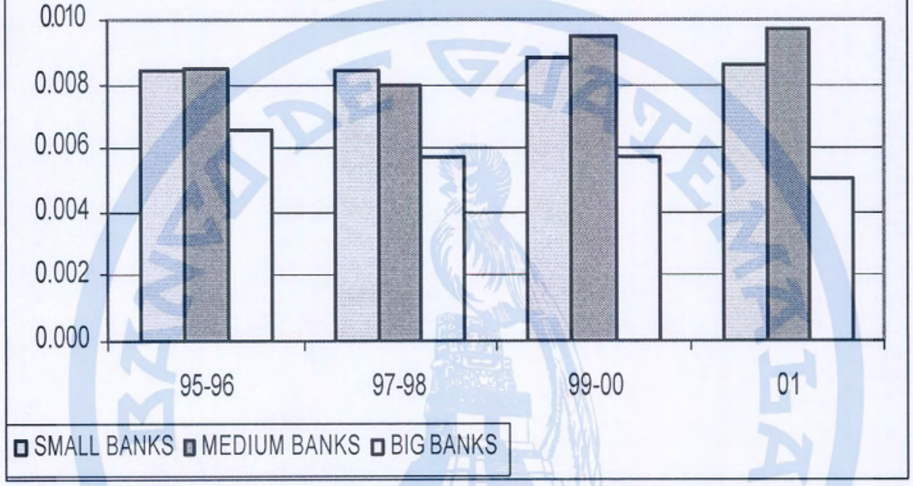
Guatemalan banking system has a total of 31 banks (4 of which are of recent mergers) and 93% of deposits from the total of formal financial sector.

2.2 Costs evolution

Banks have been classified into small, medium and large ones, under the approach of their market participation in terms of deposits sizes. It is observed a marked difference between banks which corresponds, to the small and medium groups, regarding large group, the later presents a less average costs than the first ones (Figure 2.2.1).

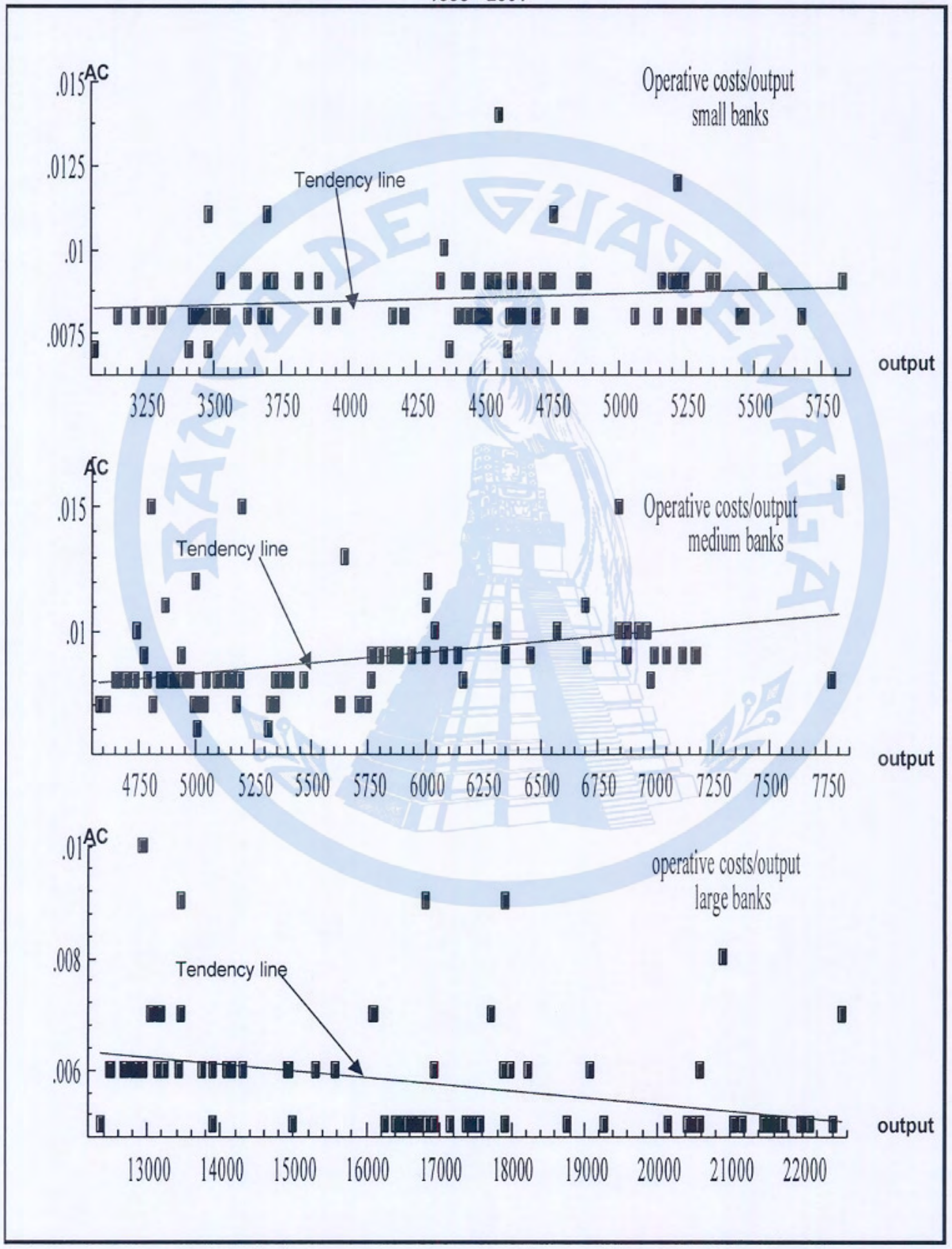
It can be observed across the period of analysis, that unitary cost of the group of large size banks has been substantially under that of the groups of small and medium banks while the evolution of the unitary cost among these last ones has been similar. On the other hand, unitary cost in the large banks shows a declining tendency, contrary to the observed tendency in group of small and medium ones, where unitary cost goes upwards.

