Revista de Análisis Económico, Vol. 10, N° 1, pp. 71-99 (Junio 1995)

MEASURES OF COST ECONOMIES IN CHILEAN BANKING:1984-1991*

BHARAT B. NAURIYAL
The World Bank**

Abstract:

This paper presents measures of cost economies in Chilean banking following the many regulatory and structural changes implemented by Chilean authorities in the aftermath of the 1981-83 financial system crisis. Utilizing panel, and annual cross section monthly data on 37 individual banking institutions in operation over 1984-91, a translogarithmic cost specification is adopted to estimate economies of scale and scope. My findings suggest the presence of persistent and significant economies of scale. Weaker evidence on the presence of economies of scope is also detected. These findings are of additional importance as the estimation methodology adopted overcomes an inherent flaw in most other similar studies that lump together different sizes of financial institutions for a cross sectional analysis over a one or two year period.

I. Introduction

Since the pioneering efforts of Benston (1965) a significant compilation of research has been accumulated on the subject of cost economies in banking. Gilbert (1984), and Clark (1988), present good reviews that trace the evolution of this literature. Mester (1987), includes a succint elucidation of some of the conceptual and

* The author would like to thank two anonymous referees for their comments on an earlier draft while assuming sole responsibility for any remaining errors.

** The findings, interpretations, and conclusions herein are solely those of the author and should not be attributed to the World Bank, its Board of Directors, its management, or any of its member countries.

econometric deficiencies in these studies. There are two notably distinct features in this literature on economies of scale and of scope in banking. First, the U.S. and Canadian banking industries dominate as the subject of these investigations. Published studies on banking systems in developing countries, on this topic, are especially rare[1]. Second, all of these studies comprise a cross sectional analysis utilizing aggregative industry level data. As Humphrey (1987) noted, an implicit assumption is thereby made that all banks in the sample lie on the same average cost curve, (a) over time and, (b) across different sized banks at one point in time. As he further notes:

> "Over time, as interest rates fluctuate, the cost curve can experience large changes in its slope. Such changes lead to quite different scale or cost economy measurements at different points in time. Thus results based on cross sections of banks for one year may not generalize well to all bank size classes. This is because different sized banks can experience significantly different cost economies. Hence looking at all banks together for even a single year, which is the method used in almost all studies, is only weakly justified and should be tested before such results are relied upon" (Humphrey (1987), page 24).

This paper presents findings of my investigation into operational efficiency in the banking system of Chile. The methodological approach adopted in the paper is fully recognizant of the caveat by Humphrey (1987) quoted above. Appealing to duality theory, Chilean banking institutions are modelled as multi-product firms. Utilizing panel monthly data on each individual banking institution in operation over 1984-91 (as opposed to cross sectional, aggregative industry data), a translogarithmic cost function specification is adopted to estimate economies of scale and of scope for seven distinct groups into which the thirty seven banking institutions could be disaggregated (very small, small, medium, large, domestic, and foreign banks and sociedades financieras). Further, with the aim of making my analysis somewhat comparable to other similar studies, and to observe operational efficiency over time, annual cross sectional analysis of costs for all banking institutions for each of the eight years, is undertaken as well. Evidence of persistent and significant economies of scale in the operations of Chilean banking institutions is found though the findings on economies of scope are not as consistent and uniform. In addition, tests of specialized alternative production technologies revealed that the hypothesis of non-jointness in production could not be rejected for one of the seven groups of banks. Most importantly, the findings here reinforce the view that for regulators and policy makers, relying on studies of cost economies that lump together different sizes of financial institutions for a cross sectional analysis over a one or two year period, may be misleading.

The paper unfolds in six sections. Section II provides the motivation for the analysis and very briefly reviews the Chilean financial system, the 1981-83 financial crisis, and the reforms and regulatory changes implemented in the aftermath of the crisis. This is followed in section III with the analytical framework. Section IV describes the data and estimation techniques. Empirical findings are discussed in section V, and section VI concludes.

II. Background

The advantage of one type of financial institution over another in terms of efficiency is most often predicated on their ability to exploit economies of scale and of scope in the provision of a myriad of financial services, information gathering, and risk management. *Economies of scale* refer to a reduction in per unit costs of output as a firm expands its scale of operations holding all other factors constant. *Economies of scope* refer to the cost savings that arise from the production of say m outputs by the same enterprise, rather than the production of each of those m outputs by different specialty firms.

If economies of scale exist, financial institutions that operate at a small scale would be at a cost disadvantage compared to the larger established ones. If economies of scope exist, specialized financial institutions would be at a cost disadvantage, and regulations that aim to restrict activities of financial institutions, and the outputs they produce, may contribute to inefficiency in the system.

While the quality, and relative ease of availability of the requisite data significantly influenced the choice of the Chilean banking system as the subject of this study, the above mentioned issues in the specific context of the Chilean banking system reinforce the motivation underlying the study. The numerous structural and regulatory changes implemented in the aftermath of the 1981-83 Chilean banking system crisis provide an opportunity to examine the impact of these changes on the operational efficiency of the Chilean banking system. For instance, as a result of these regulatory reforms, Chilean banks have been facing increasing competition in the provision of financial services from other institutions that have only recently come on the scene such as pension funds, leasing agencies, and brokerage firms. As the size of their market shrinks, Chilean banks must pay increasing attention to their cost efficiency to maintain or enhance their competitiveness.

Some background information on the Chilean banking system will serve to further underscore the motivation for this study. The years 1973-74 mark a new era in the history of the Chilean economy. With liberalization as the new orthodoxy in matters of economic policy, widespread reforms encompassing all sectors of the economy were implemented in an effort to restructure the Chilean economy along a free market orientation.

After a brief episode of rejuvenation over 1977-80, the Chilean economy struggled to cope with its second severe recession since the reforms[2]. To make matters worse, the 1982 recession was accompanied by a massive crisis in the financial system as well. Over 1981-83, 19 institutions with a 60 percent share in the financial system's total loan portfolio were intervened or liquidated. To prevent the system from collapsing, a massive bail out effort was undertaken by the central bank that entailed a transfer of resources to the private sector to the tune of U.S $6 billion, or 23.6% of Chile's 1989 GDP[3].

In addition, as part of the regulatory overhaul, a distinct move towards multipurpose financial institutions was encouraged via the relaxation of restrictions on the types of operations that the various heretofore highly specialized institutions were allowed to undertake. The intended objective of this policy was to stimulate competition and to provide institutions the opportunity to exploit economies of scale and of scope in their banking operations. The objective of this paper is to empirically assess if indeed Chilean banking has, over the period 1984-91, been successful in exploiting such cost economies.

III. Modelling bank production: A multiproduct cost function framework

There has evolved a strong consensus in banking research that applies firm theoretic models, about the need to explicitly recognize the multiproduct nature and jointness in production of the banking firm[4]. A multiproduct cost function is appropriate to model banks, since these institutions provide a number of services, and not just a single product or service. Further, such a function is capable of expressing jointness in production where inputs are shared to produce several outputs. For instance, many services that banks provide, such as clearing checks, accepting deposits, withdrawing money, share the same personnel, office and computer facilities. There is also joint use of information by different departments within the bank. Consequently, a banking firms production technology, can be appropriately represented by a transformation function:

$$F(Q; X) = 0, \qquad (1)$$

where $Q = (q_1, ..., q_m)$ is an m-dimensional vector of bank output levels, and $X = (x_1, ..., x_n)$ is an n-dimensional vector of quantities of variable inputs. In general, the production technology embodied in (1) is not observable.

A multiproduct cost function, C (Q,W) is the minimum total cost of producing the output bundle Q, given the n-dimensional vector of input prices W. McFadden (1978) has shown that if F has a strictly convex input structure, then there exists a unique multiproduct cost function:

$$C = C(Q,W) = \min W'X, \qquad (2)$$

where $W = (w_1, ..., w_n)$ is an n-dimensional vector of input prices[5].

When these conditions are met, C (Q,W) is well defined, irrespective of the functional form of F and there is a one to one correspondence between the production possibility set and the cost structure i.e., C (Q,W) is dual to F (Q, X). Phrased differently, all the information needed to obtain the corresponding cost function is contained in the production function and the converse also holds true.

Economic theory does not provide any explicit algebraic specification of the functional form to best estimate a firm's costs. As a result one of the most contentious issues regarding the appropriate methodology to evaluate bank costs pertains to the specification of the functional form that F in (1) takes - specifically, what restrictions are appropriate to impose so that it represents a realistic banks production technology? Evidence of this can be found in the various specifications that have been adopted by researchers in the reviews of studies on this topic, mentioned earlier. With developments in theory, econometric techniques, and computer technology, a wide consensus now exists that the translogarithmic specification provides the most promising approach.

In its most general form, the translogarithmic specification provides a second-order approximation to any twice differentiable function. Provided certain regularity conditions and behavioral assumptions are met, one can obtain a complete representation of the underlying production technology simply by analyzing the structure of the related cost function[6]. There is no need to a priori assume a particular production relationship and then impose it on the cost function. Moreover, the translog allows the expression of the various outputs as separate variables, and does not force us to treat homogeneity and a constant elasticity of substitution as maintained hypotheses. Thus, the translog specification permits the estimation of a cost curve that can be either upward sloping

(continuous diseconomies of scale), downward sloping (continuous economies of scale), or U shaped (Murray and White, 1983)[7].

The general specification of the translogaritmic cost function adopted in this paper can be written as:

$$\ln C = \alpha_o + \sum_{i=1}^{m} \alpha_i = \ln Q_i + \sum_{j=1}^{n} \beta_j \ln W_j + 1/2 \sum_{i=1}^{m} \sum_{k=1}^{m} \gamma_{ik} \ln Q_i \ln Q_k + \sum_{j=1}^{n} \sum_{s=1}^{n} \lambda_{js} \ln W_j \ln W_s + \sum_{i=1}^{m} \sum_{j=1}^{n} \theta_{ij} \ln Q_i \ln W_j \qquad (3)$$

To ensure that this cost function satisfies all requirements to be a 'proper' cost function, restrictions that ensure linear homogeneity in all input prices [(a)-(c)] and symmetric price responses [(d) and (e)] are imposed as follows:

$$\begin{aligned} &(a) \quad \sum_{j=1}^{n} \beta_j = 1 \\ &(b) \quad \sum_{j=1}^{n} \lambda_{js} = 0 \\ &(c) \quad \sum_{j=1}^{n} \theta_{ij} = 0 \\ &(d) \quad \gamma_{ik} = \gamma_{ki} \\ &(e) \quad \lambda_{js} = \lambda_{sj} \end{aligned} \qquad (4)$$

Given this functional specification, the various measures derived in the paper to assess operational efficiency in Chilean banking, and tests of alternative production technologies conducted such as nonjointness or separability, are enumerated in (11)-(21) in Appendix A (pp. 86-89)

IV. Data, variables, and estimation technique

The data used for the analysis were retrieved from the Income and Expenditure Statements and Balance Sheets of Assets and Liabilities of each individual institution in the Chilean banking system. These are published in monthly bulletins - *Informacion Financiera*, by the Superintendencia de Bancos y Instituciones Financieras (SBIF), and supplemented by the *Boletin Mensual* - a publication of the Banco Central de Chile. Since the number of financial institutions has varied over the period of analysis, only those institutions in existence for the entire period 1984-1991 are investigated. I thus obtain the requisite information on 37 financial institutions, of which 14 are domestic commercial banks, 19 are foreign commercial banks, and 4 are sociedades financieras.

Consequently, the data comprises a pooled sample of 3,102 observations with 94 observations on each financial institution (March 1984-December 1991)[8]. The entire analysis is carried out with real values of the variables, obtained by deflating the nominal values by the consumer price index (April 1989 = 100)[9].

