DISSERTATION

SCALE ECONOMIES, SCOPE ECONOMIES, AND STRUCTURE CONDUCT PERFORMANCE RELATIONSHIPS IN JORDANIAN BANKING SYSTEM, 1990-2000

Submitted by

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ABSTRACT OF DISSERTATION

SCALE ECONOMIES, SCOPE ECONOMIES, AND STRUCTURE CONDUCT PERFORMANCE RELATIONSHIPS IN JORDANIAN BANKING SYSTEM, 1990-2000

The objective of this dissertation is to investigate evidence of economies of scale and scope, and to analyze the competitive conditions in the Jordanian banking market during the period 1990-2000. The analysis has been prompted by the monetary authority's claims that cost savings could be expected from the merger policy, which in turns promotes efficiency of banks in Jordan. Economies of scale and scope and the SCP relationship, a substantial part of the industrial organizations literature, have been widely examined in USA and European banking systems. The dissertation aims to rectify this imbalance in the literature by providing a detailed and in-depth analysis of scale and scope economies as well as structure performance relationship in the Jordanian banking market.

The study estimates translog cost functions for the entire banking system, small banks, medium banks, large banks, domestic banks, and foreign banks. Then the estimated coefficients of the translog cost functions were utilized to compute the magnitudes of scale and scope economies. The study also estimates a full system of

translog cost equations by using the technique of Zellner's iterative seemingly unrelated regression (SUR). Finally, the study analyzes the competitive conditions in the Jordanian banking market by estimating different specifications of profit equations.

The main findings of the study on measure of overall economies of scale indicate that increasing returns to scale are observed in all classes of bank size as well as in foreign and domestic banks. The findings of the study suggest that the cost curves of the Jordanian banks were downward sloping in the years 1990-2000. Therefore, the findings of the study support the monetary authority's policy of encouraging banks to merge, particularly the small banks; since such policy will enable the banks to fully exploit economies of scale and will improve the banks' cost efficiency. This in turn will improve the efficiency of the banking market as a whole.

The results of scope economies appear to be less clear-cut than the scale economy findings. The single translog cost function results show that the banking system experienced diseconomies of scope during 1990-2000. On the other hand, the results of the full system of translog cost equations suggest that cost complementarities do exist between loans and investments. These scale and scope economies results do not provide support for the existence of natural monopoly in the Jordanian banking system.

The results obtained from investigating the competitive conditions in the Jordanian banking market show that the traditional structure-conduct-performance paradigm holds true in the Jordanian banking system, and this implies that the profit-concentration relationship is positive. This result is robust with respect to model specifications and measurement of market concentration.

The policy maker in Jordan has to make a judgment about the extent to which diminished competition, that may arises from merger policy, is offset by the benefits of lower costs, i.e. the amount of the expected savings in total costs should be compared to an estimate of the disadvantages, if any, of favoring larger banks.

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CHAPTER 1: INTRODUCTION

Background

In the aftermath of the financial crisis that hit Jordan's economy in 1989, the government has undertaken a bold and comprehensive modernization reform program in the financial sector. The program aims at improving the efficiency of the banking system, enhancing competition amongst banks, and strengthening the legal and regulatory capacity of supervisory agencies for the capital markets, insurance, pension funds, and banking. The intent of this policy is to make Jordanian companies attractive to domestic and foreign investors, adopt an interest rate policy that promotes investment and growth, and increase the banking sector's efficiency.

An important element of the reform strategy in the banking sector is to increase competition for the banking system through capital market development, and to create sound and healthy large institutions that are capable of facing the potential regional and international competition. In this regard, the Central Bank of Jordan (CBJ) plays a crucial role in banking legislation and supervision.

In 1995, the CBJ produced a new Deposit Insurance Corporation Law and a new Banking Law compatible with the Basle Agreement. The Banking Law clearly defines the scope of the banking business; spells out banking licensing procedures;

establishes CBJ's right to set core prudential requirements (including loan classification, provisioning requirement and single and group borrower credit limits and limits on loans to insiders); and establishes of the authority of the CBJ to intervene in unstable banks, including bank liquidation procedures.

The CBJ has required the banks to meet the 12% capital adequacy requirement since end June 1997, as well as to meet the minimum capital requirement of Jordan Dinar (JD) 20 millions by end December 1997.[1] CBJ may raise the level of capital to reach JD 40 million in the near future.

In the light of the CBJ policy to encourage banks to merge so as to create bigger and stronger banks, it is important to analyze the performance of the Jordanian banks through evaluating the cost economies and investigating the competitive conditions through structure performance relationships. Such an exercise will help the policy maker to carry out a current assessment and future projections of the performance and health of the banking units, and hence evaluate and maintain the stability of these institutions, which is vital to the entire economy. Gilbert (1984) stated that the empirical studies which investigated the effect of market structure on banks performance are divided into two groups, those in one group estimate the cost structure of the banking industry, and the other studies estimate the relation between measures of bank market structure and performance.

One important rationale for investigating the structure - performance relationships in Jordan is that no study has been undertaken investigating the competitive behavior of the Jordanian banking system, and such an empirical

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[1] One JD equals $1.4.

investigation may yield insights that could be of interests to bankers and policy makers. The analysis of these relationships in banking will help to evaluate the policy issue as to which type of banking structure delivers the best outcomes to the public in terms of the cost and availability of banking services. The structure performance relationship studies provide bank regulators with information on the potential social impact of bank merger and acquisitions (Evanoff and Fortier, 1988).

The empirical investigation of the structure performance relationship in Jordanian banking system will reveal which hypothesis best explains the performance of the banking system in Jordan: the Structure Conduct Performance (SCP) hypothesis or the efficient structure hypothesis. The SCP hypothesis states that market concentration influences the level of competition amongst its firms, the more concentrated the market the lower is the level of competition and the higher profits firms earn. On the other hand, the efficiency hypothesis maintains that the firm efficiency (lowest cost operations) explains the relationships between market structure and performance (Williams, Molyneux, and Thornton, 1994).

If the SCP hypothesis is found to hold in the Jordanian banking market, then the impact of the CBJ policy to encourage mergers is more likely to cause a further reduction in market competition. On the other hand, if the efficiency hypothesis is found to hold in the Jordanian banking market, then further market concentration and hence the CBJ policy of promoting mergers might be justified on efficiency grounds.

Closely related to the structure performance relationships are the concepts of scale and scope economies. They are related because these issues influence the market structure, profitability, competition, and hence the efficiency of the banking system.

Gilbert (1984) stated that there has been a significant development in the literature of the cost structure of banks, which deals with issues closely related to those in the studies of bank market structure and performance. The cost studies are designed to determine whether a policy of discouraging bank consolidations that increases market concentration prevents banks from exploiting economies of scale and scope in operating costs.

Knowledge of the cost function is important for optimal decision making by regulators. It is also important for banks to estimate its own costs since knowing the marginal cost for each service could help management decision-making. In their review of the studies that analyzed the cost function, Molyneux, Altunbas, and Gardener (1996) stated the following important reasons why the cost functions deserve empirical investigation.

1) Cost is an important factor for regulators when considering certain banking policies such as mergers. If the banking market composed of many small banks, then the regulators may adopt the merger policy if economies of scale and scope exist. On the other hand, if the market consists of small number of banks and economies of scale and scope are exhausted, and then regulators may discourage mergers on anti-competitive grounds.

2) Cost are important determinants of price and output in all markets including the banking markets, since the profit maximizing objective of the firm is to equate marginal cost to marginal revenue.

3) Costs in the form of minimum efficient scale of output are important determinants of barriers to entry, i.e. scale economies could be a barrier to

entry when fixed costs are sunk, and this allows long run extra profits which are not based on efficiency.

4) Cost influences market structure, if economies of scale exist in a given market, the number of firms in the market will be small, and an oligopolistic market structure may result in the long run.

In sum, the empirical investigation of those issues, in the light of the banking sector reform ongoing since 1989 and the CBJ policy to encourage the Jordanian banks to merge, is important to determine the structure of the banking system that best serves the public and to maintain a sound and healthy banking units which is crucial to the whole economy.

Statement of the Problem

The problem is to determine whether CBJ is following a reasonable policy to promote efficiency in the Jordanian banking system. This will be undertaken by examining the economies of scale and scope, and the structure performance relationships in the Jordanian banking industry. This is an important problem because:

1) The banks in Jordan are an important sector in the economy and dominate the financial system. The total assets of the banks constitute 85% of the total assets of the Jordanian financial system and represent 218% of gross domestic product at end 2000. The analysis of the bank costs is vital, since unstable and unhealthy financial institutions can well deliver adverse consequences to the other sectors of the economy.

2) Bank scale and scope economies provide an indicator of whether banks can remain profitable overtime. Clark (1988) stated that banks will potentially be more and more profitable if extensive cost savings can be achieved as firms expand their operations. Kim and Weiss (1989) indicated that the economic performance of banks may substantially affect the ability of the monetary policy to operate efficiently. Thus, the measurement and analysis of banks scale and scope economy is important.

3) How banks adapt in a changing environment and how they thrive becomes a critical factor in maintaining the soundness and stability of the financial institutions. The process of reforming these institutions had started in the first half of nineties and still ongoing, hence, such reforms provide an opportunity to examine in an empirical manner the effects of these changes on the scale and scope economies, and the structure performance relationships of the Jordanian banking market. This dissertation, which covers the period 1990-2000, will enable the policy makers and the bankers to detect the impact of these changes on the banking system, and also will provide evidence of whether these changes are justified. Benston (1972) indicated that "to understand the impact of changing regulations on the financial industry, it is necessary to know the cost structure of the industry, since this structure in turn determines the optimal bank size and product mix in the industry".

4) The Jordanian banks face increasing competition from foreign banks in the West Bank and Gaza Strip, where the Jordanian banks also have been working alongside the Israeli and Palestinian banks after the peace treaty with Israel;

hence the structure performance relationships, and the economies of scale and scope take an additional significance in the context of Jordanian banks.

5) The availability of the scale and scope economies, and the structure performance relationships studies in developing economies are relatively few, although many studies have been undertaken during the last three decades to investigate these issues in developed economies. As far as Jordan is concerned, this study will be the first that will undertake an empirical investigation of the scale and scope economies, and the structure performance relationships of banks in Jordan.

6) A study of the scale and scope economies, and the structure performance relationships for banking industry can provide some policy implications. Estimates of scale and scope economies can help managers to estimate costs under different scenarios, such as mergers, an increase or decrease in the number of branches, or an increase or decrease in specific outputs or services. Kolari and Zardkoohi (1987) indicated that bank managers need to know whether scope economies (or diseconomies) exist between the combined outputs in order to choose the optimal combination of outputs to produce. For regulators and policy makers, it is not only critical to know whether or not scale and scope economies exist, but knowledge of whether it applies to all sizes of banks or emerge only for specific types of output or services, and measurement of their magnitudes are also crucial (Benston, 1972). Goldstein, McNulty, and Verbrugge (1987) stated that regulators have interest in investigating the cost structure of banking sector because the regulators'

decision on mergers, entry, and branching have an impact on the size structure of the financial services industry. Also, regulators need to know whether the merger policy decreases the level of competition between banks or the increased market concentration can be justified on efficiency grounds.

7) An investigation of the cost structure and the structure performance relationships of the Jordanian banking system can provide additional lessons and policy implications for other neighboring developing economies, which are similar to the Jordanian economy, and are currently in the process of restructuring their financial systems.

Hypotheses

This dissertation will seek to undertake an empirical investigation of the incidence and magnitude of economies of scale and scope, and to investigate the structure performance relationships in the Jordanian banking system. Toward that end, the hypotheses to be tested in this dissertation are designed to focus on the following questions.