Figure 2.2.1
Average evolution of unit costs
Operative costs / output
1995 - 2001



It can also be observed in Figure 2.2.2 where average costs (AC) in small and medium size banks present a slight growth trend when product is adding. In the opposite side, big banks group shows a downward trend when product grows.

Figure 2.2.2
Average costs (AC): operative costs/output
1995 - 2001



III. MODEL SPECIFICATION

3.1 Production Approach

The approach selected is known in banking literature as "production approach". This approach responds to contributions of Benston (1965) and Bell and Murphy (1968). It describes basically the activity of banking as the production process of services to depositors and borrowers. In this sense, the only outputs are the services to depositors and borrowers, and its only inputs are labor and physical capital.

The production approach recognizes the multi-product nature of banking activities. According to different authors the appropriate measure for output in this approach is amounts of money.[8]

A natural extension of this approach is, therefore, the use of a multi-product cost function, that will be developed later, in order to test the measures of scale and scopes economies.

3.2 Defining output

An important issue to model costs is the definition of the well measure of output. According to Kolari and Zardkoohi (1987), there are theoretical reasons to select the output: first, the cost of an additional monetary unit of both, small and large accounts, should be the same. In this sense, the use of number of accounts could present some degree of confusion to interpret the results; second, the use of number of accounts instead of amounts of money may well lead to a biased estimation of model coefficients (because of multicolinearity); third, bankers prefer larger amounts per account because it is more easily handled than very small accounts; fourth, bank costs could be overestimated or underestimated only using the number of accounts (see appendix 1); fifth, banks compete to increase market share, as opposed to the number of accounts. As above suggested, the use of number of accounts presents a problem,

[8] See Benston, Hunweck, and Humprey (1982)

because it implies existence of equal cost per account across different kinds of accounts. It presents an inconvenient which makes it questionable, because the existences of different kinds of accounts, demand deposit accounts, for instance, may be more active and thus more expensive to maintain than time deposits accounts; and so forth.