I turn my attention now to the proxies for bank costs, banking outputs, prices of factor inputs, and control variables that are used in the estimated model.

Total Costs: Defined as total operating costs C, these include payments for rent, use of equipment, materials, buildings, and wages and salaries but exclude interest costs.

Banking Output: There is no consensus yet on what constitutes the proper choice of outputs and inputs and how their quantities should be measured[10]. Disagreements over the appropriate definition of bank output can partially be attributed to the multiproduct nature of financial institutions (especially banks), and is clearly reflected in the diverse measures of output that have been employed in the literature[11]. I use the Peso values of total deposits (DEP), total loans (LON), and total investments (INV), as my measures for output.

Factor Prices: Two input prices are incorporated, one for labor and the other for physical capital. The price of labor services (PLAB) is proxied by the general index of wage remunerations for the Chilean economy while the price of capital (PCAP) is estimated as the ratio of the sum of administrative expenses, depreciation, and taxes other than income taxes to the average peso value of deposits, loans, and investments[12].

Control Variables: Some similar studies have utilized control variables when estimating cost functions, in an attempt to control for differences in costs across banks due to a different number of branches, risk characteristics, regulatory aspects and the like. In the context of analyzing Chilean banks, emulating this approach is justifiable, because it is conceivable that the risk characteristics of the banks are different. Therefore, two control variables, RISK - to proxy for credit risk; and BRANCH - to account for differences in the cost of operations due to differences in the number of branches are included in the estimated cost function. RISK is defined as the sum of the peso values of provisions for doubtful loans, and default portfolio losses normalized by the peso value of total loans.

The cost equation estimated to approximate the production features of Chilean banking institutions thus takes on the following precise specification:

$$\begin{aligned} \ln C = {} & \alpha_0 + \alpha_1 \ln DEP + \alpha_2 \ln LON + \alpha_3 \ln INV + \beta_1 \ln PLAB + \beta_2 \ln PCAP + 1/2\,\gamma_{11} (\ln DEP)^2 \\ & + 1/2\,\gamma_{22} (\ln LON)^2 + 1/2\,\gamma_{33} (\ln INV)^2 + \gamma_{12} \ln DEP \ln LON + \gamma_{13} \ln DEP \ln INV \\ & + \gamma_{23} \ln LON \ln INV + 1/2\lambda_{11} (\ln PLAB)^2 + 1/2\lambda_{22} (\ln PCAP)^2 + \lambda_{12} \ln PLAB \ln PCAP \\ & + \theta_{11} \ln DEP \ln PLAB + \theta_{12} \ln DEP \ln PCAP + \theta_{21} \ln LON \ln PLAB + \theta_{22} \ln LON \ln PCAP \\ & + \theta_{31} \ln INV \ln PLAB + \theta_{32} \ln INV \ln PCAP + \pi \ln RISK + \rho \ln BRANCH + \varepsilon \end{aligned} \quad (5)$$

Because the institutions in the Chilean financial system are diverse in terms of the nature of their operations, size, origin, rate of growth, and various other traits (operational orientation, central bank intervened bank, management strategies) it is not justifiable to lump them all together with the assumption that the cost structure of all the institutions is identical. In lieu of these considerations, the 37 financial institutions are classified into seven possible groups, so that all institutions within that group possess a common important trait and thus are in some sense homogeneous.

An analysis of the various possible classification traits revealed that classifying the institutions into two groups on the basis of their affiliation, and the size of the institution, will adequately suffice. The first group broadly classifies financial institutions according to their ownership type as either a domestic bank, a foreign bank or a sociedad financiera[13]. The second group attempts to further homogenize the groupings and thus classifies the institutions on the basis of their size into one of either very small, small, medium, or large bank groups. The following specific observations derived from Table 1 provide the rationale for this classification.

(a) The 37 financial institutions on which data is collected comprise 4 sociedades financieras and 33 banks of which, in turn, 19 are foreign banks and 14 are domestic banks.

(b) The classification of banks by size was based on two determinants - the average current value of total assets, and loans made as a proportion of total loans in the financial system, both measures observed at the end of each year. The latter approach for the classification of banks into the size groups mentioned above has been commonly adopted by Chilean regulatory authorities. The grouping of banks turns out to be almost identical under both measures, though the rank of a given bank within the group may vary a little based on the measure employed. Thus, of the 33 banks, 9 are "very small" (total assets < 35 billion pesos; < 0.5 percent share in total loans), 12 are "small" (total assets 36-114 billion pesos; and each bank having 0.5-2 percent share in total loans), 7 are "medium" (185-256 billion pesos; 2-5 percent share in total loans), and 5 are "large" (294-1268 billion Pesos; greater than 5 percent share in total loans).

(c) All 9 of the very small, and 8 of the 12 small banks are foreign banks, while domestic banks dominate in the medium (5 of 7) and large categories (all 5).

(d) In terms of overall risk, reported here as a proportion of the end of year sum of loan provisions and default portfolio to total assets, foreign banks dominate in the "low-risk" category, while domestic banks make up the majority of the "high-risk" banks. Further, as it turns out, almost all the intervened banks fall in the 'domestic' classification.

(e) Most of the banks that exhibit the slowest rates of growth are domestic, while the foreign banks average much higher rates of growth. Further, the high-risk domestic banks are also those with the lowest rates of growth.

(f) All the sociedades financieras would fall in the very small size category, 2 in low and 2 in medium risk categories, and all 4 in the medium rate of growth category.

Since we have observations on 37 financial institutions, which are classified into different "homogeneous" groups, over 94 monthly periods of time, techniques for panel data estimation are employed to obtain estimates with ordinary least squares[14]. The general econometric model for each group of banks is thus specified as:

$$Y_{it} = \alpha_{1it} + \sum_{k=2}^{k} \beta_{kit} X_{kit} + \varepsilon_{it} \quad (6)$$

where i = 1, 2, ...N are the different banks in the group and t = 1, 2,...,T are the number of time periods over which we have observations on each bank. Thus Y_{it} is the value of the dependent variable for bank i at time t and X_{kit} is the value of the kth non-stochastic explanatory variable for bank i at time t. The stochastic term ε_{it} is assumed N $(0, \sigma^2)$.

TABLE 1

CHILE: BANK GROUPS BY OWNERSHIP & SIZE AND RANKINGS BY SIZE, RISK AND RATE OF GROWTH: 1984-91

	Size (Total Assets) 1/		Size (% Loans) 2/		Very Risk 3/		Rate of Growth 4/	
	Very Small		*Very Small*		*Very Low*		*Low*	
DOMESTIC	Sao Paulo	5.6	Sao Paulo	0.05	Boston	0.4	Sudamericano	1.3
Smallest-Largest	Nac Argen	9.9	Brasil	0.08	Chicago	0.5	Concepción	1.4
1 Pacífico	Brasil	12.0	Bank Tokyo	0.08	Chase	0.8	Chile	1.4
2 Internacional	Real	12.8	Bac Argen	0.09	Citibank	0.8	Internacional	1.4
3 Desarrollo	Bank Tokyo	13.7	Real	0.14	Sao Paulo	0.9	Centrobanco	1.5
4 Bice	Amer Express	21.5	Bank of Ame	0.20	Bank of Ame	1.0	Credito	1.6
5 A. Edwards	Chicago	30.0	Amer Exp	0.28	Real	1.3	Santiago	1.6
6 Bhif	Bank Of Amer	32.2	Chicago	0.29			del Estado	1.7
7 O'Higgins	Sudameris	35.8	Sudameris	0.44	*Low*		Citibank	1.9
8 Concepción							A. Edwards	2.0
9 Osorno	*Small*		*Small*		Sudameris	1.3	O'Higgins	2.0
10 Sud Americano					Amer Exp	1.5		
11 Crédito	Exterior	35.9	Morgan	0.36	Morgan	1.6	*Medium*	
12 Santiago	Continental	36.3	Continental	0.54	Bank Tokyo	1.6		
13 Chile	Hongkong	36.3	Hongkong	0.57	Continental	1.7	Real	2.1
14 Del Estado	Pacífico	49.5	Exterior	0.59	New York	2.3	Nac. Argen	2.2
	Morgan	52.6	Chase Manha	0.62	Brasil	2.6	Sao Paulo	2.2
FOREIGN	First Boston	53.0	First Boston	0.70	Bice	2.7	Bhif	2.2
Smallest-Largest	New York	54.6	New York	0.90	Nac Argen	2.9	Chase	2.2
1 Sao Paulo	Internacional	55.3	Internacional	0.91	A. Edwards	3.3	New York	2.3
2 Nac. Argentina	Chase Manha	60.2	Pacífico	1.06	Exterior	3.6	Exterior	2.3
3 Brasil	Desarrollo	63.0	Centrobanco	1.24	O'Higgins	3.8	Amer Exp	2.4
4 Real	Centrobanco	72.7	Bice	1.70			Bice	2.4
5 Bank of Tokyo	Bice	114.9	Desarrollo	1.72	*Medium*		Tokyo	2.4
6 Amer Express							Chicago	2.4
7 Chicago	*Medium*		*Medium*		Crédito	3.9	Pacífico	2.5
8 Bank of America					Santander	4.2	Hongkong	2.6
9 Sudameris	Citibank	185.3	Citibank	2.32	Osorno	4.2	Boston	2.6
10 Exterior	Santander	203.2	Santander	3.45	Sud America	4.2		

TABLE 1 (Continued)

	Size (Total Assets) 1/		Size (% Loans) 2/		Very Risk 3/		Rate of Growth 4/	
11 Continental	A. Edwards	204.2	Concepción	3.56	Hongkong	4.2	*High*	
12 Hongkong & Shanghai	Bhif	208.4	A. Edwards	3.85	Bhif	4.6		
13 Morgan	O'Higgins	214.1	O'Higgins	4.18	Desarrollo	5.5	Santander	2.9
14 First Boston	Concepción	255.6	Bhif	4.74			Sudameris	3.1
15 Repub. New York	Osorno	255.8	Osorno	5.37	*High*		Osorno	3.2
16 Chase Manhattan							Bank of Amer	3.2
17 Centrobanco	*Large*		*Large*		Del Estado	5.8	Desarrollo	3.2
18 Citibank					Pacífico	6.0	Continental	4.5
19 Santander	Sud American	294.4	Sud America	4.99	Internacional	6.0	Brasil	4.6
	Crédito	357.0	Crédito	6.21	Concepción	6.1	Morgan	5.6
	Santiago	637.7	Santiago	9.64	Centrobanco	6.7		
	Chile	1.253.0	Chile	16.59	Chile	7.7	*Average*	2.4
	Del Estado	1.268.0	Del Estado	17.97	Santiago	8.1		
Sociedad Financieras								
1 Fin. Condell	Condell	12.4	Condell	–	Condell	4.7	Condell	2.6
2 ABN Tanner 5/	Tanner	15.3	Tanner	–	Tanner	2.2	Tanner	2.8
3 Fin. Atlas	Atlas	21.3	Atlas	–	Atlas	2.2	Atlas	2.2
4 Fin. Fusa	Fusa	30.6	Fusa	–	Fusa	3.9	Fusa	2.8

1/ Billions of April 1989 Pesos (Average for 1984-91).
2/ Loans as percent of total loans of the financial system (Average for 1984-91).
3/ Unlike Credit Risk defined earlier, this is defined as Loan Provisions + Default Portofolio as a proportion of Total Assets (Average for 1984-91).
4/ Rate of Growth of real total assets (Average for 1984-91)
5/ Was Fin. Comercial until April 1990. As it operated as a financiera over most of the time period of my analysis, it is treated as such.