Economies of Scale:

1) Can banking production technology utilized by the Jordanian banks be characterized by the transcendental logarithmic form (translog function)? Murray and White (1983) mentioned that the translog cost function allows the incorporation of more than one output as separate variables. Benston, Hanweck, and Humphrey (1982) stated that the translog cost function permits the estimates of U-shaped average cost curves. Many other studies used the translog cost function such as Noulas, Ray, and Miller (1990), and Gropper (1991).

2) Does the Jordanian banking market, as a whole, show any evidence of economies or diseconomies of scale? Gropper (1991) stated that if economies of scale exist in banking, then least cost provision of banking services would be accomplished by relatively fewer, but large banks. Benston, Hanweck, and Humphrey (1982a) concluded that the studies, which used the 1960's data, reported scale economy values from 0.93-0.95 in U.S. banks.

3) Did the estimates of scale economies or diseconomies change during the period of the study 1990-2000? Humphrey and Pulley (1997) stated that deregulation of the interest rates will raise the costs of the banking industry, in response; banks may reduce branch-operating costs (cost offset), and shift to higher earning assets (revenue augmentation). Gropper (1991) stated that the regulatory changes are likely to affect the cost structure of banks, and hence, their economies or diseconomies of scale estimate. In particular, did the estimates of scale economies (if they exist) improve after 1996? since most of the structural and regulatory changes which were introduced by the CBJ took place at the end of 1996. An example of these reforms are: liberalizing the credit and debit interest rate where the interest rates are determined by the invisible hand instead of the visible hand (CBJ), the adoption of indirect instruments of monetary policy, abolishing the need to hold reserves against inter-bank deposit so as to enhance and stimulate a liquid inter-bank market, abolishing restrictions on the volume of credit facilities extended to economic sectors, deregulating the banking commission and fees, and enhancing the CBJ supervisory and regulatory role to maintain a sound and healthy banking units.

4) Are there differences in the extent to which the various banks are able to exploit economies of scale based on their size? i.e. do all bank groups exhibit the same degree of operational efficiency? Clark (1988) reviewed 13 studies and concluded that overall scale economies exist only at low levels of outputs (below $100 million in deposits), and diseconomies of scale exist at large output levels (above $100 million in deposits). On the other hand, Hughes and Mester (1998) found that banks of all sizes enjoy significant scale economies.

5) Do economies of scale characterize to the same degree the production of financial services by domestic banks, foreign banks? In other words, does the bank ownership (foreign vs. domestic) matter?

Cost Complementarities:

6) Does the Jordanian banking market as a whole, group of banks, domestic banks, and foreign banks show any evidence of cost complementarities (scope economies)? Gilligan, Smirlock, and Marshall (1984) indicated that the significance of the presence of scope economies, alongside with scale economies, is magnified by its essential role in determining whether the banking industry structure is characterized by natural monopoly. Murray and White (1983), Gilligan and Smirlock (1984), Kolari and Zardkoohi (1987), and Gilligan, Smirlock and Marshall (1984) reported significant economies of scope. Other studies such as Benston et al (1983), and Berger, Hanweck and Humphrey (1987) found no significant economies of scope.

Structure Performance Relationship:

7) Does the efficiency hypothesis explain the performance of the Jordanian banking system? The empirical results of this investigation will reveal whether the CBJ's policy of encouraging the banking units to merge can be justified on efficiency grounds. Evanoff and Fortier (1988) found evidence to support the efficiency hypothesis. Or **Does the SCP hypothesis explain the performance of the Jordanian banks?** Heggestad (1984) stated that different regulatory regimes might lead to different relationships between structure and performance; however, it is highly likely that structure will have an impact on performance. The empirical results of this investigation will provide evidence on whether higher concentration ratio implies less competition and therefore higher profits.

The purpose of the Dissertation

The main purpose of this dissertation is to know whether the CBJ's policy of encouraging the banks to merge can be refuted or justified on efficiency grounds, as well as to investigate the effects of the reform measures introduced by the CBJ on the economies of scale and scope, and the structure performance relationships of the banks in Jordan. This necessitates undertaking an empirical investigation of the scale and scope economies, and the structure performance relationships. In doing so, this dissertation will try to accomplish the following:

1) To estimate the cost structure of the Jordanian banking system by estimating cost frontier functions for the period 1990-2000.

2) To calculate the magnitudes of economies of scale in the operation of Jordanian banks and to evaluate evidence of scope economies during the period 1990-2000.

3) To calculate and compare the scale economies magnitudes between small, medium, and large banks, and between the domestic and foreign banks.

4) To compute the marginal costs of banks outputs (loans and investments) for small, medium, and large banks, as well as for foreign and domestic banks.

5) To estimate the structure performance relationships of the banking sector for the periods 1990-2000, 1990-1993, 1994-1997, and 1998-2000. The empirical investigation will reveal which hypothesis explain the performance of the banking sector, and consequently justify or refute the central bank's policy of encouraging the commercial banks to merge.

Organization of the Contents

The dissertation is organized as follows. **Chapter One** is the introduction which explains, and justifies the topic of the dissertation. It consists of the background, statement of the problem, the hypotheses, the purpose of the dissertation, and the organization of the contents.

Chapter Two is theory and literature review. This chapter consists of two sections, the first one (which is the scale and scope economies) provides the theoretical background to economies of scale and scope, explains the concept of economies of scale and scope in the context of multiproduct firms, discusses the sources of economies of scale and scope, explains the banks production and cost function, as well as the banks output measures, presents the functional form employed in the empirical estimation of banks' cost structure, and finally, provides a summary of existing literature on the scale and scope economies of the banking system. The second section is the structure performance relationships. It clarifies the importance of testing the structure performance relationships in the banking sector, and states how the structure performance debate emerged in banking. It also provides a summary of the existing literature on the structure performance relationships of the banking system.

Chapter Three is methodology, data, and definition of variables. This chapter outlines the research methodology and the econometric estimation technique employed in estimation of scale and scope economies, as well as the specification of the bank costs, outputs, and inputs. It also provides the model employed in estimating the structure performance relationship in Jordanian banking, together with an explanation of the model variables.

Chapter Four is the empirical results. This chapter presents the empirical findings on the incidence and magnitude of economies of scale of Jordanian banking system by estimating a translog cost function and a system of cost equations. It first assesses the operational efficiency obtained through the estimation of a cost function for the whole banking system during 1990-2000, then estimating a cost function for the three groups of banks as well as for the domestic and foreign banks. The third section provides the marginal costs of the two outputs (loans Y_1 and investments Y_2). The fourth section reports the results on cost complementarities between the aforementioned two outputs. Finally, the fifth section reports the empirical evidence of the structure performance relationships of the Jordanian banking system.

Chapter Five is a summary and conclusion. It summarizes the findings and conclusions of the dissertation and provides suggestions for future research.

CHAPTER 2: THEORY AND LITERATURE REVIEW

Introduction

This chapter examines the theory behind economies of scale and scope, and the structure performance relationship for financial institutions. It illustrates how the operational efficiency and the competitive conditions of the banking system are empirically evaluated. It also examines the empirical literature on economies of scale and scope, and structure performance relationship in banking market. Such review allows me to compare the results of this study with the results of other studies.

This chapter will enable me to employ the appropriate cost function and the profit equation to undertake the empirical analysis of scale and scope economies, and the structure performance relationship. It also will enable me to choose the appropriate approach to define inputs, outputs, and the cost of production for banks.

The Theoretical Background to the Economies of Scale and Scope

Humphrey (1987) indicated that the concept of economies of scale in banking industry is important because it implies that larger banks have a cost advantage over smaller ones. When a merger occurs, such competitive advantage could be enhanced.

Mester (1987a) stated that the presence of economies of scope imply that firms that were specialized would be at a cost disadvantage and that regulations that restrict the outputs of a firm is allowed to produce may lead to inefficient production. To gauge the effects of public policy in this area, it is necessary to estimate the economies of scale and scope in banking.

Economies of Scale

Economies of scale concept, or returns to scale, refer to the rate at which output changes as all factor quantities are varied. McNulty (1981) indicated that the term economies of scale describe a situation in which large firms operate more efficiently (i.e. at lower average costs) than smaller ones. Hunter and Timme (1986), and Panzar and Willig (1977) stated that economies of scale exist when an increase in all inputs deliver a greater than proportional increase in output, or when an increase in output at constant input prices leads to a less than proportional increase in total costs. In other words, economies of scale exist if a 10% rise in outputs is accompanied by only, say, 8% rise in costs. De Young (1997) defined economies of scale as the cost savings from spreading fixed costs over larger amounts of output and from making better use of specialized labor and capital inputs.

Scale economies are based on the shape of long run average cost (LAC) curve, which reflects the value of resources used in the production per unit of output, and shows the average costs at each level of output. The following Figure 2.1 exhibit the (LAC) curve and the long run marginal cost (LMC) curve with a group of short run average cost (SAC) curves and short run marginal cost (SMC) curves. The average cost curve shows the minimum average cost per unit of output at different levels of output, and the marginal cost, shows the additional cost incurred when producing an additional unit of output (Kalish and Gilbert, 1973).

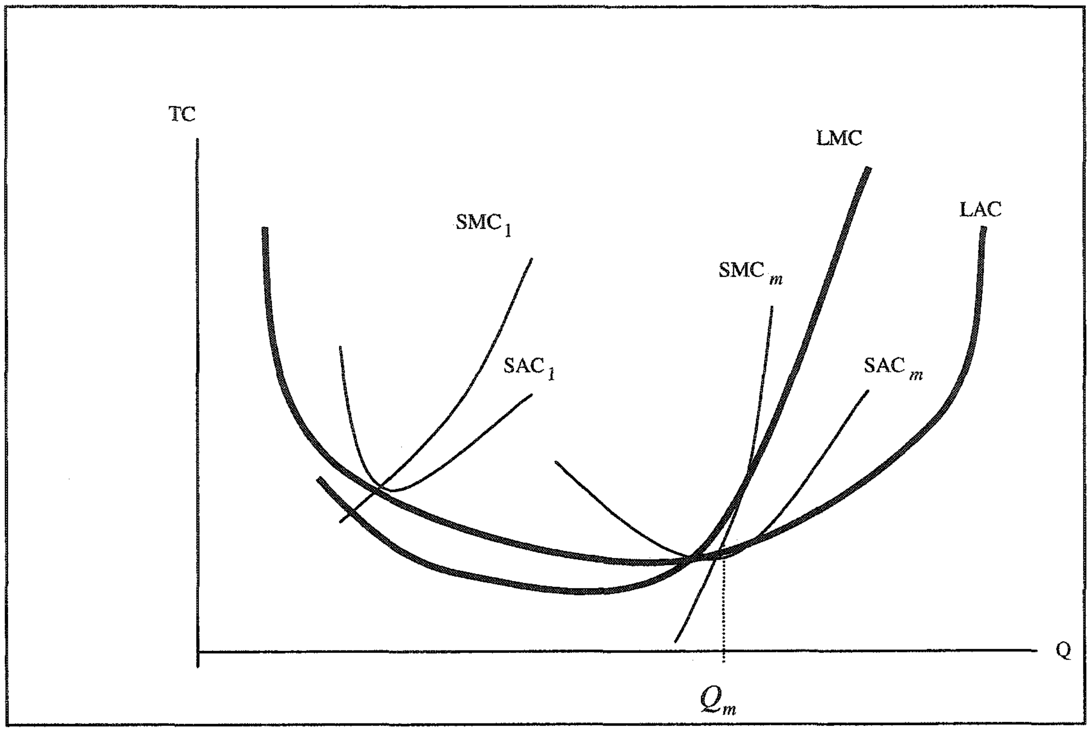

Figure 2.1 Economies of Scale and the Average and Marginal Cost Curves Shapes.
Source: Adopted from Humphrey (1990).