In this work it is preferred to use values in quetzals (Guatemalan currency) as the measure of output to correct all problems mentioned above, because the data is statistically available and perfectly handled.

3.3 Translog approximation model

Recent works have changed econometric methods, allowing the estimation of a multi-product output and potential jointness cost function. A significant advance over the constant elasticity of substitution production function (CES) is the "translog" production function developed by Christiansen, Jorgensen, and Lau (1973). The "translog" production and cost functions overcome all the problems associated with Cobb-Douglas and CES models.[9]

"Translog" function allows estimation of production (or cost) with more than one output and more than two inputs. More important, "translog" models allow estimation of U-shaped cost curves.

Applying the duality properties, "translog" cost functions are obtained by a Taylor series expansion around a specific point of a generalized log-linear cost function of the form

$$\text{Ln } C = f(\text{Ln}Q_1, \text{Ln}Q_2, \text{Ln}P_1, \text{Ln}P_2) \qquad (3.3.1)$$

[9] For details about it, see L.R. Christiansen, D. W. Jorgensen, L. J. Lau, "Transcendental Logarithmic Production Frontiers". Review of Economics and Statistics. 55 (February 1973): 28-45.

where Qi (i=1,2) are the quantities of products produced by the firm and Pi (i=1,2) are the prices of two input factors.

Following Kolari and Zardkoohi (1987) the following "translog" cost function for the case of this research is a log-linear quadratic local approximation to the arbitrary multi-product cost function specified in equation (3.3.1) around a point of expansion:

$$LnOC = \alpha_0 + \alpha_1 LnDEP + \alpha_2 LnLOA + \frac{1}{2}\phi_{11}(LnDEP)^2 + \frac{1}{2}\phi_{22}(LnLOA)^2 + \phi_{12}(LnDEP)(LnLOA) + \beta_1 LnP_K + \beta_2 LnP_L + \frac{1}{2}\gamma_{11}(LnP_K)^2 + \frac{1}{2}\gamma_{22}(LnP_L)^2 + \gamma_{12}(LnP_k)(LnP_L) + \rho_{11}(LnP_K)(LnDEP) + \rho_{12}(LnP_K)(LnLOA) + \rho_{21}(LnP_L)(LnDEP) + \rho_{22}(LnP_L)(LnLOA) \quad (3.3.2)$$

where,

Ln = natural logarithm

OC = Operative costs

DEP = Amount of deposits in thousands of quetzals

LOA = Amount of loans in thousands of quetzals

P_K = Capital price

P_L = Labor price

By symmetry $\gamma_{12} = \gamma_{21}$ and $\phi_{12} = \phi_{21}$

Duality conditions require that the cost function be linearly homogeneous in prices, or,

$$\frac{\partial LnOC}{\partial LnP_K} + \frac{\partial LnOC}{\partial LnP_L} = 1 \quad (3.3.3)$$

Which, in turn, requires the following restrictions on the parameters of function (3.3.2):

$$\beta_1 + \beta_2 = 1 \quad (3.3.4a)$$

$$\gamma_{11} + \gamma_{12} = 0 \text{ and } \gamma_{22} + \gamma_{21} = 0 \quad (3.3.4b)$$

$$\rho_{11} + \rho_{21} = 0 \text{ and } \rho_{22} + \rho_{12} = 0 \quad (3.3.4c)$$

Some researches[10] have suggested that an appropriate measure of scale economies (SE) in a multi-product case is the sum of the individual output elasticities, as follows:

$$SE = \sum_{i=1}^{n} \frac{\partial LnOC}{\partial LnQ_i} \quad , \quad \text{for n = 1,2 products} \qquad (3.3.5)$$

where,

SE < 1 $\Rightarrow$ evidence of scale economies

SE = 1 $\Rightarrow$ constant returns to scale prevail

SE > 1 $\Rightarrow$ evidence of scale diseconomies

For this research SE come given by:

$$SE = \frac{\partial LnOC}{\partial LnDEP} + \frac{\partial LnOC}{\partial LnLOA} = S1 + S2 \qquad (3.3.6)$$