A specific version of the fixed effects model was implemented to estimate cost functions for the different groups of Chilean financial institutions. This specification suggests that although the slope coefficients for each bank in the group are identical, the intercept contains two additional components, one that is constant over time but varies across banks in the group (individual effects, e.g. management style, marketing strategy), and another that varies over time but is constant across the banks (time effects, e.g. technology of production). Consequently, (16) is respecified as:

$$Y_{it} = \overline{\alpha_1} + \mu_i + \lambda_t + \sum_{k=2}^{k} \beta_k X_{kit} + \varepsilon_{it} \qquad (7)$$

$$i = 1, 2,..., N; \quad t = 1, 2,..., T$$

with the intercept $\alpha_{1it} = \alpha_1 + \mu_i + \lambda_t$, where μ_i are the individual effects and λ_t the time effects[15].

Further, specification for the behavior of the disturbances for each group of banks combines the assumptions of group-wise heteroskedasticity (since each group comprises of a number of different banks) and autocorrelation (since the data on each bank comprises a time series). In addition, since all the banks operate in the same macroeconomic and regulatory environment, it is very likely that any macroeconomic or regulatory factors that affect the banks, affect all of them similarly to varying degrees. As such it is reasonable to allow for correlation of disturbances across banks in a given group. In other words, for each group of banks, the disturbances are characterized as follows[16]:

$$E(\varepsilon_{it}^2) = \sigma_{ii} \qquad \text{(cross-sectional heteroskedasticity)} \qquad (8)$$
$$E(\varepsilon_{it}\ \varepsilon_{jt}) = \sigma_{ij} \qquad \text{(mutual correlation)} \qquad (9)$$
$$\varepsilon_{it} = \rho_i\ \varepsilon_{i,t-1} + u_{it} \qquad \text{(autocorrelation)} \qquad (10)$$

where

$$u_{it} \sim N\ (0, \phi_{ii})$$
$$E(\varepsilon_{i,t-1}\ u_{jt}) = 0$$
$$E(u_{it}\ u_{jt}) = \phi_{ij}$$
$$E(u_{it}\ u_{js}) = 0; \quad t \neq s;\ i, j, = 1, 2,..., N.$$

The analysis is conducted in two different ways. First, a cost function is estimated for each of the 7 groups - very small, small, medium, large, domestic, foreign, and sociedades financieras. Second, an attempt is made to examine operational efficiency in the financial system over time. Consequently, the financial system is analyzed for each of the eight years (1984-1991) and measures for economies of scale and scope are derived.

Before proceeding with the actual estimation, the usual diagnostic tests for failure of classical linear regression conditions to hold were conducted. The paramount concern was with the presence of autocorrelation and/or heteroskedasticity. Diagnostic tests for nonspherical disturbances were performed on the data for each banking institution individually[17].

V. Empirical findings

Summary statistics for values of selected variables from both the group-wise and yearly analysis, the respective estimated parameters, their asymptotic t ratios, and measures of overall goodness of fit are reported in Appendix B (pp. 90-95). Given the logarithmic specification, estimated parameters represent the elasticity of cost with respect to the respective variable. Overall, the results are quite satisfactory and the high explanatory power in the fitted equations supports the appropriateness of modelling banks as a multiproduct firm. The significance of the estimated coefficients is observed to increase with the number of degrees of freedom, as expected.

Tables 2 and 3 summarize my main findings on measures of economies of scale, economies of scope, marginal costs, input elasticities of substitution, and input elasticities of demand (all evaluated at the arithmetic means of the output and input variables), for the seven groups of banks, and for the banking system as a whole over time, respectively. Finally, for each group of banks, findings from tests on alternative production characteristics are reported in Table 4. While details on the relationship between each of the measures reported in these tables and the coefficients in equation 5, are relegated to Appendix A (pp. 86-89), the findings are briefly interpreted below.

V.1 Economies of Scale

The scale economy measure for both, the banking system as a whole for each of the eight years, as well as for each of the seven groups of banks, is found to be significantly less than one, providing strong evidence for the existence of economies of scale in Chilean banking. The yearly findings for the banking system, as expected, exhibit a trend towards dissipation of scale economies over time. For groups of banks, the degree of scale economies indicated is higher when the institutions are classified on the basis of size rather than ownership type.

The partial scale economy measures reflect the elasticity of cost with respect to the respective output when other outputs and input prices are held constant. They thus reflect the contribution of each output to the overall economies of scale. It should be borne in mind, that though the concept of partial scale economies is identical to that of product specific returns to scale in a single output case, they cannot be so interpreted in a multiproduct context (Fuss and Waverman, 1981).

Presence of product specific economies of scale is indicated by the negative rate of change of marginal costs for all three outputs in both cases, for groups of banks, as well as for the analysis over time. Only the production of loans by large banks indicates the absence of product specific economies.

V.2 Marginal Costs

The estimated marginal costs under both analyses, are very low and are consistent with the strong indications of economies of scale mentioned above. For instance, for very small banks the increase in costs to attract another 1000 pesos in deposits is only 0.75 Pesos. No consistent trend in the marginal costs of production of either of the three outputs is discernible for the banking system over time. For groups of banks, large banks exhibit the lowest marginal costs for loans, medium banks for deposits, and very small banks the lowest for investments. Among domestic and foreign banks, only the

TABLE 2

MEASURES OF OPERATIONAL EFFICIENCY IN THE CHILEAN BANKING SYSTEM: FINDINGS FOR GROUPS OF BANKS[a]

	VS Banks	SM Banks	MED Banks	LG Banks	DOM Banks	For Banks	SOC. FIN.
Overall Scale Economies							
S	0.4315	0.6672	0.5971	0.4319	0.7478	0.6726	0.6358
SE	0.0305	0.0258	0.0328	0.1248	0.0238	0.0144	0.0766
Partial Scale Economies							
DEP	0.1098	0.1943	0.0638	0.2261	0.1694	0.1600	0.3467
LON	0.1327	0.3276	0.3864	0.0283	0.4350	0.2824	0.2193
INV	0.1890	0.1453	0.1469	0.1774	0.1435	0.2303	0.0698
Product Specific Economies of Scale							
DEP	-2.43E-07	-1.07E-07	-1.09E-08	-2.78E-09	-1.38E-08	-6.09E-08	-5.52E-08
LON	-1.58E-07	-5.54E-08	-3.29E-08	1.03E-08	-8.76E-09	-8.34E-08	-2.19E-07
INV	-1.07E-07	-9.72E-08	-2.86E-08	-2.06E-09	-1.14E-08	-9.38E-08	-6.67E-07
Cost Complementaries							
DEP-LON	-0.0393	-0.2287	-16.3051	3.2703	-0.5389	-0.2177	1.5109
SE	0.0802	0.1134	8.4654	6.1	0.361	0.083	1.514
DEP-INV	0.1273	0.1073	0.6044	-0.6010	0.2002	0.1194	-0.6512
SE	0.0805	0.1498	1.2685	0.7872	0.1208	0.042	0.9093
LON-INV	-0.0660	-0.1704	-2.5894	-3.3510	-0.2224	-0.2497	-1.1440
SE	0.0862	0.1255	5.5211	4.3968	0.08128	0.0611	0.8784
Marginal Costs							
DEP	0.00075	0.00110	0.00039	0.00139	0.00104	0.00095	0.00382
LON	0.00086	0.00146	0.00163	0.00011	0.00172	0.00161	0.00214
INV	0.00074	0.00105	0.00133	0.00089	0.00083	0.00153	0.00227
Input Elasticities of Substitution							
LAB-CAP	1.4058	1.3050	1.5397	1.1020	1.0496	1.2811	0.9879
LAB-LAB	-1.4424	-1.0528	-1.2364	-0.7195	-0.7445	-1.2034	-0.7511
CAP-CAP	-1.3057	-1.5977	-1.9072	-1.6879	-1.4855	-1.3138	-1.2418
Input elasticietes of Demand							
LAB-CAP	0.6976	0.7231	0.8558	0.6674	0.6148	0.6630	0.5612
CAP-LAB	0.7338	0.5884	0.6889	0.4356	0.4350	0.6348	0.4384
LAB-LAB	-0.7157	-0.5833	-0.6873	-0.4357	-0.4361	-0.6228	-0.4267
CAP-CAP	-0.6816	-0.7204	-0.8533	-0.6673	-0.6156	-0.6510	-0.5511

a Evaluated at the arithmetic means of output and input variables for each group of banks. SE, the standard errors are approximate (See Fuller, 1962).

TABLE 3

MEASURES OF OPERATIONAL EFFICIENCY IN THE CHILEAN BANKING SYSTEM: FINDINGS OVER TIME[a]

	1991	1990	1989	1988	1987	1986	1985	1984
Overal Scale Economies								
S	0.8824	0.9159	0.8727	0.8300	0.8583	0.7569	0.7545	0.7789
SE	0.0192	0.0211	0.0225	0.0198	0.0153	0.0199	0.0239	0.0519
Partial Scale Economies								
DEP	0.2755	0.2155	0.1303	0.1295	0.1930	0.1159	0.1227	0.2609
LON	0.3653	0.4774	0.4992	0.4520	0.4146	0.2953	0.2996	0.2011
INV	0.2416	0.2230	0.2432	0.2485	0.2507	0.3457	0.3322	0.3169
Product Specific Economies of Scale								
DEP	-2.35E-08	-1.59E-08	-9.15E-09	-1.36E-08	-2.92E-08	-2.21E-08	-2.66E-08	-8.27E-08
LON	-1.69E-08	-1.51E-08	-1.32E-08	-1.76E-08	-1.97E-08	-1.56E-08	-1.61E-08	-1.92E-08
INV	-6.69E-08	-5.30E-08	-4.19E-08	-2.22E-08	-1.11E-08	-1.50E-08	-2.01E-08	-8.04E-08
Cost complementarities								
DEP-LON	-0.1348	-2.0604	-0.7182	-1.3424	-0.1957	-2.1223	0.1004	-0.9148
SE	0.3930	1.6873	0.9980	0.9523	0.2952	1.0336	0.1188	0.8067
DEP-INV	-0.2044	0.2046	0.4669	-0.0017	0.0768	-1.6638	0.0397	0.2272
SE	0.3243	0.6383	0.3547	0.4013	0.3045	0.9287	0.0960	0.2046
LON-INV	-0.0172	-0.2973	-0.7612	-0.1453	-0.4652	0.6060	-0.1236	-0.9679
SE	0.0521	0.5523	0.4513	0.2632	0.3085	0.3640	0.1158	0.6393
Marginal Costs								
DEP	0.00154	0.00123	0.00071	0.00071	0.00111	0.00074	0.00093	0.00236
LON	0.00173	0.00207	0.00203	0.00187	0.00166	0.00118	0.00115	0.00087
INV	0.00232	0.00207	0.00185	0.00130	0.00098	0.00124	0.00156	0.00270
Input Elasticities of Substitution								
LAB-CAP	1.3694	1.1947	1.3815	1.9441	1.3498	1.0859	1.7397	1.8149
LAB-LAB	-0.9749	-0.8997	-1.0577	-1.5565	-1.1153	-0.9367	-1.6871	-1.9391
CAP-CAP	-1.9067	-1.5841	-1.7819	-2.4166	-1.6239	-1.1829	-1.7195	-1.6443
Input Elasticities of Demand								
CAP-LAB	0.8005	0.6816	0.7833	1.0809	0.7394	0.5838	0.8901	0.8833
LAB-CAP	0.5728	0.5137	0.6040	0.8677	0.6130	0.5204	0.8818	0.9585
LAB-LAB	-0.5699	-0.5133	-0.5997	-0.8654	-0.6110	-0.5036	-0.8632	-0.9437
CAP-CAP	-0.7976	-0.6811	-0.7791	-1.0786	-0.7375	-0.5669	-0.8716	-0.8684

a Evaluated at the arithmetic means of output and input variables for each year. SE, the standard errors are approximate (See Fuller, 1962).

marginal costs for investments are higher for foreign banks. Sociedades Financieras exhibit the highest marginal costs in the production of all three banking outputs.