The previous figure shows that the long run average cost curve is declining at output level Q_m, and then begins to rise. At the minimum point Q_m, the LMC intersects the LAC. Economies of scale, are illustrated up to the output level Q_m, where the LMC curve lies below the LAC curve, and diseconomies of scale, or decreasing return to scale, thereafter, where the LMC curve lies above the LAC curve. In other words, a downward slopping LAC curve reflects scale economies, whereas an upward slope reflects diseconomies of scale, since higher average costs are incurred when more output is produced (Humphrey, 1990). Kalish and Gilbert (1973) stated that banks producing at minimum average cost (such as Q_m in figure 2.1) are run with maximum efficiency and have the size and technology best suited for their levels of output.

Clark (1988) indicated that banks realize economies of scale if technology allows production costs to rise proportionately less than output when output increases. That is, economies of scale exist if per unit or average production costs decline as output rises. Conversely, if average costs rise with output, diseconomies of scale are present.

The existence of economies of scale implies that the average cost of producing a good in the long run decreases as more of the output is produced. Hence, economies of scale are measured by the ratio of the percentage change in output. Since a firm expands its scale of operations, scale economies arises if it reduces the average cost of output, holding all other factors constant. Thus, economies of scale can be defined either in terms of the firm's production function or its corresponding cost function, since scale economies are the inverse of increasing return to scale. As a result, we can say that there are constant costs, when the production function presents constant return to scale, scale economies when the production function presents increasing returns to scale, and diseconomies of scale when the production function presents decreasing returns to scale. In other words, if economies of scale ratio is less than one, economies of scale arises, as average long run cost is declining. If the ratio is equal to one, scale economies do not exist, as average cost is constant, and when the ratio is greater than one, diseconomies of scale exist, as average cost curve is increasing.

This concept of declining average costs is not easily extended to the multi-product firm and makes the analysis and interpretation of economies of scale somewhat complex, because average cost is only defined for single product processes. The heterogeneity in the multi product firm's output prevents the construction of an unambiguous measure of aggregate output. The problem with aggregating all outputs into a single index is like adding apples and oranges. Besides, since the production of all bank outputs requires usage of the same inputs of bank, it becomes impossible to allocate costs to derive the average costs of each output. Thus, it becomes necessary to redefine an equivalent average cost for the multi product firm as an alternative approach to the aggregation of outputs. This is done by constructing what is called ray average costs (RAC) curve (Mester, 1987b).

Ray Average Cost

Gilligan, Smirlock, and Marshall (1984) stated that the concept of ray average cost (RAC) relates total production costs to a proportionate increase in all outputs. It generalizes average costs to the multi product firm without recourse to arbitrary aggregate output indices. It implies the behavior of costs as the size of the firm's output bundle changes proportionately.

Costs under RAC is analyzed in terms of a bundle of outputs, where each bundle is a composite good and is comprised of a predetermined fixed proportion of each of the outputs. That is, all output quantities are increased along a ray extending from the origin in output space, while all input quantities are required to follow the least cost expansion path. Along a ray, the bundle varies, but the outputs hold among themselves the same proportion.

Baumol and Braunstein (1977) indicated that it is not possible to define average cost for a multi product firm since it is not possible to construct an unambiguous index of output for a set of heterogeneous products. On the other hand, it can be determined how costs relate to output scale when outputs increase proportionately (i.e. as we move away from the origin along any ray in output space). In a formal way, for the ray through some given output y', which arbitrarily set equal to unity, $RAC = \frac{C(ky')}{k}$, where C is total costs, k is the number of units in the bundle. RAC is strictly declining (scale economies in the single product case) if $\frac{C(ky')}{k} > \frac{C(vy')}{v}$ for $v > k$.

Mester (1987b) stated that the multi product cost functions do not have a natural scalar quantity over which costs may be averaged; hence, RAC is used to express the analogue of average cost. The degree of multi product scale economies defined over the entire product set $(y_1,......y_n) = y$ is given by $S(y) = \frac{C(y)}{y} \times \nabla C(y) = \frac{C(y)}{\sum_{i=1}^{n} y_i} C_i(y)$, where $C_i(y) = \frac{\partial c(y)}{\partial y_i}$. Returns to scale are increasing, constant, or decreasing as S>1, S=1, and S<1 respectively. Increasing returns at y implies declining ray average costs at y[2].

Baumol, Panzar, and Willig (1988), defined ray average costs as follows:

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[2] The gradient of C is $\nabla C(y) = (\frac{\partial C(y)}{\partial y_1},........\frac{\partial C(y)}{\partial y_n})$

RAC (Q)=$\dfrac{TC(Q)}{\sum Qi}$= $\dfrac{TC(tq^0)}{t}$ where q^0 is the unit bundle for a particular mixture of outputs- the arbitrary bundle assigned the value 1- and t is the number of units in the bundle tq^0=Q. This is the average cost of the composite commodity whose unit is the vector q^0 and whose scale output is given by the scalar t. Ray average cost is said to be increasing (decreasing) at Q if RAC (Tq) is an increasing (decreasing) function of scalar t, at $t = 1$. Moreover, ray average cost is said to be minimized at Q if RAC (Q)<RAC (Tq), for all positive t=1. This is illustrated in figure 2.2, which also shows the behavior of total cost along the ray OR. It can be seen that the ray average cost and total cost have the usual relationships. Hence, they intersect at the unit level of output q^0, and RAC reaches its minimum at output $Q = Q^0$ at which the ray OT is tangent to the total cost surface in the hyper plane erected on OR.

The following figure 2.2 shows the concept of RAC for a multi product firm as a three dimensional diagram. The lower part of the diagram is the output space for total loans and total securities, that are produced in the proportion given by the ray OR. The term ray illustrates why the production costs are called ray average cost. In terms of Figure 2.2, the output vector moves along the ray OR. The minimum point of RAC is at the output bundle q^0which corresponds to the most efficient scale for the firm producing loans and securities in the proportion specified by the ray OR.

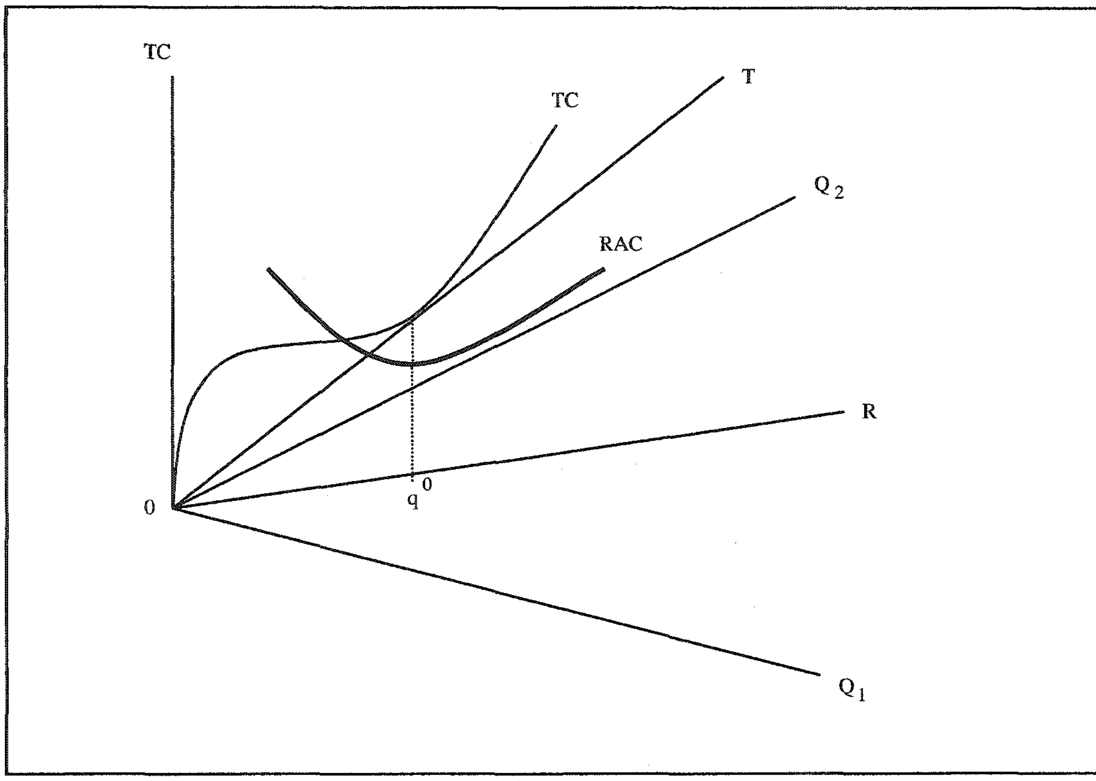

Figure 2.2 Economies of Scale for Multi Product Firm: the Concept of RAC.
Source: Adopted from Baumol, Panzar, and Willig, 1988, P. 50.

Thus, the degree of scale economies at q^0 are defined as the elasticity of output with respect to cost which is equal to $\frac{1}{1-e}$, where e is the elasticity of relevant average cost curve. This variable (the degree of scale economies) is greater than, less than, or equal to one as returns to scale are locally increasing, decreasing, or constant and as the ray average cost curve's slop is negative, positive, or zero, respectively. Kolari and Zardkoohi (1987) stated that economies of scale in a multi product firm occur if for (X_1,......, X_m) quantity of inputs and (Q_1,....., Q_n) quantity of outputs, the proportionate increase in the output vector (wQ_1,......, wQ_n) exceeds the proportionate increase in the input vector (vX_1,....., vX_m), where $w > v$.

Minimum Efficient Scale (MES)

The shape of the LAC curve is very important, not only because of its implications for scale economies, but also because of its effects on the potential level of competition. Its not always the case that the banks face a U shape average cost curve, but they may face an L shaped long run average cost curve, where firms encounter first increasing then constant returns to scale (Scherer, 1980).

In the case of the L shaped LAC, the large banks are at no relative cost disadvantage compared with smaller banks. Typically, the number of competitors and ease of entry will be greater in industries with U shaped LAC curves than those with L shaped LAC curves (Geroski, 1991). Sawyer (1985) stated that the minimum efficient scale is explained as the output level at which LAC curve is at first minimized. Therefore, the minimum efficient scale will be found at the minimum point on a U shaped LAC curve (output Q_m in figure 2.1), and at the corner of an L shaped LAC curve.

Scherer (1980) indicated that competition will tend to be most intense within industries in which the minimum efficient size is small relative to total industry demand because of correspondingly small barriers to entry, namely those relating to capital investment and very specialized labor requirement. Conversely, the competition can be less intense when MES is large relative to total industry output, because barriers to entry tend to be substantial. Shepherd (1985) stated that the barriers to entry effects of MES depend on the size of MES institution relative to total industry demand as well as the slop of the LAC curve at points of less than MES size operations.

Economies of Scope

Economies of scope (or cost complementarities) generate cost savings from producing multiple goods and services jointly through the same firm rather than through specialized firms. These potential cost savings are to be differentiated from economies of scale, which refers to lower costs per unit of a single good or service as total output of that good or service rises.

Mester (1987a) stated that since the financial institutions are multi product firms, the cost studies should consider, in addition to scale economies, scope economies when trying to determine the efficient structure of financial institutions. Producing a variety of product allows banks to select not only their scale of operations, but also which products they will provide. Banks can get cost savings depending on the volume and mix of outputs they choose to supply. If it's cheaper to produce a group of outputs together in a single firm rather than separately in specialized firms, then there are economies of scope between the products.

Two groups of potential economies of scope should be characterized. Firms can realize internal scope economies through joint production and marketing, while consumers can realize external economies of scope through joint consumption. On the production side, scope economies seem to be available where facilities devoted to one objective or to serving a single market are not fully utilized and are capable of being deployed simultaneously to serve other targets and other markets. On the consumption side, economies of scope exist when providing multiple products or services at a single location or through a single firm saves consumers the time and expense of searching for and purchasing these items through specialized providers.