Developing S_1 and S_2 respectively, we have,

$$S_1 = \alpha_1 + \phi_{11} LnDEP + \phi_{12} LnLOA + \rho_{11} LnP_K + \rho_{21} LnP_L \qquad (3.3.7)$$

$$S_2 = \alpha_2 + \phi_{22} LnLOA + \phi_{12} LnDEP + \rho_{12} LnP_K + \rho_{22} LnP_L \qquad (3.3.8)$$

Respect to scope economies, following Zúñiga and Dagnino (2001),

$$\frac{\partial^2 Ln(OC)}{\partial Ln(DEP) \partial Ln(LOA)} = \phi_{12} < 0 \qquad (3.3.9)$$

[10] See for example Dagnino and Zuñiga (2001) and Burdisso (1997)

It means, ϕ_{12} coefficient is a first order condition. This condition is not enough, therefore, it must require that,

$$\phi_{12} + \alpha_1 * \alpha_2 < 0 \text{ (sufficient condition)} \qquad (3.3.10)$$

where,

ϕ_{12} = parameter of two products combination
$\alpha 1, \alpha 2$ = parameter for each individual product

3.4 Data and data construction

Data comes principally from the Superintendencia de Bancos (SB) monthly statistical bulletins. Data belongs to thirty-one banks organized into three groups of banks (small, medium and large banks) from 1995 to 2001.[11] The sample includes only banks that were created before 1995. There are four banks recently created, although these banks are relatively of small size, the reason for not including those in the sample, is due to incomplete data.

In regard to the variables, total operative costs (OC), are equal to the sum of salaries, benefits, occupancy expense, and other expenses. Deposits are the sum of amount of demand deposits, saving deposits, and time deposits. Loans are the amount of different types of loans, according to the balance sheet of each bank. The price of capital, P_K, is defined as the ratio of occupancy expense to total of branches (the measure of plant size) like the opportunity cost of the capital. The price of labor, P_L, equals to salaries plus benefits divided by number of employees. All variables are measured in terms of thousands of quetzals. The nominal variables were deflated

[11] The criteria for bank classification by groups is the size of market according with deposit amounts in quetzals reported by SB.

with Price Consumer Index (PCI) and stock variables represent balances at the end of each month.

IV. ECONOMETRIC TECHNIQUE

The econometric technique used in this research, is known in the literature as "panel data" or "longitudinal group." This technique is able to analyze statistical data that combines time series with cross section data. It allows researchers to classify economic effects that cannot be distinguished by themselves with the use of cross section or time series separately. According to Pindyck and Rubinfeld (2001) the use of panel data has two important advantages: (1) the groups of panel data, in general, provide an increased number of data, which generates additional freedom degrees; and (2) to embody variables with cross section and time series can diminish, in a considerable way, situations that arise when a problem of omitted variables exists.

4.1 Simple OLS technique

The first technique with the use of panel data simply combines all data of time series with that of cross section, and then the underlying pattern is estimated using OLS.

Now, it is possible to considerate a model with two variables:

$$Y_{it} = \alpha + \beta X_{it} + \varepsilon_{it}, \quad i = 1,2,...,N \text{ and } t = 1,2,...,T \qquad (4.1.1)$$

where, N is the number of units of cross sectional data (individuals) and T is the number of periods.

If it is assumed that the classic error term is completed, separated regressions with cross sectional data can be considerated, with regression implying N observations. For example, for period t = 1 the following regression can lead:

$$Y_{i1} = \alpha + \beta X_{i1} + \varepsilon_{i1} \qquad i = 1,2,...,N \qquad (4.1.2)$$

Therefore we have N number of equations of this type. In the same way, it can be estimated N time-series regressions can be estimated with a number T of observations each. However, the combination of NT observations, can lead to obtain efficient parameters.

Certain degree of homogeneity exists among the individuals of the cross section analysis and through the time, series analysis which is not completely correct in some cases, because heterogeneity could be present. Derived of that, variants like "fixed effects" or "random effects" will be necessary.