V.3 Economies of Scope[18]

A negative value for the measure of product specific economies of scope for a given output combination suggests cost complimentarities. By this criterion, exceptions to evidence on product specific economies of scope is indicated over time for deposit-loan activities in 1985, for loan-investment activities in 1986, and for deposit-investment activities in 1986 and 1991.

For groups of banks, not only is the presence of cost complimentarities indicated for each group of banking institutions, but the output pair combinations for which cost complimentarity is evidenced, exhibits some degree of uniformity. For instance, the very small, small, and medium size banks show proof of cost complimentarities only in their deposit-loan activities while the domestic and foreign banks provide evidence of product specific scope economies in their deposit-loan and loan-investment activities. The strongest evidence is provided by medium size banks in terms of the magnitude of the product specific scope economy measure, and by foreign banks in terms of the most statistically significant estimate. On the other hand, weak indications of cost complimentarities are found in the deposit-investment, and loan-investment activities of the large banks, and sociedades financieras.

Taking into consideration the approximate standard error for the scope economy measure discussed here, these otherwise apparently strong indications on product specific economies of scope are actually found to be statistically significant only for small, medium and foreign banks in deposit-loan activities, and for domestic and foreign banks in loan-investment activities[19]. In the analysis over time, somewhat significant (10% level) indications of cost complimentarities are found only for deposit-loan and deposit-investment activities in 1986 and for loan-investment activities in 1989. Overall thus, though many of the point estimates reported in Tables 2 and 3 are not significantly different from zero, they are negative thereby providing at least weak evidence in favor of the presence of cost complimentarities. Yet the fact that all output pairs in the product mix do not provide evidence of cost complimentarities suggests that global economies of scope are absent.

V.4 Input Elasticities of Substitution and Input Elasticities of Demand

For both, the banking system over time, and all groups except sociedades financieras, the input elasticity of substitution observed is a positive value and is greater than one reflecting a high degree of substitutability between labor and capital. The only notable exception is found in the case of the Sociedades Financieras which seem to be operating with technology that mitigates their ease of substitution between the two inputs. In terms of size, the very small banks exhibit the highest degree of substitutability of labor for capital, while the largest banks show the least. This is not necessarily a surprise as it may simply be a reflection of greater flexibility in the production technology adopted by the smaller banks while the larger banks show more rigidity and thus less responsiveness in terms of adjusting factor inputs to changes in their relative prices.

The own input elasticities of demand are negative for all groups and are less than 1 in absolute magnitudes indicating an inelastic demand. The most notable feature here is

TABLE 4

TESTS FOR ALTERNATIVE PRODUCTION STRUCTURE[a] GROUPS OF BANKS

	Value of Test Statistic For			
Bank Group	Homogeneity	Separability	Non-Jointness	Cobb-Douglas
Very Small	100.1	53.8	14.7	138.2
Small	244.0	59.2	53.9	269.0
Medium	59.4	15.1	2.4[b]	50.5
Large	24.3	11.9	11.6	21.8
Domestic	18.8	130.4	77.2	135.0
Foreign	36.6	192.4	97.8	217.8
Soc. Fin	19.3	10.7	11.8	29.8
Critical Value (5%)	12.6	7.8	7.8	18.3
Degrees of Freedom	6	3	3	10

a The test statistic is calculated as $-2\log(L_1/L_0)$ and is distributed as a $\chi 2$ with degrees of freedom equal to the number of additional restrictions contained in the null hypothesis. L_1 and L_0 are the values of the unconstrained and constrained likelihood functions.

b Cannot reject null hypothesis.

that demand for labor for the banking system as a whole is seen to become increasingly inelastic over time. Economic theory predicts that when only two inputs are employed in the production process, they must be substitutes. This is borne out by the cross elasticities of input demand which are positive over time and for all groups.

V.5 Alternative Production Structures

Tests of various specialized production structures were conducted for the seven groups of banks, using the Likelihood Ratio test[20]. While the findings confirm the appropriateness of modelling banking production in Chile in a multiproduct framework they do yield one seemingly surprising result - the hypothesis of non-jointness in production cannot be rejected for medium banks. It should be kept in mind though, that, since the translog is a second order approximation, the tests are approximate and local (as opposed to global; see Mester (1987)).

VI. Conclusions

This paper investigated the cost structure of Chilean banking institutions over the 1984-91 period. Measures of economies of scale and of scope presented in the paper provide a comprehensive assessment of one of the important aspects of the degree of operational efficiency in the Chilean banking system. The major conclusions that emerge from the analysis are:

1. A multiproduct framework is appropriate to model Chilean banking output production.

2. The findings of a scale economy measure significantly less than one for each of the seven groups into which the thirty seven banking institutions could be classified, and persistence of this finding in the cross sectional analysis of all institutions taken together over each of the eight years from 1984-91, clearly suggests that economies of scale were present in Chilean banking during this period.
3. The evidence on the presence of product specific economies of scope is not uniform. When classified by size, statistically significant evidence is established for the presence of cost complimentarities in the deposit-loan activities of the small and medium sized banks only. When classified by ownership type, statistically significant evidence is established for the presence of cost complimentarities in the deposit-loan activities of foreign banks, and in loan-investment operations for both domestic and foreign banks. In all other cases either no evidence or only weak evidence of the existence of cost complimentarities is established. The lack of cost complementarities among all output combinations suggests that global economies of scope remain unexploited in Chilean banking.
4. On a more general note, the findings presented here show clearly that the degree of cost economies indicated can vary quite substantially when all financial institutions are lumped into one category and analyzed over a year or two, as opposed to when they are analyzed under some homogeneous group classification scheme. The significance of this finding has obvious implications not only for researchers, but also for regulators and policy makers.

Finally, while the findings presented here validate recent perceptions in Chilean financial circles regarding excess capacity in the banking system (de la Cuadra and Valdes-Prieto, 1992), the extent and magnitude of operational inefficiency indicated raises two obvious questions. First, how have Chilean banks sustained profitability? Second, given the sufficient incentives for mergers, what factors explain the conspicuously low level of consolidation activity within the Chilean banking system? To be able to draw clear cut policy implications from the findings presented in this paper will first require answers to these two questions. Last but not the least, there remain important issues pertaining to the 'obligaciones subordinadas' on the books of all intervened banks (See Nauriyal, 1993, for details). To what extent the obligation on the part of the intervened banks to devote seventy percent of their annual profits towards repurchases, from the central bank, of their share of the non-performing portfolio may have provided them with incentives that ultimately are reflected in the measures derived in this paper are anybody's guess.

Appendix A

MEASURES OF COST ECONOMIES AND TESTS FOR ALTERNATIVE PRODUCTION TECHNOLOGIES

A. *Economies of Scale*

The overall measure of scale economies, S is the sum of the individual partial scale economies and can be obtained from the estimated parameters of the translogarithmic cost function in (3) as:

$$S = \sum_{i=1}^{m} \partial \ln C / \partial \ln Q_i$$

$$S = \sum_{i=1}^{m} \alpha_i + \sum_{i=1}^{m} \sum_{k=1}^{m} \gamma_{ik} \ln Q_k + \sum_{i=1}^{m} \sum_{j=1}^{n} \theta_{ij} \ln W_j \quad (11)$$

$S < 1 \Rightarrow$ economies of scale (costs increase proportionately less than output)
$S = 1 \Rightarrow$ constant returns (costs increase in the same proportion as output)
$S > 1 \Rightarrow$ diseconomies of scale (costs increase proportionately more than output)

B. *Economies of Scope*

(i) Global Economies of Scope

These can be computed from the expression

$$SC = [C(Q_i) + C(Q_{m-i}) - C(Q)] / C(Q) \quad (12)$$

where Q_i is the vector with a zero component in place of q_i for all i ε m and Q_{m-i} is the vector with a zero component in place of q_i for all i ε m. Thus the expression measures the relative increase in cost if Q were produced in two groups i and m-i. There exist global economies of scope if SC > 0 and diseconomies of scope if SC < 0.

However, the translog is undefined for a zero value for any of the outputs rendering the above expression practically unquantifiable. This problem has been overcome most commonly by evaluating the expression by substituting $Y_i = 0.001$ for $Y_i = 0$ and using mean values for all other variables. Nonetheless, since the translog specification is a second order approximation, it may display imprecise, and even unstable, estimates when values are chosen for exogenous variables which are not near the mean values of the actual data.

(ii) Product Specific Economies of Scope

A sufficient condition for the existence of cost complimentarities is that the matrix of second derivatives of the cost function with respect to output, $C_{ik} = \partial^2 C / \partial Q_i \, \partial Q_j$ be positive semidefinite. In terms of the parametersof the translog cost function, the existence of product specific economies of scope implies that

$$\gamma_{ik} + \alpha_i \alpha_k < 0 \quad (13)$$

Phrased simply, the necessary (but not sufficient) condition for pairwise cost complementarities requires that their cross product term be negative and statistically different from zero. The sufficient condition for pairwise cost complementarities requires that the cross product term not only be negative but also greater in absolute value than the product of the output elasticities of the two products being considered.

C. Marginal Costs

Marginal costs are computed as:

$$MC_i = C_i/Q_i \; [\partial \ln C/\partial \ln Q_i] \tag{14}$$

where C_i is the proportion of costs devoted to the production of output q_i. The expression is evaluated at the mean values of the output and input variables.

D. Product Specific Economies of Scale:

Panzar and Willig (1981) have developed a measure for product specific economies of scale. However as Fuss and Waverman (1981) note, the Panzar and Willig measure requires knowledge of the cost function in the region where one or more outputs are zero, and such levels are generally unobservable. Inaddition, Fuss and Waverman (1981) rightly emphasize that in spite of its intuitive appeal, the concept of output specific returns to scale in the context of joint multi-output production cannnot be defined. At best a crude indicator of such economies is provided by examining the rate of change of output specific marginal costs, $\partial^2C/\partial Q_i^2$. If the marginal costs of output Q_i are declining (expression < 0), it would suggest product specific economies of scale for output Q_i, and vice versa.

E. Input Elasticities of Substitution and Input Elasticities of Demand:

Following Binswanger [1974], the Allen partial elasticity of substitution between factors of production σ_{lk}, can be obtained from the parameters of the estimated cost equation as

$$\sigma_{lk} = (\lambda_{lk} + S_l S_k)/S_l S_k, \quad \text{for } l \neq k\text{; and}$$

$$\sigma_{ll} = [\lambda_{ll} + S_l(S_l - 1)]/S_l S_l \tag{15}$$

where S_l, S_k are the factor input cost shares. Given the input elasticity of substitution, the elasticities of demand for factor inputs is obtained as

$$\varepsilon_{lk} = \sigma_{lk} S_k, \text{ for } l \neq k\text{; and}$$

$$\varepsilon_{ll} = \sigma_{ll} S_l \tag{16}$$

F. Test For Non-jointness in Production:

If the Chilean banks have separate production functions for each output/service, then this can be tested by imposing nonjointness on their production process. Because non-jointness implies that the marginal cost of each output is independent of the level of any other output, i.e.,

$$\partial^2 C/\partial q_i q_k = 0, \; i \neq k \tag{17}$$

In terms of the parameter restriction on the translog cost function, this is equivalent to:

$$\gamma_{ik} = 0, \; i \neq k \tag{18}$$

G. Test For Separability in Production:

On the other hand, separability in the production process implies that the ratio of any two marginal costs is dependent only on the output mix, and is independent of the input prices, i.e.,

$$\frac{\partial}{\partial \ln w_i} \left[\frac{(\partial \ln C/\partial \ln q_i)}{(\partial \ln C/\partial \ln q_x)} \right] = 0 \tag{19}$$

In terms of parameter restrictions for the translog cost function, separability in the production process would require that:

$$\theta_{ij} = 0, \quad \text{for all } i, j. \tag{20}$$

H. Test for Homogeneity:

A homothetic production structure is further restricted to be homogeneous if and only if the elasticity of cost with respect to each output is constant. In terms of parameter restrictions on the translog cost function, this requires:

$$\sum_{i=1}^{m} \gamma_{ij} = 0 \qquad j = 1, 2, \ldots m \tag{21}$$

$$\sum_{j=1}^{m} \theta_{ij} = 0 \qquad j = 1, 2, \ldots n$$

I. Test for a General Cobb-Douglas Production Structure:

This production structure entails that all second-order parameters in the translog specification be 0.