De Young (1997) indicated that economies of scope arise from using the same inputs to produce several different types of output. For example, it is less expensive for banks to use the same group of tellers to process savings and checking accounts and the same group of loan officers to handle auto and home improvement loans than it is to employ separate tellers and loan officers for each kind of deposit and loan.

Clark (1988), and Mester (1987b) suggested that economies of scope exist if the costs from joint production of all products in the product mix are less than the sum of the costs of producing each product separately. That is, considering two outputs, Q_1 and Q_2, and their separate cost functions, $TC(Q_1)$ and $TC(Q_2)$. If the joint cost of producing the two outputs is expressed by $TC(Q_1,Q_2)$ then economies of scope exist if $TC(Q_1,Q_2) < TC(Q_1)+TC(Q_2)$, and diseconomies of scope if the inequality is reversed.

The concept of scope economies can be explained geometrically in Figure 2.3. The figure illustrates that the scope economies concept involves a comparison of $TC(Q_1,0)+TC(0,Q_2)$ the sum of the heights of the cost surface over the corresponding points on the axes, with $TC(Q_1,Q_2)$, the height of the cost surface at point (Q_1,Q_2) which is the vector sum of $(Q_1,0)$ and $(0,Q_2)$. If $TC(Q_1,Q_2)$ lies below the hyperplane OAB which goes through the origin and points $TC(Q_1,0)$ and $TC(0,Q_2)$, then the condition for scope economies is achieved. Thus in Figure 2.3 the height of D, the point on plane OAB above (Q_1,Q_2), must equal $TC(Q_1,0)+TC(0,Q_2)$ since the hyperplane is defined by $TC = aQ_1 + bQ_2$ for some constants a, b. Hence, $TC(Q_1,0) = aQ_1$ and $TC(0,Q_2) = bQ_2$, and $TC(Q_1,Q_2)$ must be less than $aQ_1 + bQ_2$ for scope economies to hold (Baumol, Panzar, and Willig, 1988).

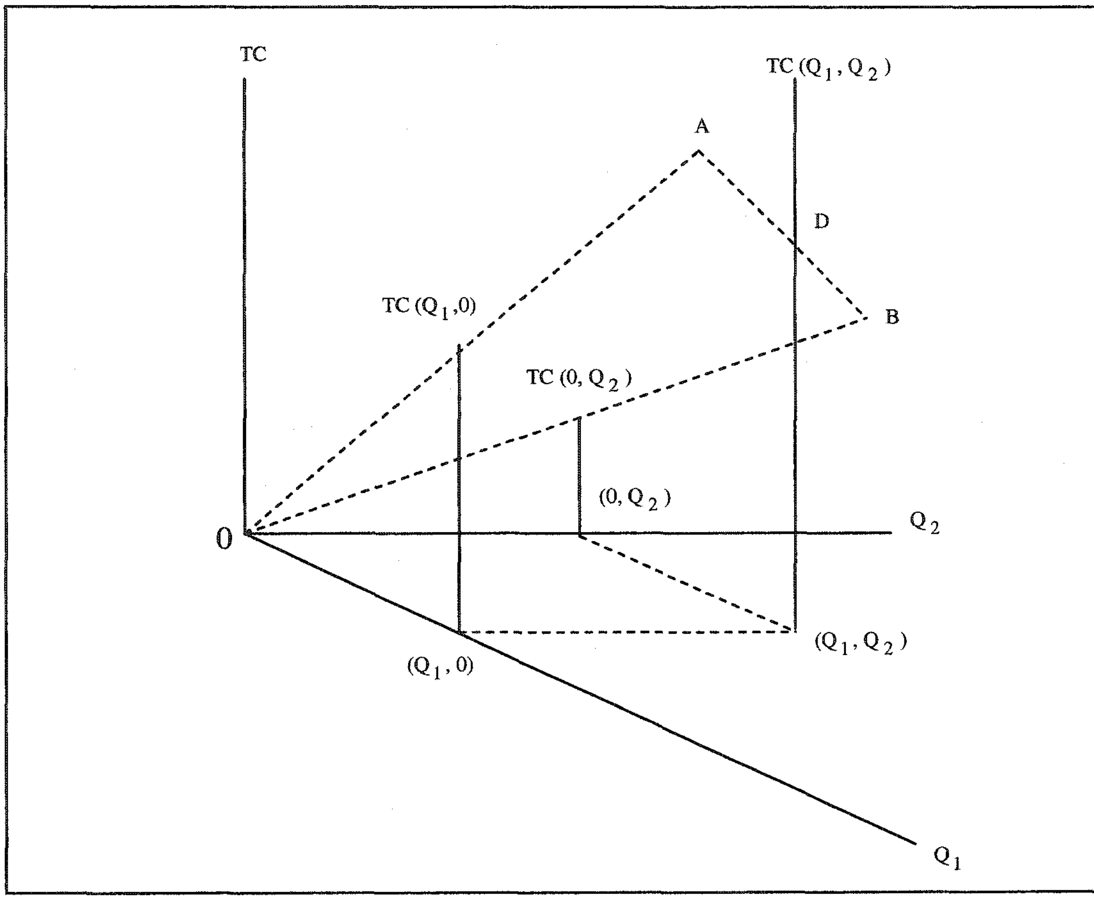

Figure 2.3: The Concept of Scope Economies.
(Source: Adopted From Baumol, Panzar, and Willig, 1988, P.72).

Baumol, Panzar, and Willig (1988) indicated that when the firm produces many products, even where ray average cost decline everywhere, the absence of cost complementarities may prevent natural monopoly. For example, if cost complementarities are absent, a multi product institution can be split up into several specialized firms without any increase in costs. Cost complementarities, and the concepts related to it, play an important role in the analysis of the banking firm given its multi product industry structure. Kim (1986) stated that the presence of cost complementarities alongside with economies of scale are sufficient to guarantee subadditivity which is necessary and sufficient for natural monopoly; i.e. it is most efficient for one firm to supply the industry output.

Kolari and Zardkoohi (1990, 1991) stated that the economies of scope are important to estimate because they provide information about the structure of the industry. The sufficient conditions for natural monopoly to occur in an industry with multi product firms are that economies of scale and scope be present. The existence of scale economies is a necessary but not a sufficient condition for a single producer to dominate an industry characterized by multiple products. A single producer could dominate an industry if it could reap scale and scope economies.

Sources of Economies of Scale and Scope

Molyneux et al (1996) stated that economies of scale may arise from one or more sources; first, the more efficient use of some or all inputs with an increasing volume of output. A bank may have an excess capacity of some inputs so that an increase in output may not require a proportional increase in all inputs. Some inputs might be indivisible by output; the presence of indivisibility should help reduce costs per unit of output if the output level is increased. A second source of economies of scale is that many inputs cost less when they are purchased on a larger scale, for example, machinery, equipment, and building usually cost less per unit of capacity when larger size are purchased.

A third source is that large banking operations allow a more efficient organization of resources as well as greater input and process specialization in production than do small banking operations. In small operations, the same machines and workers must often be employed for a variety of tasks; for example, tellers may also be assigned to sorting checks and auditing accounts part time. Specialization could also deliver a more economical use of materials purchased by the bank, for example, if the specialized tellers and loan officers process a greater volume of deposit and loan accounts per unit of labor, then per unit labor costs can be reduced through increased specialization. Mester (1987a) stated that a larger scale of operations allow employees to become more specialized and build up proficiency in their specific task. If a loan officer can concentrate solely on servicing loan accounts, he may do a better job compared to a situation where he has to allocate his time between loans and doing the bank's payroll.

Kolari and Zardkoohi (1987) mentioned the law of large numbers as a source of certain economies of scale. Large banks may not need to hold as much cash balances as do small banks. Since holding cash balances is costly, larger banks should bear lower costs of holding cash balances than do small banks. Moreover, larger banks are better able to diversify their assets and reduce risk as well as to offer various services to customers. Better diversification is associated with larger scale economies.

Benston (1972) concluded that a major source of economies of scale is the use of lower skilled labor by larger firms. Besides, the ability of the firm to use sophisticated machinery also was found to be a source of economies of scale, for example, computers can process a large volume of transactions at a small additional cost per transactions, consequently, reduce the per unit cost of the firm.

Clark (1988) indicated that economies of scale and scope might arise from information production. If the information, which gathered previously to make lending decisions, is reused to make similar loans to the same customer or to other customers in the same industry, it will provide a source of economies of scale and scope.

Hughes and Mester (1998) mentioned that increasing the capital of the bank deliver economies of scale from risk management and risk signaling. Higher level of capitalization provides an incentive to allocate additional resources to manage risk, hence conveys a credible signal to depositors that their deposits are safe. As a bank's scale increases, its portfolio of loans and deposits become more diversified, and diversification offers less risk and, hence, cost savings in managing risk and in signaling the bank's riskiness to outsiders.

McAllister and McManus (1993) introduced the financial scale economy. They show that as the bank loan portfolios increase in size up to $1 billion, the standard deviation (risk) of the rate of return declines due to diversification benefits. This reduction in risk reduces the amount of financial capital, which must be held by the bank to keep the risk exposure of the bank’s creditors at a given level. Because capital is the most expensive marginal source of funding, this creates a financial scale economy by which banks can lower their average costs of funds as scale increases by holding a smaller proportion of capital.

Berger (2000) mentioned that the integration of financial services which delivers larger institution can generate cost scale efficiency gains due to conventional scale economies, such as spreading fixed costs over more units of output; taking advantage of technologies that require large scale to achieve minimum average cost;

issuing large sizes securities to reduce the impact of fixed issue costs; reusing managerial expertise and information; or economic of scale in marketing/brand name recognition, and in monitoring the risk of counterparties.

Cost savings can also be achieved through scope economies, from the simultaneous production of several different outputs in a single firm. Sources of scope economies have been indicated by Baumol, Panzar, and Willig (1988), Berger, Hanweck, and Humphrey (1987), and Mester (1987a). In banks, jointness in production is evident in the joint use of information by different divisions, for example, in evaluating a loan application of a depositor. For the banking firms, costs can be saved or revenues improved by supplying joint products due to:

1) Spreading fixed costs and quasi fixed costs. Berger, Hanweck, and Humphrey (1987) indicated that if banks posses excess capacity, fixed or quasi fixed brick-and-mortar branch costs, data processing costs, or loan officer and teller expenses could be spread over an expanded product mix. Economies of scope also arise form sharing common facilities and overheads. A bank can enjoy cost savings if the outputs it produces share labor, capital, and maintenance costs.

2) Information economies. In banking firm, information generated from servicing a client's deposits and loans may be reused as a costless input in dealing with an installment or mortgage loan for the depositor at the same bank. Larger financial firms, for example, can develop standardized procedures as skills increase such as credit assessment, market information, documentation and collection methods. Thus, it may be less expensive for depositors banks' to

provide them with loans than for other banks to provide the same type of service (Pulley and Humphrey 1993).

3) Risk reduction. Joint production provides opportunity to diversify assets and can help reduce portfolio and interest rate risks. Regulators often impose concentration limitations, such as loan limits to a single borrower or less formal restrictions for example, discouraging loan concentrations to certain industries and/or in loan categories that seem excessive.

4) Customer cost economies. Customers may reduce their transactions costs by doing business in a wide range of products and services at the same branch. Therefore, bank profits may be maximized by attempting to minimize both the sum of bank-incurred and customer-incurred costs, through large balances, or increased market share.