4.2 Fixed effects variant

A well-known variant like "fixed effects" arises of the idea that the intercept for each one of the individuals is not fixed, neither in the cross section as in the time series.

To correct this problem the literature of panel data introduces indicative variables that lead intercept term changes across time and individuals. The fixed effects model can be written as follows:

$$Y_{i1} = \alpha + \beta X_{i1} + \gamma_2 W_{2t} + \dots + \gamma_N W_{Nt} + \delta_2 Z_{i2} + \delta_3 Z_{i3} + \dots + \delta_T Z_{iT} + \varepsilon_{i1} \qquad (4.2.1)$$

where,

$$W_{it} = \begin{cases} 1 \text{ for an i-individual, } i=2,\dots,N \\ 0 \text{ in any other case} \end{cases}$$

$$Z_{it} = \begin{cases} 1 \text{ for a t-period, } t=2,\dots,T \\ 0 \text{ in any other case} \end{cases}$$

4.3 Random effects variant

Another variant is known in the panel data literature as "random effects". It improves the estimate for OLS, explaining the interference of cross sectional and time series. It corresponds to a variant of the estimate process for GLS. However, it is restricted to a certain number of variables that never surpass the number of individuals.

To introduce an indicative variable could be an indication of a natural lack of knowledge about the model that can be described through error term. It has to be selected a cross-section and time series model in which the error term could correlate across time and individuals. It can be written as follows:

$$Y_{it} = \alpha + \beta X_{it} + \varepsilon_{it} \qquad (4.3.1a)$$

$$\varepsilon_{it} = u_i + v_i + \omega_{it} \qquad (4.3.2b)$$

where,

$u_i \sim N(0, \sigma_u^2)$ = error component of cross section

$v_i \sim N(0, \sigma_v^2)$ = error component of time series

$\omega_{it} \sim N(0, \sigma_\omega^2)$ = combined error component

V. RESULTS

The results correspond to a sample of 24 banks for each year for the 1995-2002 period (Table 1). Estimates were obtained using a translog function with panel data technique. Estimates of overall economies of scale (SE) and scope economies (SCE) are constructed from the parameter estimates.[12]

Table 1

Group	Data panel model	S_1	S_2	ϕ_{12}	$\alpha_1 * \alpha_2$	SE	SCE1	SCE2	R^2
Small banks	Random effects	-0.193	1.326	0.09	-0.4736	1.519	0.09	-0.04262	0.85
Medium banks	GLS	-2.488	3.256	0.009	-9.551008	0.768	0.009	-0.08596	0.99
Large banks	OLS	1.26	-0.994	1.012	-6.300948	0.266	1.012	-6.37656	0.72
Medium + large	OLS	6.116	-5.987	0.688	-44.612991	0.129	0.688	-30.6937	0.67
System	Random effects	-1.334	1.239	0.008	-2.167444	-0.095	0.008	-0.01734	0.90

SCE1= First condition for scope economies
SCE2= Sufficient condition for scope economies

According to the results, important diseconomies of scale were found for smaller banks (SE>1), few economies of scale for medium banks, and important economies of scale for larger banks (SE<1). In addition, the weights SCE2 suggest important economies of scope for all groups of banks. The same situation is observed when scale economies of the banking system are tested.

On the other hand, it proved the economies of scale were tested by adding medium and large banks, the results observed indicate that the incorporation of big banks to the medium size banks group, it resulted in an improvement of scale economies.

[12] Parameter estimates are available from the author upon request.

It is very important to notice that the results described above suggest strong influence of big banks in the overall banking system.

VI. CONCLUSIONS

1) This work estimates a cost function for Guatemalan banking system, derived from the use of the econometric technique of panel data, in order to capture not observable heterogeneity. This wouldn't had been possible with cross section or time series separately. The criterion to select distinct variants of data panel (OLS, GLS, fixed effects, and random effects) was the number of individuals in each group because there is a restriction when the number of variables surpasses the number of individuals in a random effect technique.

2) Through this work, important differences in levels and in trend for average costs have been found across the different bank groups before estimations were made. They reinforce the idea of measuring scale economies for each group of banks.