Each of the production structures outlined under F-I above, is tested as an alternative to the translog specification to model the production of financial services by Chilean financial institutions. The Likelihood Ratio test provides a useful and convenient way to proceed for that purpose.

Appendix B

SUMMARY STATISTICS AND PARAMETER ESTIMATES FOR GROUP AND YEARLY ANALYSIS

TABLE 5

SUMMARY STATISTICS: REAL VALUES OF VARIABLES BY GROUPS OF BANKS

Very Small Banks

Variable*	N	Mean	Minimum	Maximum
Total Assets	846	19382	4045.7	55363
Cost	846	36.686	2.4438	405.45
Deposits	846	5381.2	151.91	33983
Loans	846	5675.7	637.17	25395
Investments	846	9392.2	673.07	36026
Price of Labor	846	90.774	37.661	190.49
Price of Capital	846	0.001324	0.00013428	0.044167
Risk	846	0.017921	0.00058123	0.73735
Labor Share	846	0.49621	0.039735	0.70042
Capital Share	846	0.52198	0.2	0.6365
Brancb	846	1.6	1	5

Small Banks

Variable	N	Mean	Minium	Maximum
Total Assets	1128	57252	2988.9	166020
Cost	1128	126.22	20.63	892.19
Deposits	1128	22232	777.34	96480
Loans	1128	28320	175.26	93954
Investments	1128	17540	0.16745	70224
Price of Labor	1128	90.787	37.661	190.49
Price of Capital	1128	0.0009812	0.00013244	0.021788
Risk	1128	0.029642	7.7815E-05	0.30786
Labor Share	1128	0.55407	0.068421	0.67491
Capital Share	1128	0.45092	0.060606	0.62218
Branch	1128	8.7	1	34

Medium Banks

Variable	N	Mean	Minimum	Maximum
Total Assets	658	219440	123040	417900
Cost	658	506.63	138.61	1533.4
Deposits	658	83273	15965	208910
Loans	658	120020	51886	310600
Investments	658	56145	7389.5	639990
Price of Labor	658	90.775	37.661	190.49
Price of Capital	658	0.0009093	0.00025575	0.0057005
Risk	658	0.034704	0.0039063	0.20477
Labor Share	658	0.55585	0.10417	0.79633
Capital Share	658	0.44744	0.1893	0.68921
Branch	658	35.3	12	77

Large Banks

Variable	N	Mean	Minium	Maximum
Total Assets	470	764370	216170	1862800
Cost	470	1399.6	308.93	7972.8
Deposits	470	227280	42155	547310
Loans	470	345170	134720	696510
Investments	470	279950	22122	875270
Price of Labor	470	90.786	37.661	190.49
Price of Capital	470	0.0006981	0.00018688	0.003501
Risk	470	0.057059	0.010673	0.32427
Labor Share	470	0.60562	0.23786	0.78614
Capital Share	470	0.39533	0.12546	0.47812
Branch	470	99.4	23	201

Domestic Banks

Variable	N	Mean	Minimum	Maximum
Total Assets	1316	375210	25216	1862800
Cost	1316	719.13	53.381	7972.8
Deposits	1316	117330	10991	547310
Loans	1316	182160	12038	696510
Investments	1316	124130	2392	875270
Price of Labor	1316	90.788	37.661	190.49
Price of Capital	1316	0.0007627	0.00018688	0.0071498
Risk	1316	0.047468	0.0050208	0.32427
Labor Share	1316	0.58573	0.15584	0.73368
Capital Share	1316	0.41444	0.12546	0.53965
Branch	1316	51.1	1	201

Foreign Banks

Variable	N	Mean	Minium	Maximum
Total Assets	1786	50865	2988.9	335530
Cost	1786	122.17	2.4438	1288.6
Deposits	1786	20627	151.91	199130
Loans	1786	21405	175.26	162590
Investments	1786	18418	0.16745	119970
Price of Labor	1786	90.775	37.661	190.49
Price of Capital	1786	0.0012038	0.00013244	0.044167
Risk	1786	0.020035	7.7815E-05	0.73735
Labor Share	1786	0.51756	0.039735	0.68333
Capital Share	1786	0.49554	0.060606	0.60052
Branch	1786	7.7	1	59

All Banks

Variable	N	Mean	Minimum	Maximum
Total Assets	3102	188470	2988.9	1862800
Cost	3102	375.43	2.4438	7972.8
Deposits	3102	61653	151.91	547310
Loans	3102	89604	175.26	696510
Investments	3102	63266	0.16745	875270
Price of Labor	3102	90.781	37.661	190.49
Price of Capital	3102	0.0010166	0.00013244	0.044167
Risk	3102	0.031673	7.7815E-05	0.73735
Labor Share	3102	0.54648	0.039735	0.62476
Capital Share	3102	0.46114	0.060606	0.54619
Branch	3102	26.1	1	201

Sociedades Financieras

Variable	N	Mean	Minium	Maximum
Total Assets	376	20056	8386.1	54709
Cost	376	132.3	25	378.31
Deposits	376	12022	2935.1	84567
Loans	376	13589	4017	33066
Investments	376	4072.9	6.2511	15151
Price of Labor	376	90.783	37.661	190.49
Price of Capital	376	0.0019127	0.00025227	0.0054763
Risk	376	0.021883	0.0027278	0.06378
Labor Share	376	0.56808	0.29412	0.73458
Capital Share	376	0.44382	0.13636	0.59657
Branch	376	16.4	3	37

* Asset, Cost, Deposit, Loan, and Investment values in millions of April 1989 Pesos. Other variables are as defined in section III.

TABLE 6

ESTIMATED PARAMETERS OF THE LOST FUNCTION. ANALYSIS BY GROUP OF BANKS–POOLED OLS WITH INDIVIDUAL AND TIME EFFECTS

Very Small Banks

Variable Name	Estimated Coefficient	Standard Error	T-Ratio 830 DOF
DEP	0.3588	0.1917	1.871
LON	-0.0241	0.1974	-0.122
INV	0.4781	0.2047	2.335
PLAB	-0.3760	0.1279	-2.938
PCAP	1.3760	0.1279	2.938
DEP2	0.1056	0.0254	4.151
LON2	0.0276	0.0262	1.053
INV2	0.1270	0.0231	5.490
DEPLON	-0.0306	0.0196	-1.556
DEPINV	-0.0442	0.0234	-1.890
LONINV	-0.0544	0.0204	-2.659
PLAB2	0.1048	0.0113	9.261
PCAP2	0.1048	0.0113	9.261
PLABCAP	-0.1048	0.0113	-9.261
PLABDEP	-0.0419	0.0154	-2.711
PCAPDEP	0.0419	0.0154	2.711
PLABLON	0.0582	0.0126	4.591
PCAPLON	-0.0582	0.0126	-4.591
PLABINV	-0.0520	0.0138	-3.767
PCAPINV	0.0520	0.0138	3.767
RISK	-0.0083	0.0082	-1.018
BRANCH	0.0936	0.0181	5.167
R-Square:		R2	0.795
Log Likelihood Function:		LLF	530.763
Durning-Watson:		DW	1.937
Sum of Squared Errors:		SSE	680.693

Small Banks

Variable Name	Estimated Coefficient	Standard Error	T-Ratio 1112 DOF
DEP	0.2710	0.2621	1.034
LON	-0.2221	0.2159	-1.028
INV	0.6201	0.0779	7.953
PLAB	0.6418	0.1666	3.852
PCAP	0.3581	0.1666	3.852
DEP2	0.3275	0.0482	6.793
LON2	0.1961	0.0234	8.379
INV2	0.1319	0.0071	18.334
DEPLON	-0.1684	0.0296	-5.681
DEPINV	-0.0608	0.0201	-3.015
LONINV	-0.0326	0.0166	-1.954
PLAB2	0.0760	0.0112	6.753
PCAP2	0.0760	0.0112	6.753
PLABCAP	-0.0760	0.0112	-6.753
PLABDEP	-0.0890	0.0215	-4.134
PCAPDEP	0.0890	0.0215	4.134
PLABLON	0.0479	0.0169	2.830
PCAPLON	-0.0479	0.0169	-2.830
PLABINV	-0.0698	0.0112	-6.234
PCAPINV	0.0698	0.0112	6.234
RISK	0.0288	0.0075	3.827
BRANCH	0.1489	0.0142	10.480
R-Square:		R2	0.893
Log Likelihood Function:		LLF	800.835
Durning-Watson:		DW	1.978
Sum of Squared Errors:		SSE	917.881

Medium Banks

Variable Name	Estimated Coefficient	Standard Error	T-Ratio 642 DOF
DEP	1.9073	0.8573	2.224
LON	-8.4303	1.1916	-7.074
INV	0.2988	0.6648	0.449
PLAB	1.1356	0.5678	1.999
PCAP	-0.1356	0.5678	-1.999
DEP2	0.0949	0.0558	1.701
LON2	1.1366	0.1483	7.660
INV2	0.0619	0.0273	2.261
DEPLON	-0.2260	0.0859	-2.630
DEPINV	0.0344	0.0378	0.909
LONINV	-0.0699	0.0538	-1.299
PLAB2	0.1338	0.0257	5.204
PCAP2	0.1338	0.0257	5.204
PLABCAP	-0.1338	0.0257	-5.204
PLABDEP	-0.0569	0.0326	-1.743
PCAPDEP	0.0569	0.0326	1.743
PLABLON	-0.0959	0.0448	-2.139
PCAPLON	0.0959	0.0448	2.139
PLABINV	-0.0344	0.0263	-1.308
PCAPINV	0.0344	0.0263	1.308
RISK	-0.0139	0.0170	-0.814
BRANCH	0.1118	0.0397	2.815
R-Square:		R2	0.877
Log Likelihood Function:		LLF	771.584
Durning-Watson:		DW	2.002
Sum of Squared Errors:		SSE	535.257

Large Banks

Variable Name	Estimated Coefficient	Standard Error	T-Ratio 454 DOF
DEP	0.5252	1.1252	0.466
LON	5.6130	2.4415	2.299
INV	-0.6531	0.6476	-1.008
PLAB	1.7380	0.5756	3.019
PCAP	-0.7380	0.5756	-3.019
DEP2	-0.0935	0.1320	-0.708
LON2	-0.9288	0.3061	-3.034
INV2	-0.0373	0.0550	-0.677
DEPLON	0.3222	0.1511	2.131
DEPINV	-0.2579	0.0655	-3.933
LONINV	0.3152	0.1088	2.894
PLAB2	0.0243	0.0343	0.710
PCAP2	0.0243	0.0343	0.710
PLABCAP	-0.0243	0.0343	-0.710
PLABDEP	-0.0091	0.0657	-0.139
PCAPDEP	0.0091	0.0657	0.139
PLABLON	-0.1343	0.1013	-1.326
PCAPLON	0.1343	0.1013	1.326
PLABINV	0.0364	0.0404	0.901
PCAPINV	-0.0364	0.0404	-0.901
RISK	0.0982	0.0280	3.509
BRANCH	-0.0408	0.0935	-0.436
R-Square:		R2	0.720
Log Likelihood Function:		LLF	448.657
Durning-Watson:		DW	1.861
Sum of Squared Errors:		SSE	384.727