Berger (2000) indicated that scope efficiency gains may arise from the integration of financial service providers into universal-type organizations, through sharing physical inputs like offices or computer; employing common information systems like investment departments; or reusing managerial expertise or information. For example, a consolidated commercial bank and insurer may lower total costs by integrating their distribution systems. They may cross-sell using each other's customer database at a lower cost than building and maintaining two databases.

Bank Production and Cost Function Technology

Bank Production Function

Kolari and Zardkoohi (1987) indicated that a production function is a technical relation that identifies the relationships between inputs and outputs. In other words, the production transformation is a mathematical expression for a process that transforms inputs into outputs. An important concept in the production theory is that there are some alternatives in the use of inputs to produce particular quantities of outputs.

Banks, as with other firms, have certain alternative methods in the production function to transform inputs such as labor and capital to produce outputs such as loans and other investments. It is important to know how much loans and other investments can be produced with certain combination of labor and capitals, given the existing state of technology. The costs of these inputs are the salaries and benefits, and capital expenses. The banking firm produces several outputs, but in the simplest case of the production function they produce only one homogeneous output Q. Using the most efficient technology, the production function is single valued, continuous, and twice differentiable which can be written as follows:

$$Q = f(L, K) \tag{1}$$

The above function shows that the flow of output Q is produced, given a flow of input labor (L) and capital (K). The production function is a microeconomic concept, which is purely technical relation and may be constructed without any reference to market conditions or prices.

The idea of economies of scale, as mentioned earlier, relates to the rates at which output changes as all input quantities are varied. In other words, the concept of economies of scale indicates that when the increase in output is proportionate to the increase in inputs, then returns to scale are said to be constant. If output increases by less than proportionate, then diseconomies of scale exist, and if output increases by more than proportionate, then economies of scale exist. The return to scale relationship may be shown using the following formula:

$$f(kL, kK) = k^v f(L, K) = k^v Q \qquad (2)$$

where k represents some constant by which inputs are increased and the power v of k denotes what is called the degree of homogeneity of the production function and is a measure of return to scale:

If v=1 the production function shows constant return to scale.

If v<1 the production function shows decreasing return to scale.

If v>1 the production function shows increasing return to scale.

In general, the production function is homogeneous of degree v if, when inputs increase by the constant k, output increases by the constant k^v. As a consequence, if v=1 then $k = k^v$, if v>1 then $k < k^v$, and if v<1 then $k > k^v$.

Figure 2.4 below displays the concept of returns to scale. The horizontal axis measures inputs. The vertical axis measures outputs. The three curves in this figure show the three input output relations for returns to scale: increasing, constant, and decreasing returns to scale.

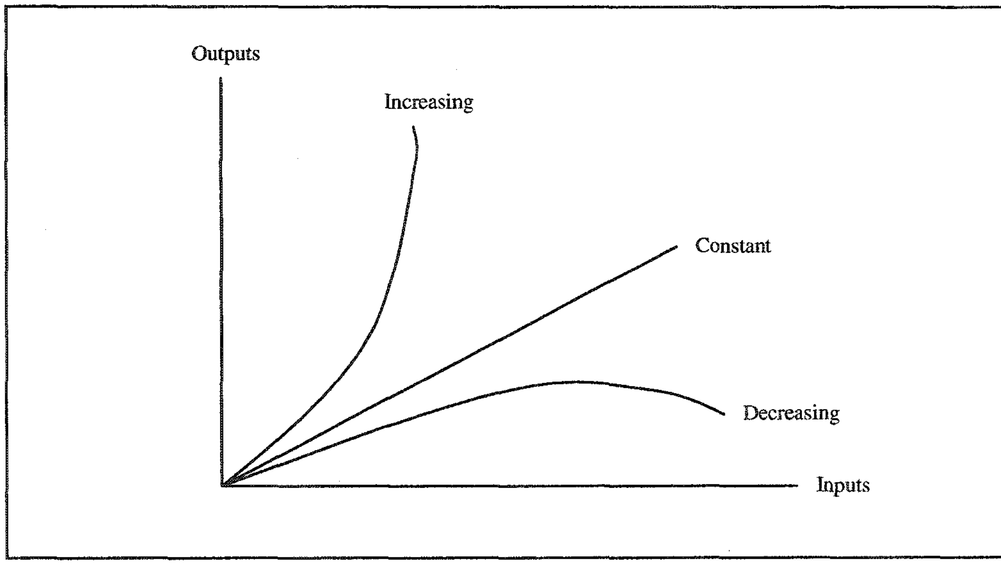

Figure 2.4: Returns to Scale.

Bank Cost Function

The production technology embodied in the previous production function (1) is not observable. The cost function is derived from the production function, which is the minimum total costs of producing the output bundle Q, given the input prices.

Diewert (1992) stated that the use of the cost function has the advantage over production functions in that statistical estimation of the unknown parameters are simpler. Besides, the parameters of the cost function, which characterize production technology, can be estimated much more accurately using various cost function techniques. Simply, total cost is a multi variable function, which is determined by many explanatory factors. Where total cost is determined as the sum of expenditures on all inputs, however, the value of cost can be specified as a function of the level of output and the prices of all inputs, this is the cost function. In other words, it can be shown that the bank's total cost is the sum of quantities of inputs employed, $X = (x_1,....,x_n)$, multiplied by their factor prices, $P = (p_1,..., p_n)$. Specifically, the total cost (TC) of producing output in equation (1) is simply as follows:

$$TC = p_1 L + p_2 K \tag{3}$$

where p_1 and p_2 are prices of labor and capital inputs. Consequently, we can derive the average total cost (ATC) from total cost (TC) by dividing by output (Q). Thus:

$$ATC = \frac{TC}{Q} \tag{4}$$

Then TC can be expressed in terms of the following formula:

$$TC = ATC \times Q = \frac{p_1 L + p_2 K}{Q} f(L, K) \tag{5}$$

The above equation states that total costs are a function of labor, capital, price of labor, price of capital, and the quantities of output produced Q. If we hold input prices constant, the properties of the production function will be exhibited by the cost function.

Following Jorgenson (1986) and Shephard (1970), the cost function TC can be derived from the production function under the following conditions:

1. Positivity. The cost function has to be positive for positive input prices and a positive level of production.

2. Homogeneity. The cost function is homogeneous of degree one in input prices.

3. Monotonicity. The cost function is increasing in input prices and in the level of output.

4. Concavity. The cost function is concave in input prices, i.e. if the price of a single input rises, ceteris paribus, it will cause costs to increase but at a decreasing rate, because the more expensive factor will be substituted by cheaper inputs.

Diewert (1974) indicated in the application of duality theory that given certain regularity conditions (mentioned above), cost function is dual to the production function. In other words, all the information needed to obtain the corresponding cost function is contained in the production function and the converse also holds true.

Therefore, the structure of production can be analyzed empirically taking either a production function or a cost function. Christensen and Greene (1976) indicated that the direct estimation of the production function is attractive when the level of output is endogenous; on the other hand, the estimation of the cost function is more attractive when the level of output is exogenous which, is the case in banking market.

Bank Output Measures: The Production and Intermediation Approaches

There has been a controversy in the banking literature as to what constitute inputs and outputs and how to measure them. Clark (1984) stated that this lack of consensus regarding the definition of what a bank produces and how to measure this product is reflected in a diversity of measures of bank output employed in the economies of scale and scope literature. The disagreement over the appropriate definition of bank output can be attributed to the multi product nature of banks. According to Sealey and Lindley (1977), the failure to carefully analyze the technical and economic aspects of production at financial institutions generates the lack of agreement concerning the appropriate measures of outputs and inputs for the financial firms.

Generally, the empirical studies that examine the cost structure of banks usually adopted one of two approaches, either the production or the intermediation approach[3]. According to the production approach, banks utilize labor and capital to produce deposit and loan accounts. Hence, output in this approach is proxied by the number of accounts of loans and deposits. Benston (1965) incorporated the number of accounts of loans and securities instead of the dollar volume of these accounts; he argued that banks operations, and hence costs, is closely related to the number of accounts they process. Total costs are the operating costs (excluding interest expenses) used to produce these products. Humphrey (1985), and Benston et al (1988) indicated that the output produced by banks might be viewed as the number of accounts of loans and deposits, since most banks' operating costs are incurred by the processing of loan and deposit documents as well as by the debiting and crediting of deposit and loan accounts.

In the intermediation approach, banks are considered as intermediators of financial services rather than producers of loan and deposit accounts. That is, banks are viewed as collecting deposits and purchasing funds to be subsequently intermediated into loans and investments. Hence, the dollar value or any other currency value of the loans and investments are proxied as output measures; labor, capital, and deposits are inputs. Thus, consistent with this approach, total costs are comprised of operating costs and interest expenses (Mitchell and Onvural, 1996).

[3]For the discussion of the alternative approaches and their differences, see Clark (1988), Gilbert (1984), and Berger, Hanweck, and Humphrey (1987).

This approach emphasized the intermediation role of banks, i.e. banks produce intermediation services through the collection of deposits together with purchased inputs, such as labor and physical capital, and the transfers of these deposits to loans and other investments, hence, this approach treats deposits as a third input along with capital and labor (Hughes, 1997).

Gilligan and Smirlock (1984) concluded that defining output of the bank by the asset side of the balance sheet (loans and investments) in dollar volume is more appropriate than defining output in terms of liabilities (deposits). They found in their study that the sum of squared errors is lower for the asset side output measures than for the liability side.

In the production approach, deposits are considered as an output. Sealey and Lindley (1977) indicated that using deposits, as an output is incorrect, they argued that the confusion over outputs and inputs comes from the failure to distinguish between technical and economic aspects of production in financial firms. The technical aspect of production deals with the transformation of inputs into other goods or services as an output. The output of banks in the technical sense is the financial services provided to the depositors and borrowers. Economic production creates a product, which has higher value than the original inputs, and then this value must be valued at market prices; deposits have no value to the bank unless transformed to loans and other investments. Hughes, Mester, and Moon (2001) implemented an empirical test to find whether deposits should be modeled as an input or an output. They found that the data strongly imply that deposits' empirical influence on costs is theoretically consistent with that of an input. Jagtiani, Nathan, and Sick (1995) obtained insignificant scale coefficients in all the models that include deposits as an output; they indicated that this may be the result of output misspecification, hence, they conclude that measures of scale and scope economies are sensitive to output definition.

The production process of the financial firm is a multistage process where intermediate outputs, such as deposits, which borrowed from depositors and serviced by the firm's labor and capital are used in the production of loans and other investments. Therefore, the final output of the bank (loans and other investments) is produced with labor, capital, and deposits.

Kolari and Zardkoohi (1987) preferred to measure bank outputs in dollar amounts, because they believed that banks compete to increase market share of dollar amounts, as opposed to the number of accounts. Also, the use of number of accounts as the measure of bank output implies that there are equal costs per account, which is not the case, for instance, a demand deposit account may be more active and hence, more costly to maintain than time deposit account. Banks are multi service firms, and dollar measurement is the only common denominator; i.e. security investments cannot be measured in number of accounts. Humphrey (1985) stated that the dollar measure of bank output is suitable when considering the intermediation role of banks. Therefore, to have a reliable description of this intermediation role, interest expenses should be considered alongside the operating expenses when measuring the economies of scale.

Shaffer and David (1991) considered deposits as inputs in the bank's production function for two rationales: first, deposits incur positive costs and do not produce revenue until transformed into assets. Second, deposits act as substitutes for other sources of funds in the production of loans and other assets.

The choice of one of the previously mentioned approaches, and hence, the definition of output influences the magnitudes of the economies of scale and scope. Berger, Hanweck and Humphrey (1987) indicated that the production approach might find more economies of scale than appropriate, as larger banks generally employ a higher proportion of purchased funds. On the other hand, Humphrey (1990, 1985), Kolari and Zardkoohi (1991), and Clark (1988) indicated that the scale and scope economy results are reasonably robust to the use of either the number of accounts or the dollar value in the accounts, i.e. using both of these alternative representations of bank output in the same model for the same year leads to similar scale and scope economy results.