3) Important economies of scale in large banks were found, as well as a few economies of scale in medium banks and important diseconomies in small banks. These results, suggest the idea that big banks are operating, in average, in the declining area of their long-term average cost curve. On the other hand, the group of medium banks is operating close to the constant returns of the long-term average cost curve. Finally, it is inferred that the group of small banks is operating in the increasing portion of its long-term average cost curve.

4) When large banks and medium banks were put together, the results observed indicate more important scale economies than those calculated for medium and large banks separately. However, when scale economies were calculated for the whole banking system, the results obtained showed a substantially smaller coefficient of less than one that indicates the existence of important scale economies. This result comes to reinforce the strong influence of large banks.

5) Scope economies were found in each individual group, in the consolidated group, and in the banking system, as well.

6) As a final result, it is inferred that for the banking system as a whole, the group of lager banks is the only one that is operating efficiently in its average cost curve and it exerts a strong influence over the rest of the banking system in Guatemala.

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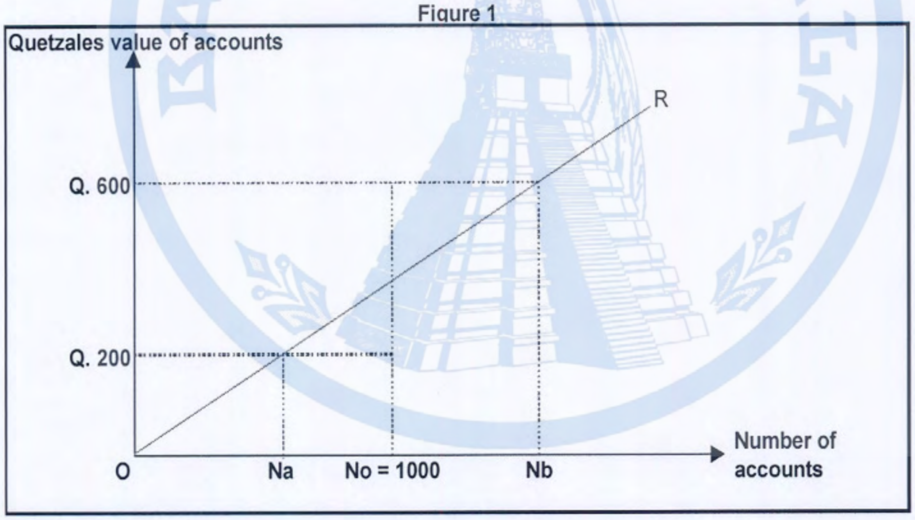
Appendix 1

Underestimation and overestimation of output with number of accounts

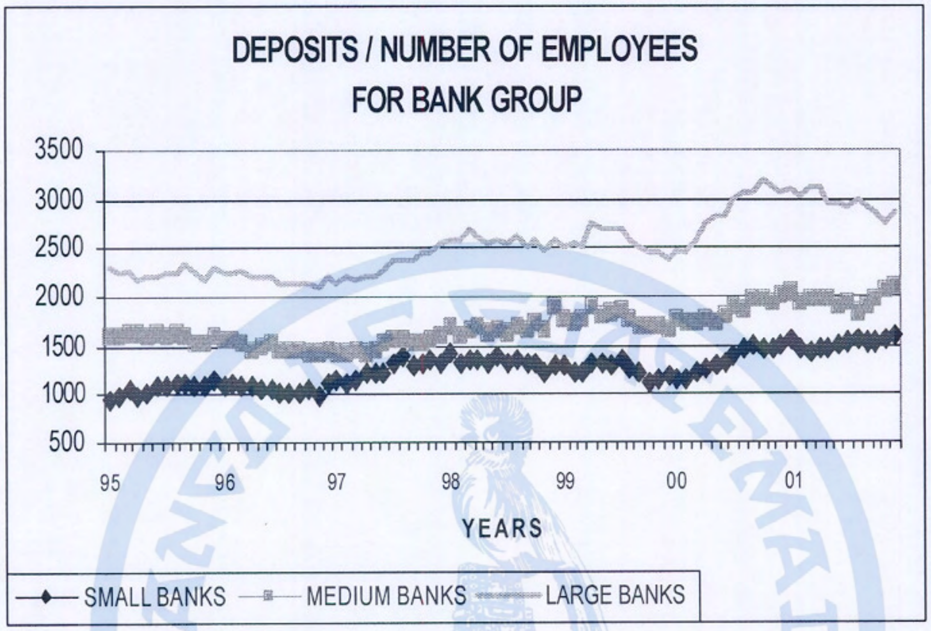
Following Kolari and Zardkoohi, figure 1 illustrates a potential bias using the number of accounts as a variable. Bank A and bank B are assumed to have 1,000 deposit accounts each. The average sizes of accounts in banks A and B are Q.200 and Q.600, respectively. The line OR shows a hypothetical regression line between size of accounts and number of accounts. If operative costs depend on the number of accounts, bank B would be larger than bank A, but they would have the same operative cost. Since operative expenses per unit asset are relatively lower for bank B than for bank A, bank A should increase its account size to be competitive with bank B.