CRITICAL T VALUES FOR TWO SIDED TESTS

10%	SIGNIFICANCE	1.645
5%	SIGNIFICANCE	1.960
1%	SIGNIFICANCE	2.576

TABLE 6 (Continued)

Domestic Banks

Variable Name	Estimated Coefficient	Standard Error	T-Ratio 1300 DOF
DEP	0.8565	0.3094	2.768
LON	-0.4262	0.2812	-1.515
INV	0.2298	0.1361	1.687
PLAB	0.0235	0.1755	0.134
PCAP	0.9765	0.1755	0.134
DEP2	0.1493	0.0480	3.107
LON2	0.2803	0.0453	6.188
INV2	0.1420	0.0092	15.389
DEPLON	-0.1738	0.0405	-4.283
DEPINV	0.0032	0.0212	0.154
LONINV	-0.1244	0.0170	-7.311
PLAB2	0.0120	0.0190	0.631
PCAP2	0.0120	0.0190	0.631
PLABCAP	-0.0120	0.0190	-0.631
PLABDEP	-0.0309	0.0274	-1.125
PCAPDEP	0.0309	0.0274	1.125
PLABLON	0.0753	0.0220	3.413
PCAPLON	-0.0753	0.0220	-3.413
PLABINV	-0.0753	0.0220	-3.413
PCAPINV	0.0753	0.0220	3.413
RISK	-0.0008	0.0085	-0.103
BRANCH	0.0414	0.0202	2.048
R-Square:		R2	0.855
Log Likelihood Function:		LLF	1210.635
Durning-Watson:		DW	2.087
Sum of Squared Errors:		SSE	1080.023

Foreign Banks

Variable Name	Estimated Coefficient	Standard Error	T-Ratio 1770 DOF
DEP	0.3790	0.1096	3.458
LON	-0.4635	0.1029	-4.502
INV	0.4010	0.0917	4.372
PLAB	-0.0541	0.0743	-0.728
PCAP	1.0054	0.0743	0.728
DEP2	0.0925	0.0156	5.920
LON2	0.1533	0.0150	10.193
INV2	0.1081	0.0105	10.272
DEPLON	-0.0420	0.0107	-3.898
DEPINV	-0.0326	0.0129	-2.510
LONINV	-0.0638	0.0108	-5.904
PLAB2	0.0719	0.0069	10.282
PCAP2	0.0719	0.0069	10.282
PLABCAP	-0.0719	0.0069	-10.282
PLABDEP	-0.0329	0.0095	-3.459
PCAPDEP	0.0329	0.0095	3.459
PLABLON	0.0273	0.0089	3.057
PCAPLON	-0.0273	0.0089	-3.057
PLABINV	-0.0257	0.0067	-3.816
PCAPINV	0.0257	0.0067	3.816
RISK	0.0282	0.0055	5.122
BRANCH	0.1425	0.0118	11.989
R-Square:		R2	0.882
Log Likelihood Function:		LLF	524.983
Durning-Watson:		DW	1.985
Sum of Squared Errors:		SSE	1434.741

Sociedades Financieras

Variable Name	Estimated Coefficient	Standard Error	T-Ratio 360 DOF
DEP	-0.8588	1.1890	-0.722
LON	-1.4873	0.8937	-1.664
INV	0.7249	0.3140	2.308
PLAB	0.5026	0.5438	0.924
PCAP	0.4974	0.5438	0.924
DEP2	-0.2544	0.1030	-2.468
LON2	0.1723	0.1159	1.486
INV2	0.0201	0.0102	1.955
DEPLON	0.2335	0.1035	2.256
DEPINV	-0.0285	0.0542	-0.526
LONINV	-0.0657	0.0439	-1.496
PLAB2	-0.0030	0.0296	-0.103
PCAP2	-0.0030	0.0296	-0.103
PLABCAP	0.0030	0.0296	0.103
PLABDEP	0.1485	0.0838	1.771
PCAPDEP	-0.1485	0.0838	-1.771
PLABLON	-0.1470	0.0619	-2.374
PCAPLON	0.1470	0.0619	2.374
PLABINV	0.0069	0.0144	0.480
PCAPINV	-0.0069	0.0144	-0.480
RISK	0.0324	0.0198	1.631
BRANCH	0.1745	0.0505	3.450
R-Square:		R2	0.790
Log Likelihood Function:		LLF	395.693
Durbin-Watson:		DW	1.944
Sum of Squared Errors:		SSE	307.709

CRITICAL T VALUES FOR TWO SIDED TESTS

10%	SIGNIFICANCE	1.645
5%	SIGNIFICANCE	1.960
1%	SIGNIFICANCE	2.576

TABLE 7

SUMMARY STATISTICS: REAL VALUES OF VARIABLES BY YEAR OF ANALYSIS

1991

Variable	N	Mean	Minimum	Maximum
Total Assets	396	173940	4996.4	1143500
Cost	396	466.37	12.758	3628
Deposits	396	83563	722.85	546510
Loans	396	98366	1202.5	638260
Investments	396	48629	673.07	437560
Price of Labor	396	171.44	160.62	190.49
Price of Capital	396	0.000812	0.000182	0.00222
Risk	396	0.020638	0.000408	0.09914
Labor Share	396	0.5846	0.39394	0.95389
Capital Share	396	0.41832	0.14511	0.63553
Branch	396	31.485	1	201

1990

Variable	N	Mean	Minium	Maximum
Total Assets	396	174910	4886.5	1145100
Cost	396	441.27	11.585	3315.1
Deposits	396	77332	699.72	529760
Loans	396	101890	1064.9	667030
Investments	396	47629	1266.8	406690
Price of Labor	396	134.02	120.71	156.32
Price of Capital	396	0.000863	0.000132	0.00714
Risk	396	0.023018	0.000316	0.07992
Labor Share	396	0.57048	0.15584	0.87429
Capital Share	396	0.42998	0.12546	0.84416
Branch	396	29.879	1	194

1989

Variable	N	Mean	Minimum	Maximum
Total Assets	396	180170	4550.9	1207400
Cost	396	405.82	11.769	3840.5
Deposits	396	74492	385.45	531700
Loans	396	99985	1154.6	639720
Investments	396	53363	1398.4	544700
Price of Labor	396	104.42	95.41	116.88
Price of Capital	396	0.000817	0.000270	0.00796
Risk	396	0.02405	0.000340	0.10601
Labor Share	396	0.56704	0.13596	0.86363
Capital Share	396	0.43722	0.13637	0.86404
Branch	396	28.03	1	190

1988

Variable	N	Mean	Minium	Maximum
Total Assets	396	184340	4045.7	1386800
Cost	396	364.07	11.181	4323.8
Deposits	396	66126	259.77	547310
Loans	396	87990	1401	561010
Investments	396	69377	608.75	719780
Price of Labor	396	87.569	81.307	93.335
Price of Capital	396	0.000765	0.000191	0.00235
Risk	396	0.022937	0.000354	0.08182
Labor Share	396	0.55597	0.3	0.8629
Capital Share	396	0.44631	0.13743	0.73333
Branch	396	25.939	1	191

1987

Variable	N	Mean	Minimum	Maximum
Total Assets	396	194650	3272.8	1502100
Cost	396	325.41	10.812	3098.8
Deposits	396	56352	421.87	502870
Loans	396	81423	800.78	549120
Investments	396	83594	212.79	787950
Price of Labor	396	71.65	66.12	79.423
Price of Capital	396	0.000795	0.000134	0.00660
Risk	396	0.023457	0.000289	0.09665
Labor Share	396	0.54784	0.29787	0.9633
Capital Share	396	0.45413	0.16777	0.71698
Branch	396	25.03	1	190

1986

Variable	N	Mean	Minium	Maximum
Total Assets	396	200410	3043.2	1594400
Cost	396	321.21	10.914	3156.1
Deposits	396	50156	151.91	502040
Loans	396	80474	175.26	622770
Investments	396	89640	435.15	875270
Price of Labor	396	59.884	55.714	65.066
Price of Capital	396	0.000961	0.000197	0.01257
Risk	396	0.029808	0.000191	0.09623
Labor Share	396	0.53759	0.21514	0.92929
Capital Share	396	0.47926	0.060606	0.84367
Branch	396	24.485	1	190

1985

Variable	N	Mean	Minimum	Maximum
Total Assets	396	215180	2988.9	1862800
Cost	396	325.54	5.3571	3834.2
Deposits	396	42739	155.75	420370
Loans	396	84531	637.17	680310
Investments	396	69211	0.5	838870
Price of Labor	396	49.103	45.081	54.3
Price of Capital	396	0.001375	0.00018	0.02179
Risk	396	0.053451	0.004	0.31688
Labor Share	396	0.51168	0.06214	0.9159
Capital Share	396	0.50689	0.0875	0.93215
Branch	396	22.424	1	185

1984

Variable	N	Mean	Minium	Maximum
Total Assets	330	183260	5217	1508300
Cost	330	349.38	2.4438	7972.8
Deposits	330	38624	388.29	419790
Loans	330	80690	927.81	696510
Investments	330	40969	1002.6	547030
Price of Labor	330	39.631	37.661	42.151
Price of Capital	330	0.001886	0.000311	0.04416
Risk	330	0.060898	0.002540	0.73735
Labor Share	330	0.48668	0.039735	0.91265
Capital Share	330	0.52815	0.14214	0.89468
Branch	330	21.727	1	185

* Asset, Cost, Deposit, Loan, and Investment values in millions of April 1989 Pesos. Other variables are as defined in section III.

TABLE 8

ESTIMATED PARAMETERS OF THE COST FUNCTION: YEARLY ANALYSIS - POOLED OLS

1991

Variable Name	Estimated Coefficient	Standard Error	T-Ratio 379 DOF
DEP	0.7497	0.6752	1.110
LON	-0.0229	0.5117	-0.044
INV	-0.0610	0.3966	-0.153
PLAB	-0.8253	0.6314	-1.307
PCAP	1.8253	0.6314	1.307
DEP2	0.2110	0.1026	2.056
LON2	0.1882	0.0477	3.941
INV2	0.2056	0.0302	6.803
DEPLON	-0.1175	0.0696	-1.689
DEPINV	-0.1586	0.0587	-2.701
LONINV	-0.0185	0.0414	-0.449
PLAB2	0.0903	0.0501	1.802
PCAP2	0.0903	0.0501	1.802
PLABCAP	-0.0903	0.0501	-1.802
PLABDEP	0.0104	0.0572	0.183
PCAPDEP	-0.0104	0.0572	-0.183
PLABLON	-0.0133	0.0416	-0.319
PCAPLON	0.0133	0.0416	0.319
PLABINV	0.0085	0.0331	0.257
PCAPINV	-0.0085	0.0331	-0.257
RISK	0.0374	0.0135	2.768
BRANCH	0.1119	0.0170	6.582
CONSTANT	7.1139	4.2297	1.681
R-Square:		R2	0.982
Log Likelihood Function:		LLF	382.081
Durbin-Watson:		DW	1.692
Sum of Squared Errors:		SSE	385.804