Operating Costs or Total Costs Measure

Another area in banking literature that lacks consensus is whether to use the operating costs or total costs (operating costs plus interest expenses) for the empirical analysis of the cost structure of banks. This situation stems from the lack of the consensus on whether to use the production approach or the intermediation approach.

The production approach emphasizes the use of the operating costs, while the intermediation approach emphasizes the use of total costs[4]. Many studies such as Benston (1972), Benston et al (1982), Gilligan, Marshall and Smirlock (1983), Nelson (1985), and Evanoff, Israilevich, and Merris (1990) used operating costs because they were interested in the production process, not the intermediation process.

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[4] See Humphrey (1985) and Kolari and Zardkoohi (1987).

Benston, Hanweck, and Humphrey (1982) stated that excluding the interest expenses from total costs is valid when the issue being investigated pertains the bank's ability to produce and service loans and deposits using internal funds and management. On the other hand, Noulas, Ray, and Miller (1990) indicated that excluding the interest expenses may bias the results, because large banks for example fund a larger proportion of assets with nondeposit accounts which have low operating, but high interest costs. Thus, incorporating only operating costs will produce higher economies of scale than actually exist.

Banking studies have used total costs to empirically estimate the cost structure of banks. Humphrey (1990) supported this definition of costs and concluded that if only operating costs are used in a statistical analysis of bank scale economies, then economies of scale estimates would be over estimated. Hunter and Timme (1986) obtained these results, they found significant scale economies when bank costs are proxied by the operating costs, and no significant economies of scale when total costs are used. Thus, the proper comparison of costs and measurement of scale and scope economies must rely on total costs rather than only operating costs. Dietsch (1993) indicated that incorporating the total costs is consistent with the fact that the objective of banks is to minimize total costs, not only operating costs.

Specifying the Functional Form

Economic theory does not provide any explicit algebraic specification of the functional form to estimate the costs of the firm. It only stipulates the conditions that an appropriate cost function must fulfill. Proper cost functions are defined in accordance with Baumol et al (1988), Caves, Christensen, and Tretheway (1980), and

Le Compte and Smith (1990) as being consistent with the definition of a cost function, i.e. a suitable functional form should satisfy the following properties:

1. The cost function should be non-negative and non-decreasing, concave, linearly homogeneous in the input prices, and non-decreasing in its outputs. These conditions ensure that it is consistent with minimization of the outlay on inputs, at given prices subject to the technological constraint.

2. The cost function should present a reasonable cost figure for output vectors that involve zero output for some goods.

3. The cost function should not in itself prejudge the presence or absence of any of the cost properties[5].

4. The cost function should contain a manageable number of unknown parameters to be estimated and be easily estimable.

5. The cost function should be flexible, i.e. capable of approximating an arbitrary function to a desired order of accuracy, and should not impose any a priori restrictions on the values of the partial derivatives.

The flexibility requirement is important, because it provides a second order local approximation to an arbitrary twice-differentiable cost function, and hence, allow for the possibility of modeling a wide variety of production structures.

It is clear from Gilbert's (1984) survey that one of the most contentious issues regarding the appropriate methodology to estimate bank costs pertains to the specification of the functional form that the production function takes, specifically,

[5] The constant elasticity of substitution and the Cobb-Douglas cost functions are notorious for this.

what restrictions are appropriate to impose so that it represents a realistic banks production technology.

Up until the early 1980's, the major flow in the studies conducted was to either subsume the multi product nature of bank into a single output measure, or the assertion that banks can be treated as having a separate and independent production function for each of its output[6]. This led to the estimation of separate cost functions for each measure bank output. Most of this was carried out using the Cobb-Douglas (CD) specification. However, CD specification has many drawbacks: first, it allows only estimating increasing, decreasing, or constant cost curves (cannot show all three) which does not allow U-shaped average cost curve in which small banks have decreasing average costs, medium banks have approximately constant average costs, and large banks have increasing average costs (Humphrey, 1985). Second, it imposes serious restrictions on the a priori admissible pattern of substitution between inputs and outputs; third, it constraints the elasticity of substitution between inputs to equal one; fourth, it disregards the existence of a dual relationships between production functions and cost functions. Most bank studies that have used the CD specification ignore this dual relationship (Berger and Humphrey, (1994)).

The next advance in functional forms for the production function came with the introduction of the constant elasticity of substitution (CES) production function. It is more general than the CD specification, and allows for any degree of substitutability between two inputs factors. This CES function is perfectly adequate for the analysis of production with one output and two factor inputs. However, when applied to a situation where the bank produces more than one output or employs more than two

[6] See Mester (1987).

inputs, as the case of the Jordanian banking market, this functional from is highly restrictive and does not force the elasticity of substitution between each pair of inputs to be the same (Molyneux et al, 1996).

Gilbert (1984) and Murray and White (1983) stated that even though the previously mentioned functional forms are very convenient specifications for the purposes of modeling and estimation, they restrict the relation between costs and output to conclusions of either economies of scale or diseconomies of scale throughout the range of output, ruling out the estimation of a U shaped cost curve.

Due to the problems associated with the CD and CES specifications, a new flexible functional form was introduced by Christensen, Jorgenson, and Lau (1973). This functional form, transcendental logarithmic functional form, allows estimation of cost functions with more than one output, as separate variables, and more than two inputs. Further, it allows for any degree of substitutability at all levels of input employment. Most important, it allows the estimation of a U-shaped cost curve, which implies that the larger banks are more efficient than smaller ones in the negative slope portion of LAC, and smaller banks are more efficient than larger banks in the positive slop portion of LAC. The flexibility of this cost function, which is illustrated by equation (9) in chapter three, shows that the elasticity of cost with respect to output can be quiet different at different levels of output, so it is possible to find economies of scale at some levels of output and diseconomies of scale at other levels (Goldstein, McNulty, and Verbrugge, 1987).

This Translog cost function has been widely used by many recent studies, including: Benston, Hanweck, and Humphrey (1982), Benston, Berger, Hanweck, and

Humphrey (1983), Murray and White (1983), Gilligan, Smirlock, and Marshall (1984), Kolari and Zardkoohi (1987, 1990, and 1991), Kim and Weis (1989), Mester (1987b), Clark and Speaker (1994), and Hunter and Timme (1991). Benston et al (1983) indicated that the use of the translog functional form is valuable because it provides a second order local approximation to an arbitrary cost function that is valid at any data point other than those at or approaching zero output levels for some of the products.

Caves, Christensen, and Tretheway (1980), and Dietsch (1993) stated that the translog cost function permits us to determine the characteristics of the underlying production function by analyzing the form of the related cost function, provided that the cost function satisfies certain regularity conditions and behavioral assumptions; i.e., the cost function is dual to the production function. Evanoff and Israilevich (1990) stated that this duality between them ensures that they contain the same information about production possibilities and one could obtain from analyzing the structure of the related cost function a description of the production process that is equivalent to that provided by the production function. There is no need to a priori assume a particular production relationship and then impose it on the cost function (McNulty, 1982). Mester (1987a) indicated that the only a priori restrictions imposed, in the translog specification, are those that make the cost function consistent with the existence of a dual production transformation.

Humphrey (1990) concluded that a functional form that permits the estimated average cost curve to be U shaped, rather than monotonic is preferred. Thus the translog specification dominates the CD and the CES form when measuring bank scale and scope economies and yields different scale and scope economy results as well.

The translog cost functional form is essentially a Taylor series expansion in output quantities and input prices, and thus it provides a second order approximation to an arbitrary cost function[7]. This translog cost function can be expressed as follows:

$$\ln TC = \alpha_0 + \sum_{i=1}^{m} \alpha_i \ln Q_i + \sum_{i=1}^{n} \beta_i \ln p_i + \frac{1}{2}\sum_{i=1}^{m}\sum_{j=1}^{m} \delta_{ij} \ln Q_i \ln Q_j + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \gamma_{ij} \ln p_i \ln p_j + \sum_{i=1}^{n}\sum_{j=1}^{m} \rho_{ij} \ln p_i \ln Q_j \qquad (6)$$

Where, TC is total cost, Q_i represent the m outputs, P_i represent the n inputs. There are m+1 independent α_i parameters, n independent β_i, m (m+1)/2 dependent δ_{ij} parameters since it is assumed that $\delta_{ij} = \delta_{ji}$ for $1 \le i < j \le m$, n (n+1)/2 independent γ_{ij} parameters since it is assumed that $\gamma_{ij} = \gamma_{ji}$ for $1 \le i < j \le n$, and mn independent ρ_{ij} parameters in the translog cost function defined by (6). However, if the constraint of the homogeneity of degree one in the input prices on the cost function defined by (6) is imposed, then it is required that the following restrictions on the parameters hold:

$$\sum_{i=1}^{n} \beta_i = 1; \quad \sum_{i=1}^{n} \gamma_{ij} = 0; \qquad 1 \le j \le n$$

$$\sum_{i=1}^{n} \rho_{ij} = 0 \qquad 1 \le j \le m$$

[7] See Christensen, Jorgenson, and Lau (1973).

Overall, the translog cost function shown in equation (6) must have the following properties if production and cost function theories are to be fully integrated. Kim (1985) stated that this function must be:

1. Homogeneous of degree one in input prices. Linear homogeneity in input prices is a precondition for the existence of a duality relationship between the production and cost functions.

2. The second order outputs and inputs parameters must be symmetric, that is, for instance, in the cost function defined by (6), $\delta_{ij} = \delta_{ji}$ for $1 \leq i < j \leq m$, and $\gamma_{ij} = \gamma_{ji}$ for $1 \leq i < j \leq n$, respectively.

3. The cost elasticities must be non-negative.

4. Concave in input price and non-decreasing in both input prices and level of output.

Gropper (1991) indicated that the above restrictions insure that there exist a unique correspondence between the cost function and the underlying production function[8].

The previous sections discussed the theory behind scale and scope economies, explained the approaches employed to investigate these economies, clarified the functional forms utilized by the banking studies as well as the constraints imposed on these functions. This dissertation, accordingly, will adopt the intermediation approach and the translog cost function to investigate the incidence and magnitudes of scale and scope economies in the Jordanian banking system.

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[8] For more details, see Diewert (1973).

Empirical Studies of Economies of Scale and Scope

Many studies have been undertaken during the last three decades to estimate empirically the economies of scale and scope in banking markets. These studies focused primarily on whether or not an increase in the size of bank outputs could lead to lower average costs, whether costs vary for different banks of the same size, and whether cost complementarities exist in bank outputs. These studies have produced a variety of results, but for the most part they have found economies of scale only among small banks (banks with less than $100 million in total assets), and diseconomies of scale among larger banks[9]. Other studies (few) restricted their samples to banks above $1 billion in total assets have found economies of scale in large banks. On the other hand, the empirical studies, generally, found very little evidence of substantial cost scope economies within the banking industry (e.g., Berger, Hanweck, and Humphrey, 1987; and Noulas, Ray, and Miller, 1993). Clark (1996) stated that the widely divergent estimates of optimal scope economies provide little support for a conclusion of global economies of scope. Hence, the empirical literature on bank scope economies provides little consensus on the existence of scope economies.

Pre-Translog Cost Specification Studies

Alhadeff (1954) was the first systematic study of banking cost. He compared total costs of California branches and unit banks for 1938-1950, and found economies of scale for small and large banks, and constant returns for the middle size banks. In other words, average cost declined for the banks with assets up to $5 millions and over

[9] See Berger and Humphrey (1991)

$275 millions, but remained constant for the medium sized banks. He also found that branch banks had higher average costs than unit banks.