Figure 1



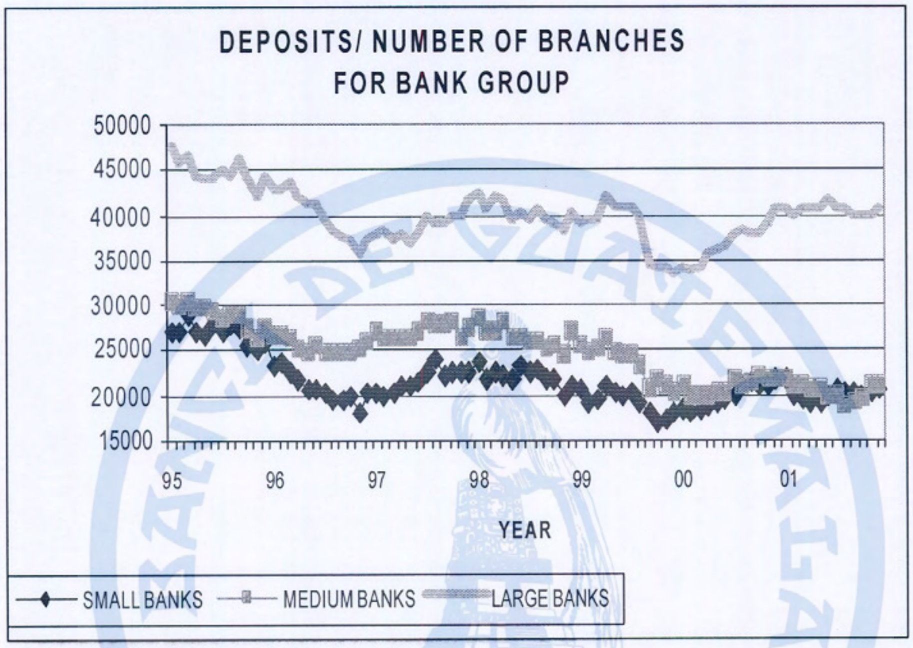
Since the number of accounts considers large and small accounts as equals, bank activities to attract and service large accounts will be underestimated by the cost function leading to biased estimated parameters. In Figure 1 the segment **No Nb** approximates the number of accounts which bank underestimates B's activities in serving and attracting a large account. Conversely, the segment **No Na** approximates the number of accounts by which bank A's activities when serving and attracting a small account are overestimated.

Appendix 2



DEPOSITS / NUMBER OF EMPLOYEES
FOR BANK GROUP
3500
3000
2500
2000
1500
1000
500
95
96
97
98
99
00
01
YEARS
SMALL BANKS
MEDIUM BANKS
LARGE BANKS

Appendix 3



DEPOSITS/ NUMBER OF BRANCHES
FOR BANK GROUP
50000
45000
40000
35000
30000
25000
20000
15000
95
96
97
98
99
00
01
YEAR
SMALL BANKS
MEDIUM BANKS
LARGE BANKS