1990

Variable Name	Estimated Coefficient	Standard Error	T-Ratio 379 DOF
DEP	1.5546	0.6373	2.439
LON	-1.2818	0.5917	-2.165
INV	0.1222	0.4232	0.288
PLAB	-0.6339	0.4549	-1.393
PCAP	1.6339	0.4549	1.393
DEP2	0.0596	0.0652	0.914
LON2	0.2022	0.0351	5.746
INV2	0.1276	0.0329	3.869
DEPLON	-0.0677	0.0445	-1.518
DEPINV	0.0145	0.0482	0.301
LONINV	-0.1406	0.0367	-3.827
PLAB2	0.0477	0.0432	1.105
PCAP2	0.0477	0.0432	1.105
PLABCAP	-0.0477	0.0432	-1.105
PLABDEP	-0.1151	0.0529	-2.176
PCAPDEP	0.1151	0.0529	2.176
PLABLON	0.1433	0.0476	3.007
PCAPLON	-0.1433	0.0476	-3.007
PLABINV	0.0134	0.0355	0.377
PCAPINV	-0.0134	0.0355	-0.377
RISK	0.0261	0.0151	1.732
BRANCH	0.0879	0.0183	4.779
CONSTANT	6.9931	2.7866	2.509
R-Square:		R2	0.980
Log Likelihood Function:		LLF	317.683
Durbin-Watson:		DW	1.848
Sum of Squared Error:		SSE	386.053

1989

Variable Name	Estimated Coefficient	Standard Error	T-Ratio 379 DOF
DEP	0.7404	0.6326	1.170
LON	-0.9651	0.5505	-1.752
INV	0.6234	0.3337	1.868
PLAB	-1.2041	0.4736	-2.542
PCAP	2.2041	0.4736	2.542
DEP2	0.0135	0.0643	0.210
LON2	0.1499	0.0455	3.291
INV2	0.1452	0.0249	5.813
DEPLON	-0.0036	0.0527	-0.068
DEPINV	0.0053	0.0413	0.128
LONINV	-0.1595	0.0340	-4.690
PLAB2	0.0945	0.0411	2.297
PCAP2	0.0945	0.0411	2.297
PLABCAP	-0.0945	0.0411	-2.297
PLABDEP	-0.0643	0.0599	-1.073
PCAPDEP	0.0643	0.0599	1.073
PLABLON	0.1286	0.0490	2.621
PCAPLON	-0.1286	0.0490	-2.621
PLABINV	-0.0184	0.0296	-0.624
PCAPINV	0.0184	0.0296	0.624
RISK	-0.0241	0.0149	-1.613
BRANCH	0.1509	0.0219	6.860
CONSTANT	10.081	2.9455	3.422
R-Square:		R2	0.985
Log Likelihood Function:		LLF	337.198
Durbin-Watson:		DW	1.869
Sum of Squared Errors:		SSE	383.770

1988

Variable Name	Estimated Coefficient	Standard Error	T-Ratio 379 DOF
DEP	1.3832	0.4987	2.773
LON	-0.9187	0.3744	-2.453
INV	-0.0206	0.2774	-0.074
PLAB	-2.5490	0.6877	-3.706
PCAP	3.5490	0.6877	3.706
DEP2	0.0578	0.0607	0.952
LON2	0.2314	0.0291	7.933
INV2	0.1420	0.0276	5.139
DEPLON	-0.0715	0.0375	-1.903
DEPINV	0.0268	0.0456	0.587
LONINV	-0.1643	0.0312	-5.256
PLAB2	0.2342	0.0623	3.758
PCAP2	0.2342	0.0623	3.758
PLABCAP	-0.2342	0.0623	-3.758
PLABDEP	-0.1173	0.0434	-2.701
PCAPDEP	0.1173	0.0434	2.701
PLABLON	0.1173	0.0308	3.805
PCAPLON	-0.1173	0.0308	-3.805
PLABINV	0.0214	0.0268	0.797
PCAPINV	-0.0214	0.0268	-0.797
RISK	-0.0385	0.0127	-3.013
BRANCH	0.1887	0.0185	10.186
CONSTANT	17.522	3.7936	4.618
R-Square:		R2	0.984
Log Likelihood Function:		LLF	398.514
Durbin-Watson:		DW	1.684
Sum of Squared Error:		SSE	384.206

CRITICAL T VALUES FOR TWO SIDED TESTS

10%	SIGNIFICANCE	1.645
5%	SIGNIFICANCE	1.960
1%	SIGNIFICANCE	2.576

TABLE 8 (Continued)

1987

Variable Name	Estimated Coefficient	Standard Error	T-Ratio 379 DOF
DEP	0.0735	0.4822	0.152
LON	-0.5455	0.4002	-1.362
INV	0.6440	0.2739	2.350
PLAB	-1.0323	0.5650	-1.827
PCAP	2.0323	0.5650	1.827
DEP2	0.1599	0.0378	4.226
LON2	0.2712	0.0305	8.883
INV2	0.0660	0.0165	3.997
DEPLON	-0.1556	0.0266	-5.842
DEPINV	0.0294	0.0269	1.091
LONINV	-0.1138	0.0251	-4.526
PLAB2	0.0870	0.0549	1.582
PCAP2	0.0870	0.0549	1.582
PLABCAP	-0.0870	0.0549	-1.582
PLABDEP	-0.0174	0.0434	-0.402
PCAPDEP	0.0174	0.0434	0.402
PLABLON	0.0803	0.0348	2.304
PCAPLON	-0.0803	0.0348	-2.304
PLABINV	-0.0178	0.0260	-0.686
PCAPINV	0.0178	0.0260	0.686
RISK	-0.0447	0.0105	-4.222
BRANCH	0.1575	0.0136	11.572
CONSTANT	9.7625	3.0338	3.217
R-Square:		R2	0.991
Log Likelihood Function:		LLF	374.478
Durbin-Watson:		DW	1.617
Sum of Squared Errors:		SSE	376.813

1986

Variable Name	Estimated Coefficient	Standard Error	T-Ratio 379 DOF
DEP	2.1050	0.4117	5.113
LON	-0.9920	0.3471	-2.857
INV	-0.7619	0.3499	-2.177
PLAB	-0.4127	0.4483	-0.920
PCAP	1.4127	0.4483	0.920
DEP2	0.0798	0.0485	1.645
LON2	0.1522	0.0344	4.414
INV2	0.2278	0.0383	5.946
DEPLON	-0.0341	0.0355	-0.959
DEPINV	-0.0599	0.0417	-1.434
LONINV	-0.1498	0.0339	-4.409
PLAB2	0.0221	0.0412	0.536
PCAP2	0.0221	0.0412	0.536
PLABCAP	-0.0221	0.0412	-0.536
PLABDEP	-0.1613	0.0385	-4.190
PCAPDEP	0.1613	0.0385	4.190
PLABLON	0.1438	0.0319	4.504
PCAPLON	-0.1438	0.0319	-4.504
PLABINV	0.0781	0.0288	2.709
PCAPINV	-0.0781	0.0288	-2.709
RISK	-0.0205	0.0121	-1.687
BRANCH	0.2176	0.0136	15.979
CONSTANT	5.6613	2.5651	2.207
R-Square:		R2	0.986
Log Likelihood Function:		LLF	285.635
Durbin-Watson:		DW	1.397
Sum of Squared Error:		SSE	376.918

1985

Variable Name	Estimated Coefficient	Standard Error	T-Ratio 379 DOF
DEP	0.3840	0.3112	1.233
LON	0.4781	0.3037	1.574
INV	0.0240	0.2531	0.095
PLAB	-1.5401	0.1974	-7.798
PCAP	2.5401	0.1974	7.798
DEP2	0.0476	0.0720	0.660
LON2	0.2061	0.0719	2.863
INV2	0.1116	0.0233	4.779
DEPLON	-0.0832	0.0644	-1.292
DEPINV	0.0303	0.0429	0.707
LONINV	-0.1351	0.0474	-2.846
PLAB2	0.1918	0.0236	8.110
PCAP2	0.1918	0.0236	8.110
PLABCAP	-0.1918	0.0236	-8.110
PLABDEP	-0.0163	0.0323	-0.505
PCAPDEP	0.0163	0.0323	0.505
PLABLON	-0.0116	0.0292	-0.399
PCAPLON	0.0116	0.0292	0.399
PLABINV	0.0257	0.0295	0.868
PCAPINV	-0.0257	0.0295	-0.868
RISK	-0.0035	0.0121	-0.294
BRANCH	0.2204	0.0207	10.605
CONSTANT	8.6987	1.1158	7.795
R-Square:		R2	0.981
Log Likelihood Function:		LLF	233.914
Durbin-Watson:		DW	1.817
Sum of Squared Errors:		SSE	386.270

1984

Variable Name	Estimated Coefficient	Standard Error	T-Ratio 379 DOF
DEP	-0.4567	0.4127	-1.106
LON	1.6010	0.3954	4.048
INV	-0.5053	0.3471	-1.455
PLAB	-1.5889	0.2563	-6.198
PCAP	2.5889	0.2563	6.198
DEP2	0.2168	0.0969	2.238
LON2	0.2478	0.0856	2.895
INV2	0.2487	0.0788	3.154
DEPLON	-0.1834	0.0793	-2.310
DEPINV	-0.0036	0.0685	-0.053
LONINV	-0.1587	0.0580	-2.734
PLAB2	0.2094	0.0318	6.581
PCAP2	0.2094	0.0318	6.581
PLABCAP	-0.2094	0.0318	-6.581
PLABDEP	0.0523	0.0489	1.069
PCAPDEP	-0.0523	0.0489	-1.069
PLABLON	-0.0629	0.0478	-1.316
PCAPLON	0.0629	0.0478	1.316
PLABINV	0.0097	0.0336	0.290
PCAPINV	-0.0097	0.0336	-0.290
RISK	0.0437	0.0132	3.296
BRANCH	0.1668	0.0199	8.379
CONSTANT	9.5352	1.2563	7.590
R-Square:		R2	0.989
Log Likelihood Function:		LLF	164.307
Durbin-Watson:		DW	1.431
Sum of Squared Error:		SSE	299.334

CRITICAL T VALUES FOR TWO SIDED TESTS

10%	SIGNIFICANCE	1.645
5%	SIGNIFICANCE	1.960
1%	SIGNIFICANCE	2.576

Notes

1 A review of some recent research on cost economies in banking in developing countries is presented in Cuevas (1989).

2 In 1975 real GDP declined by 12.9 percent. The 1982 recession was even more severe as real GDP plunged 14.1 percent.

3 World Bank (1989) estimate. For a detailed discussion of the nature, causes and consequences of the financial crisis, and subsequent banking reforms see Nauriyal (1993).

4 Adar et al (1975) were the first strongest proponents for adoption of this approach. Santomero (1984) provides a good review of the modeling of banking firm production.

5 A convex input structure basically requires that (a) F be twice differentiable, (b) F be strictly increasing in Q and strictly decreasing in X, and (c) Q is finite if and only if X is finite. See McFadden (1978).

6 These conditions are that the firm pursue cost minimization, and that costs be positive, homogeneous, non-decreasing, and a concave function of factor prices.

7 Though suitably appealing in all other respects, the translog cost specification has one important shortcoming. Because the natural logarithm of zero is not finitely defined, $q_i = 0$ implies $\ln q_i = -\infty$, which in turn implies that $\ln C = -\infty$, and therefore $C = 0$. This is to say that whenever a multiproduct firm does not produce all of the various outputs, the translog cost function automatically yields zero costs. To surmount this problem, Caves et al. (1980) proposed the use of a Box-Cox transformation to define output quantities, while maintaining the log metric for cost and input prices. This "hybrid translog" specification has not proved very popular however, because it is generally difficult to analyze and it does not permitrepresentation of the relevant cost properties as tractable expressions of its parameters (Baumol et al., 1988).

8 Of the four sociedades financieras, one (Financiera Comercial), was restructured and rechartered in April, 1990 to begin operations as a bank. However, since this institution operated as a sociedad financiera for all but one year of the period of investigation, I treat it as such in my analysis.

9 On a related point, all adjustments I make to the data are unrelated to the 'correccion monetaria' adjustments which are reported in the monthly financial statements. The item correcion monetaria in the financial statements is a mandatory aggregate adjustment for inflation that can be made to total income and total expenses. Since such an adjustment in the data source is not for each disaggregated item on the income and expenditure statement but rather an aggregated adjustment, one for total income and one for total expenses, I simply take the unadjusted nominal values of each relevant variable and deflate them by the CPI, to ensure that there is no double correction.