Horvits (1963) analyzed the cost structure using the earning assets (loans plus investment) as the output measure, and total costs including the interest expenses as the cost measure. This study found economies of scale for small and large banks and constant returns for medium sized banks, i.e. similar to the results provided by Alhadeff (1954).

Kolari and Zardkoohi (1987) criticized the previous two studies of using earning assets instead of total assets as the measure of bank output. His criticism is based on the assumption that using earning assets exclude other assets (such as trust operations) in total output measure, and this might tend to exaggerate the average unit costs of large banks. To avoid this bias, a study by Schweiger and McGee (1961) used total assets instead of earning assets as a measure of bank output. This study found economies of scale for all sizes of banks as well as a negative relationship between size and average costs, i.e. average cost decreased as bank size increased, and therefore, larger banks were found to have a cost advantage over small banks.

A different approach to the measurement of cost was undertaken by Greenbaum (1967). He developed a weighted output index and found evidence of a U-shaped average cost curve, indicating that average cost declined for small sized banks, but increased for large banks, he emphasized that branch bank operating costs were higher than unit bank costs

Benston (1965a) was the first to use a CD cost function to investigate economies of scale in banking. His study marked an important change in methodology when he used in his model a detailed cost data. He proxied output of banks as the number of accounts, and excluded the interest expenses from the cost measure. His result indicated that economies of scale were present (but not great) for all banking services. Moreover, he concluded that efficiency of operations is not largely a function of bank size. He also concluded that banks with three or less branches were found to have cost benefits, after three branches, cost increased and outweighed the benefits of large size.

Another important scale economy study which used the CD specification was undertaken by Kalish and Gilbert (1973). They examined how bank efficiency is related to their size and organizational form using 1968 data and a sample of 898 commercial banks. Their results show that the cost curve was U shaped. Moreover, unit banks had the lowest operating cost followed in turn by affiliated banks and branch banks. They found that at lower output levels, banks affiliated with holding companies had greater cost efficiency. At higher output levels, banks affiliated with a holding company had higher average costs.

Mollineaux (1978) applied the theory of profit to estimate economies of scale and organizational efficiency in banking. He used the net operating income as the dependent variable which is regressed on input and output prices. He concluded that banks in branching states had constant returns to scale, while increasing returns were found in unit banking states. He also concluded that imperfect competition exists in banking industry, suggesting that market structure may influence bank profits.

The major conclusion that can be drawn from the previous studies was that economies of scale are present, since most of the studies generate a decreasing average cost curve over a relatively large range of bank outputs. These studies also concluded that economies of scale are exhausted at low levels of output (Kolari and Zardkoohi, 1987). However, Berger and Humphrey (1994) indicated that the results of these studies overstate the true scale economies for three reasons: first, these studies employed the CD cost function which cannot show a U-shaped average cost curve. Second, these studies exclude the large banks which had more than half of all industry assets by 1980; and third, these studies failed to distinguish between scale economies at the branch office level and at the firm level.

Translog Cost Specification Studies

The Production Approach Studies

Benston, Hanweck and Humphrey (1982b) were the first to use the translog cost function to estimate scale economies. Their study represents a major step forward in empirical research within the banking industry. They proxied output by a measure of divisia index, which is defined as the weighted average of the number of accounts of outputs. Their findings indicate that the average cost curves are U shaped. They found diseconomies of scale in unit banks with above $50 million in deposits, and small economies of scale in branching banking states. They concluded that the optimum size of a bank was relatively small, between $10 and $25 million in deposits.

Benston, Berger, Hanweck, and Humphrey (1983) regressed operating costs on two input prices (labor and capital), number of branches, a binary variable, and five different banking outputs (demand deposits, time and saving deposits, real estate loans, commercial loans, and installment loans) for the year 1978. They found evidence of economies of scale at the branch level for all deposits classes, although these were not statistically significant for the largest banks. In addition, for unit banks, economies of scale were reported for banks up to $75-100 millions in deposits size, whereas all unit banks with more than $200 millions in deposits experienced diseconomies of scale.

Benston, Berger, Hanweck, and Humphrey (1983) also tried to estimate economies of scope. They found some slight evidence of interproduct cost complementarities, especially for banks in unit states.

The study of Gilligan, Smirlock, and Marshall (1984) estimated bank cost functions that explicitly recognize the multiproduct nature of banks. Bank outputs were defined as the number of deposits and loans accounts. Moreover, input prices of labor and capital were included in their model. To be consistent with the production approach, operating costs were included instead of the total costs to examine the existence of scale and scope economies. They conclude that small banks with less than $25 million deposits experienced economies of scale, banks with deposits ranged between $25-100 experienced constant returns to scale, and large banks (beyond $100 million deposits) experienced diseconomies of scale. They also concluded that the cost function is characterized by economies of scope.

Gilligan and Smirlock (1984) examined economies of scale and scope for more than 2700 unit states banks for 1973-1978. Bank output was defined in terms of dollar amount of demand and time deposits and loans and securities. They found U-shaped cost curves, i.e. economies of scale for small banks (less than $25 millions deposits) and diseconomies of scale for banks with over $50 millions deposits. They also found that the structure of bank costs is characterized by jointness, so that the cost of producing one output depends on the level of other outputs. These results led them to conclude that jointness must be accounted for in evaluating regulatory policy.

Kilbride, McDonald, and Miller (1986) extend the functional form analysis used by Clark (1984) to examine economies of scale in 1737 units banks, 1858 independent banks, and 1036 multi bank holding company affiliates for the years 1979-1983. The total assets of these banks ranged from $1.2 million to $54 billion dollar. With respect to the unit banks, they found an output elasticity equal to 0.958. As for the independent banks and the multi bank holding company affiliates, they found greater scale economies in the former and no scale economies for the latter. They also found that the level of scale economies declines as the level of output increases for each of the three types of banks.

Goldstein, McNulty, and Verbrugge (1987) estimated a translog production cost function for 3500 savings and loan firms for the period 1978-1981, with asset sizes ranging from $10 million to more than $1 billion. Their results indicate significant economies of scale over a wide range of output. These economies tend to be greater in the smaller size classes, and persist across the medium and larger classes.

Kolari and Zardkoohi (1987) estimated the economies of scale and scope for a sample of banks over the period 1979-1983 using three different models. Model 1 defined output as the dollar value of demand and time deposits. Model 2 specified output as the dollar value of loans and securities, and model 3 specified output as the dollar value of loans and total deposits. They found that the cost curves were U shaped, i.e. significant economies of scale for banks with up to $50 million in deposits size, and significant diseconomies of scale for banks above $50-100 million in deposits size. Their study also estimated the economies of scale for unit banks and branch banks for the years 1970, 1980, and 1982. They concluded that unit banks had cost curves that were flat, and branch banks had U shaped cost curves with minimum costs occurring in the range of $50-200 million in deposits. With regard to scope economies, they found that cost complementarities are present in the joint production of loans and deposits. Their results showed that large banks do not have a cost advantage over small banks with respect to expanding outputs jointly. Besides, banks can reduce the cost of expansion by about 30-50% by increasing outputs at the same time than increasing outputs separately.

Cebenoyan (1988) estimated a translog production cost function for the branch and unit banks (with less than $1 billion in deposits) during the period 1980-1983. They found that economies of scale are exhausted after $25 million of deposits for the unit banks, and diseconomies of scale for all sizes of branch banks.

Kim and Weis (1989) investigated the total factor productivity (TFP) growth of 17 Israeli banks for the period 1979-1982. They decompose the TFP growth into three components: scale economy and output growth, branching effect, and technological change effect. They estimated a translog cost function which contains the following arguments: operating costs, loans and deposits as outputs, and three factors of production (labor, capital, and computer services). Their results indicated an overall scale elasticity for the typical bank equal to 0.6494. Both large and small banks experience economies of scale amounted to 0.7121 and 0.6237 respectively. They also found that the scale economy and output growth have contributed to about 80% of the

TFP growth whereas branch growth and technical change have contributed to 20% of the growth.

Dowling and Philippatos (1990) investigated the cost structure of the savings and loan firms during the period 1973-1983 using two different methodologies: the translog cost function and a frontier frame methodology. The elasticities estimated from both methodologies indicate that there were opportunities for significant reductions in cost for firms with asset sizes up through $1 billion. Both approaches suggest that the minimum efficient scale for firms declined during 1973-1983.

In general, the translog production approach suggests that the cost curves in banking market are U shaped. These studies conclude that scale economies exist at the levels of output between $25-200 million in deposit size, and there is little consensus as to the optimal size of the banking firm (Hunter, Timme, and Yang, 1990). Evidence of cost complementarities were also found by some of these studies.

The Intermediation Approach Studies

Murray and White (1983) estimated the cost function of the credit unions in Canada for the year 1977 in order to test for economies of scale and scope. They proxied output by the dollar value of mortgage loans, other loans, and investments in excess of reserve requirements. Three inputs were incorporated in the cost function, those are price of labor, capital, and deposits. Total costs comprised of operating costs plus interest expenses. They found that the credit unions experienced significant economies of scale as they expanded their level of output, and that large multi product firms were more cost efficient than small single product firms. They also found evidence of cost complementarities or jointness in production between mortgage and other lending activities.

Clark (1984) used a generalized functional form cost functions to estimate the economies of scale for 1205 banks for the period 1972-1977. He found that the estimated output elasticities of cost derived from the cost functions, while significantly less than one, were never below 0.95. This result led him to conclude that the economies of scale in banking industry are small and operating efficiency is unlikely to be substantially improved by an increase in bank size.

Berger, Hanweck, and Humphrey (1987) introduced a methodology for evaluating the competitive viability of banks and apply it to 1983 data. Their study used both the production and intermediation approach to estimate banks scale and scope economies and to examine the robustness of the results. A translog cost function was fitted to the data, which covers 413 branching state banks and 214 unit state banks (separately). They found that branch banks experienced slight economies of scale, and slight diseconomies of scale at the level of the banking firm. Whereas, unit state banks showed large scale diseconomies for large banks. These diseconomies for large unit state banks, combined with substantially higher costs than similarly sized branch banks, suggested that these banks were not competitively viable. They also concluded that there were diseconomies of scope in banking; that is output mix was determined for reasons other than cost consideration, such as risk diversification, customer convenience, and joint demand of products.

Mester (1987b) investigated the cost structure of 149 savings and loans (S&L). She estimated two models of translog cost function for the year 1982. She regressed total costs on three factor input prices and three outputs. In model 1, she found that none of the equations is significantly different from zero, hence the typical S&L would not benefit from expanding the level of loan it produces or investments it holds. In model 2, one of the equation is significantly greater than one, and the other two equations are not, indicating that S&L would gain by increasing the level of mortgage loans while leaving other loans and investments at their current levels. As for the economies of scope, she found that savings and loans exhibit neither global nor product specific economies of scope and that no two outputs are cost complements.

Kolari and Zardkoohi (1990) estimated a modified translog cost models for cooperative and saving banks in Finland for the years 1983 and 1984 to provide evidence on the scale and scope economies. They found that cost curves for both cooperative and saving banks tend to be L shaped at the plant level and U shaped at the firm level. They also found scope diseconomies in the joint production of advances and bills. Their results led them to conclude that natural monopoly conditions are not present in Finnish thrift institutions.

The study of Le Compte and Smith (1990) aimed at testing the effects of structural changes of inputs and outputs markets on the economies of scale and scope in the S&L industry. They regressed total costs on the dollar volume of mortgage lending, consumer loans, and investments, as well as on three factor inputs (labor, capital, and deposits) for the years 1978 and 1983. They found economies of scale for small S&L and diseconomies of scale for large ones, i.e. the S&L industry is faced with the traditional U-shaped cost curves. They also found significant cost complementarities in production process during 1978 and separable cost function for the 1983.