10 For instance, demand deposits can be considered inputs to the extent that banks use them to make loans. On the other hand, to the extent that they provide the benefits of convenience and store of value to depositors, offering of deposit services by banks can be considered an output. Such problems arise because banks also provide services which are difficult to measure with a quantitative unit.

11 A survey of these measures is presented in Gilbert (1984).

12 Administrative expenses include among others, expenses for office supplies and furnishings, rents for office space, repair and maintenance of fixed assets, advertising, and fines paid. Non-income taxes include real estate taxes and other stamp taxes.

13 Sociedades Financieras are banking institutions that are not allowed to offer checking deposit services. Although this classification has little to do with ownership per se, they are placed as a distinct category within the ownership grouping solely as a matter of convenience. Since they operate under a different set of regulations than banks, they are analyzed separately.

14 The alternative technique of estimating the system of equations that comprises the cost equation and the share equation easily derived from it, using the Seemingly Unrelated Regression Equations (SURE) framework is not the preferred estimation approach. The efficiency gains from SURE can only be justified in studies that employ cross sectional data since it is well known that such a procedure could yield seriously biased estimates if the analysis is also undertaken over time as it implicitly assumes that there is no lag in the adjustment of costs to changes in factor input prices (Johnston [1984]). Though OLS is not immune to this drawback, the misspecification of both the cost function and the share equation is likely to amplify the bias in estimation with SURE. Further, when the residuals for each bank in a given group exhibit different orders of autocorrelation, efficiency gains from SURE under such conditions are unknown, and have yet to be documented.

The individual bank and time effects are isolated by estimating:

$$(Y_{it} - Y_{i.} - Y_{.t} + Y_{..}) = \sum_{k=2}^{K} (X_{kit} - X_{ki.} - X_{k.t} + X_{k..})\,\beta_k + \upsilon_{it}$$

where $X_{ki.} = \sum_{t=1}^{T} X_{kit}/T;\ X_{k.t} = \sum_{i=1}^{N} X_{kit}/N;\ X_{k..} = \sum_{i=1}^{N}\sum_{t=1}^{T} X_{kit}/NT$

The individual and time effects, and the intercept are thus obtained as:

$$\hat{\mu}_i = (Y_{i.} - Y_{..}) - \sum_{k=2}^{k} (X_{ki.} - X_{k..})\,\beta_k;\ \hat{\lambda}_t = (Y_{.t} - Y_{..}) - \sum_{k=2}^{k} = (X_{k.t} - X_{k..})\,\beta_k$$

$$\hat{\alpha}_1 = Y_{..} - \sum_{k=2}^{k} X_{..}\,\beta_k.$$ See Judge et. al (1988) for more details.

16 See Kmenta (1989).

17 Because of the nature of the data, tests were conducted for detection of an AR(1), AR(4), AR(8), and AR(12) process for each bank. These tests suggested an AR(12) process correction for only 6 banks, that also exhibited a significant ρ for either an AR(1) or AR(4) process correction. Eleven banks showed a significant ρ for an AR(8) process correction, while all of these banks also showed a significant ρ for either an AR(1) or AR(4) process correction. Since "true" correction for higher order autocorrelation requires a complex set of transformations on the error terms or loss of information as the first set of observations need to be dropped, the possible gains from doing so were sacrificed and traded off in favor of a less accurate albeit relatively simpler process, by correcting all banks that indicated any autocorrelation of order AR(8) or AR(12) for only either an AR(1) or AR(4) process. In each case, the Prais-Winston correction was performed as this procedure preserves all observations with the necessary transformations to correct for autocorrelation (Judge et al. 1988, pg. 195).

The Breusch-Pagan-Godfrey test and Glejser test were applied to diagnose the presence of heteroskedasticity. The Breusch-Pagan-Godfrey test suggested the presence of heteroskedasticity in only 7 of the 37 financial institutions at the 5 percent level, while the Glejser test was more sensitive indicating the presence of the problem in 23 of the 37 institutions. Upon further exploration based on an eyeball test of the residuals plotted against time, and the predicted value of the dependent variable, no significant problem was suggested. Rather a few outliers in the data seemed to suggest spurious heteroskedasticity. Consequently, the problem was not paid any more attention.

In sum, of the 37 financial institutions, data for nineteen institutions was corrected for the presence of an AR(1) autocorrelation process and another 5 institutions for an AR(4) process.

18 There are two concepts of economies of scope - global and product-specific, both of which are discussed in Appendix A. As discussed briefly in Gilligan Smirlock, & Marshall (1984), Clark (1988), and in detail in Benston et. al (1983), the inherent limitations of the translog specification make any estimate of global economies of scope unreliable and the exercise of obtaining such a measure adds little value to this study. Instead, as a viable alternative to computing an unreliable measure for global economies of scope under such circumstances, researchers have demonstrated that a sufficient condition for the presence of global economies of scope is the existence of product-specific economies of scope, i.e. cost complementarities, among all pairs of products in the product mix. Consequently, only product-specific economies of scope are derived and reported.

19 This reinforces the crucial importance of reporting not only the scale and scope economy estimate but also their standard error - a practice that many prior studies have failed to adhere to. The findings presented here illustrate clearly why it is imprudent to draw regulatory implications, and worse yet, base policy recommendations on scale or scope economy measures presented without their standard errors.

20 See Buse (1982) for a theoretical elucidation, and Murray and White (1983), Fuss and Waverman (1981) among others, for an application.

References

ADAR, Z., AGMON TAMIR, AND YAIR E. ORGLER, 1975, Output Mix and Jointness in Production in the Banking Firm, Journal of Money, Credit, and Banking 7, 235-43.

AVERY, ROBERT B., 1977, Error Components and Seemingly Unrelated Regressions, Econometrica 45, 199-209.

BALTENSPERGER, E., 1972, Economies of Scale, Firm Size, and Concentration in Banking, Journal of Money, Credit and Banking 3, 467-88.

BANCO CENTRAL DE CHILE, Various Issues, Boletin Mensual, Departmento de Informaciones Estadisticas y Publicaciones, Santiago.
BAUMOL, WILLIAM J., JOHN C. PANZAR, AND ROBERT D. WILLIG, 1988, Contestatble Markets and the Theory of Industry, (Harcourt Brace Jovanovich: New York).
BENSTON, GEORGE J., 1965, Branch Banking and Economies of Scale, Journal of Finance 20, 312-331.
BENSTON, GEORGE J., 1972, Economies of Scale of Financial Institutions, Journal of Money, Credit, and Banking 4, 321-341.
BENSTON, GEORGE J., ALLEN N. BERGER, GERALD A. HANWECK, AND DAVID B. HUMPHREY, 1983, Economies of Scale and Scope in Banking," Research Paper in Banking and Financial Economics, Board of Governors of the Federal Reserve System, 1983.
BENSTON, GEORGE J., GERALD A. HANWECK, AND DAVID B. HUMPHREY, 1982, Scale Economies in Banking: A Restructuring and Reassessment, Journal of Money, Credit, and Banking 14, 435-456.
BERGER, ALLEN N. GERALD A. HANWECK, AND DAVID B. HUMPHREY, 1986, Competitive Viability in Banking: Scale, Scope, and Product Mix Economies, Journal of Monetary Economics 20, 501-520.
BINSWANGER, HANS P. 1974, A Cost Function Approach to the Measurement of Elasticities of Factor Demand and Elasticities of Substitution, American Journal of Agricultural Economics 25, 377-386.
BUSE, A., 1982, The Likelihood Ratio, Wald, and Lagrange Multiplier Tests: An Expository Note, The American Statistician 36, 153-157.
CAVES, DOUGLAS W., LAURITUS R. CHRISTENSEN, AND MICHAEL W. TRETHEWAY, 1980, Flexible Cost Functions for Multiproduct Firms, Review of Economics and Statistics 62, 477-481.
CHRISTENSEN, L.R., D.W. JORGENSON, AND L.J. LAU, 1973, Transcendental Logarithmic Production Frontiers, Review of Economics and Statistics 55, 28-45.
CLARK, JEFFREY A., 1988, Economies of Scale and Scope At Depository Financial Institutions: A Review of Literature, Economic Review, Federal Reserve Bank of Kansas City (September/October 1988), 16-33
CUEVAS, CARLOS E., 1989 "Transaction Costs of Financial Intermediation in Developing Countries, Department of Agricultural Economics and Rural Sociology Ocassional Paper No. 1469, The Ohio State University.
DE LA CUADRA S. AND SALVADOR VALDES-PRIETO, 1992, Banking Structure in Chile, in George Kaufman ed. Banking Structures in Major Countries, (Kluwer Academic Publishers: Boston).
FULLER WAYNE A., 1962, Estimating the Reliability of Quantities Derived from Empirical Production Functions, Journal of Farm Economics 44, 82-89.
FUSS, MELVYN A. and Leonard Waverman, 1981, "Telecommunications" in: G. Fromm ed. Studies in Public Regulation, (Harvard University Press:Cambridge).
GILBERT, R. ALTON, 1984, Bank Market Structure and Competition: A Survey, Journal of Money, Credit, and Banking 16, 617-645.
GILLIGAN, THOMAS W., MICHAEL SMIRLOCK, AND WILLIAM MARSHALL, 1984, Scale and Scope Economies in the Multiproduct Banking Firm, Journal of Monetary Economics 13, 393-405.
HUMPHREY, DAVID B., 1987, Cost Dispersion and the Measurement of Economies in Banking, Economic Review 73, Federal Reserve Bank of Richmond, 24-38.
JOHNSTON, J., 1984, Econometric Methods, (McGraw-Hill:New York).
JUDGE, G.G., W.E. GRIFFITHS, R. C. HILL, H. LUETKEPOHL, AND TSOUNG-CHAO LEE, 1988, The Theory and Practice of Econometrics, Wiley: New York).
KMENTA, JAN, 1989, Elements of Econometrics, (Macmillan: New York).
KOLARI, JAMES AND ASGHAR ZARDKOOHI, 1987, Bank Costs, Structure, and Performance, (Lexington Books: Lexington, MA).
LAITINEN, K., A Theory of the Multiproduct Firm, (North Holland:New York).
MCFADDEN, DANIEL, 1978, Cost, Revenue, and Profit Functions, in: M. Fuss and D. McFadden, eds., Production Economics: A Dual Approach to Theory and Applications, Vol.1, (North Holland, Amsterdam).
MESTER, LORETTA J., 1987, A Multiproduct Cost Study of Savings and Loans, Journal of Finance 42, 423-445.
MURRAY, JOHN D. AND ROBERT W. White, 1983, Economies of Scale and Economies of Scope in Multiproduct Financial Institutions: A Study of British Columbia Credit Unions, Journal of Finance 38, 887-902.
NAURIYAL, BHARAT B., 1993, An Assessment of Operational Efficiency in the Chilean Banking System: 1984-1991, Unpublished Ph.D. Dissertation, Department of Economics, The Ohio State University, Columbus, Ohio.

PANZAR, J.C., AND R.D. WILLIG, 1981, "Economies of Scope, American Economic Review 71, 268-272.
SEALEY, C.W. AND J.T. LINDLEY, 1977, Inputs, Outputs, and a Theory of Production and Cost at Depository Institutions, Journal of Finance 32,
SANTOMERO, ANTHONY M., 1984, Modeling the Banking Firm: A Survey, Journal of Money, Credit, and Banking 16, 576-602.
SUPERINTENDENCIA DE BANCOS E INSTITUCIONES FINANCIERAS, Various Issues, Information Financeria, Santiago.
WORLD BANK, 1989, Chile, in: Trends in Developing Economies, The World Bank, Washington, D.C., 78-84.