Gropper (1991) examined the direction and magnitude of the possible shifts in the structure of banks costs for the period 1979-1986. The study concentrated on economies of scale for smaller and medium sized banks. He found that economies of scale exist beyond small levels of outputs for the years prior to 1982 and also significant scale economies present in later years for branch banks and unit states banks. He also pointed out that the degree of scale economies increased over the 1979-1986 time period. He concluded that the effect of regulatory and technological changes may have been to give larger banks a cost advantage over that which existed in previous years. Also there may be increased cost pressure for smaller banks to become larger either through mergers or through internal growth.

Kolari and Zardkoohi (1991) used both the production and intermediation translog cost functions to obtain estimates of economies of scale and scope for commercial banks for the years 1981, 1983, and 1985. They found evidence that cost curves were downward slopping in these years, i.e. all banks regardless of their asset sizes experienced economies of scale. These economies tend to increase as bank size increased. They also found jointness in the production of different combinations of outputs.

Dietsch (1993) estimated a translog cost function to investigate the scale and scope economies, using a sample of 343 French banks for the year 1987. He regressed total costs on three factor prices (labor, capital, and financial capital), and four output measures (deposits, loans, securities, and interbank market activity). He found that scale economies exist in all classes of banks size whatever the form of the estimated cost model, but these economies are not large in magnitude. The scale economies were lower when considering total costs than when he considers operating costs. He also found that economies of scale increases with the size of banks. These results led him to conclude that the large banks posses a cost advantage compared to the small and medium sized banks, and the competitive viability of small banks is not guaranteed in the future.

In measuring the scope economies, his study used the operating costs instead of total costs, based on the assumption that cost complementarities are more related to the use of labor and physical capital than to the use of financial capital. Moreover, his results show that cost complementarities exist in deposits and loans, investment in securities and interbank market activity, and loans and interbank market activity.

McAllister and McManus (1993) estimated a translog cost function, which took into consideration, in addition to outputs and input prices, the financial capital of the bank. They found substantial increasing returns to scale for banks below $500 million in total assets, and constant returns to scale above this level of assets.

Fields, Murphy, and Tirtiroglu (1993) examined the cost structure of 28 banks in Turkey for the years 1986 and 1987. The banks size ranged from $20 million to $9.8 billion in loans. They found no significant evidence of scale economies for either 1986 or 1987.

Clark and Speaker (1994) estimated a generalized translog cost function for 402 commercial banks for the year 1989 to provide evidence on the extent of economies of scale and scope. The dependent variable, which is total costs, is regressed on eight output measures, and two factor input prices. They found large and significant economies of scale for all size classes, and these economies of scale remain well beyond a bank size of $1 billion of total assets. They also found economies from the joint production of selected product pairs, but these efficiencies are offset by diseconomies in the production of other pairs. They conclude that many smaller banks can improve their productive efficiency through increases in size.

Hughes, Lang, Mester, and Moon (1996) used a structural model of production which accounts for nonneutrality toward risk as well as risk neutrality. They have provided evidence of large and increasing scale economies that apply to geographic expansion as well as to local expansion. They found significant economies of scale with a mean value of 1.144. They also found that the scale economies estimates increase as banks grow larger: banks with assets less than $3 million have scale economies of 1.120, while banks with over $50 billion in assets have scale economies of 1.254. They conclude that since the degree of scale economies increase as banks expand geographically, then there is potential for greater operational efficiency through interstate branching.

Mahajan, Rangan, and Zardkoohi (1996) estimated a translog intermediation cost function for 13,118 domestic banks and 595 U.S. based multinational banks for the period 1987-1990, so as to detect the cost advantages of becoming multinational. Their model incorporated three outputs, three input prices, and a measure for the number of branch offices for both groups of banks. They found diseconomies of scale at all size levels of domestic bank at the plant level. With regard to the multinational bank at the plant level, scale economies are exhausted by the $500 million size. At the firm level, multinational banks experienced diseconomies of scale which increase with size, whereas the domestic bank experience economies of scale at all sizes. These results led them to conclude that the cost structure of domestic and multinational banks are different.

The results of their study show that the domestic banks face greater diseconomies of scope with increase in size, whereas multinational banks experience lesser diseconomies of scope than domestic banks with decrease in size, and eventually turn positive beyond $10 billion size level.

Hunter and Timme (1986) investigated the effect of technical change on large banks scale economy. They analyzed the cost structure of these banks over the period 1972-1982. Outputs in their translog cost function were proxied by the dollar volume of all loans, securities, and deposits. Bank technology is incorporated by using time variable which is used as an index of the level of bank technology. They found that the technical change delivers significant cost reductions for banks. They generated significant economies of scale when costs are measured in terms of operating costs, and constant returns to scale when interest expenses were included in the cost measure. They concluded that the inclusion of interest expenses, derived with increased competition in an increasingly deregulated and inflationary market had offset the scale and technical change cost benefits.

Noulas, Ray, and Miller (1990) estimated a translog cost function for large banks with assets above $1 billion. They incorporated four output measures, four variable inputs, and a quasi fixed input. They found economies of scale in banks with assets between \$1-3 billion, diseconomies of scale in banks with assets between \$3-6 billion and continued through larger bank class sizes.

Hunter, Timme, and Yang (1990) investigated the costs subadditivity for a sample of 311 large commercial banks, using a multiproduct translog cost function for the year 1986. Significant increasing scale economies were found for banks up to \$5 billion in assets, and constant scale economies for banks with assets ranged between \$5-10 billion. Banks with assets between \$10-25 billion are found to exhibit mild diseconomies, while the largest banks with above than \$25 billion in assets experience significantly large diseconomies of scale.

The results of their study suggested that the cost functions of large banks were not subadditive, and hence, there were not measurable cost complementarities in multiproduct production. However, they concluded that the absence of subadditive costs does not necessarily mean that large banks would be better off breaking up production into a group of specialty firms. Other factors justify the multiproduct bank production in the absence of costs subadditivity, such as uncertainty, transactions costs, the shareability of inputs, and minimization of consumer-born transaction costs.

Evanoff, Israilevich, and Merris (1990) generated cost estimates for the period 1972-1987 for large 164 commercial banks using a generalized cost model which subsumes the neoclassical cost model as a special case, this model allows them to measure directly the effect of regulation and technical change on bank production costs. They found small economies of scale, the technical progress has a negative impact on scale economies, and the cost of regulation for the sample banks was small and significant, i.e. averages about 2% of actual costs.

Evanoff and Israilevich (1990) used the shadow price model to evaluate the production process of large commercial banks and to generate cost estimates utilizing a generalized cost function. In their model, they incorporated four outputs (investment securities and three types of loans), three factor input prices, technology measure, number of bank offices, and holding company structure measure. They found scope economies, minor economies of scale, and average cost curve is a U-shaped one. They also found a significant role exerted by the technological change in reducing costs

Hunter and Timme (1991) examined the technological change and its effect on the scale of output for large commercial banks over the period 1980-1986. They improved their study conducted in 1986 by accounting for multiproduct bank production, and conducting direct tests of nonneutral technological change and the relationship between firm size and technological change. They found technological change act to lower the real cost of bank production by about 1.0% per year, with larger banks enjoying a higher reduction in costs. They also found significant production economies, or at least no significant diseconomies in large banks financial intermediation.

The study of Shaffer and David (1991) estimates cost functions for the 100 largest U.S. commercial banks for the year 1984. These banks ranged in size from a low of $2.5 billion of total assets to a high of $120.6 billion of total assets. Their study used the technique of hedonic cost functions to correct for heterogeneity across banks. Output is measured as total assets, costs are defined in terms of total operating expenses, and deposits were taken as inputs. Their results casts doubt on previous findings that economies of bank scale are exhausted below $100 million in assets.

They found that minimum efficient scale in their sample ranged from $15 billion to $37 billion in assets, hence, they conclude that there will be some cost incentive or benefit to expansion or consolidation amongst large banks.

Shaffer (1994) estimated a revenue restricted cost function for a sample of 100 large commercial banks which account for 45% of all USA bank assets. The assets size of these institutions ranging from $1.28 billion to $142 billion over the period 1984-1986. Economies of scale were found across the entire sample, and the estimated scale elasticity ranged from 0.64 to 0.99.

Jagtiani, Nathan, and Sick (1995) investigated the effects of including the off balance sheets activities on the economies of scale and scope. They estimated multi output cost functions of large banks for the year 1988. They found that the empirical results are sensitive to output specification. For example, models that exclude deposits from output specification generate economies of scale which disappear when deposits are included. They conclude that the economies of scale do not exist, and the off balance sheet activities have little or no significant effect on the scale economies measures. Besides, no evidence of cost complementarity was found for most combinations of outputs.

Clark (1996) includes in his model the opportunity costs to evaluate the efficiency of banks. He found economies of scale in banks up to $2 billion of total assets. He concludes that the smaller, less diversified banks will continue to remain competitively viable, and found no evidence that banks can achieve gains in production or economic efficiency by expanding beyond $ 2 billion of total assets.

Jagtiani and Khanthavit (1996) investigated the effects of the growth of off balance sheet activities, and the impacts of risk based capital requirement on the cost structure of large 91 banks for the period 1984-1991. They regressed total costs on three outputs, three input prices, a measure of technological index, and a measure of change to risk based capital requirement. They found economies of scale and scope prior to the risk based capital requirement, and diseconomies of scale and scope after risk based capital requirement. Their results led them to conclude that the introduction of risk based capital requirements present a significant structural change in the large banks, and the large banks have financial incentives to shrink somewhat in order to capture scale economies.

Hughes and Mester (1998) estimated a translog cost function which is conditioned on the level of capital. They used 1989 and 1990 data on a sample of 286 large banks (over $1 billion of assets). Their cost function includes five outputs measured in dollar terms, and four inputs. They found that banks in all four size categories are operating with relatively large scale economies, and as banks grow larger in asset size they are able to economize on the use of financial capital, besides, the cost of signaling decreases for the largest banks, because larger banks are better able to diversify their portfolio. They show that when the cost function takes into consideration the role of financial capital as a signal of risk and as a cushion against losses for potentially risk averse bank managers, the scale economies become detectable.

Hughes, Mester, and Moon (2001) investigated the effects of risk and capital of banks on banks scale economies. They investigated various production models which took into consideration the banks' capital structure and risk taking, using 1994 data on 441 highest level bank holding companies. They found that the estimated scale economies depend on how banks' capital structure and risk taking is modeled. When equity capital, in addition to debt, is included in the production model and cost is computed from the value-maximizing expansion path rather than the cost-minimization path, banks are found to have large scale economies that increase with size. They also found that banks' diversification and risk taking have statistically and economically significant effects on their scale economies. Better diversification is associated with larger scale economies while increased risk taking and inefficient risk taking are associated with smaller scale economies.

The majority of the translog intermediation approach studies report evidence of economies of scale for relatively small banks (banks with less than $50 million in deposit size). And relatively a few studies estimated the cost structure of large banks and found that scale economies appear for these institutions. For example, the study of Shaffer and David (1991) found scale economies up to $37 billion in asset size, the study of Hunter and Timme (1986) reported significant economies of scale, and the study of Noulas, Ray, and Miller (1990) generated economies of scale in banks with assets ranged between $1-3 billion. Clark (1996) indicated that the empirical studies using samples dominated by banks with total assets in excess of $1 billion report minimum efficient scales that fall between $2 and $10 billion dollars of total assets. On the other hand, most of large and small bank studies could not find evidence on the existence of economies of scope. Out of thirteen small and large bank studies reviewed, four studies only reported evidence on scope economies.

Structure Conduct Performance Relationships

The Theoretical Background

Martin (1988) stated that the economists who were concerned about the private exercise of market power and its effect on the public developed the structure conduct performance (SCP) framework. This framework simply stated that market structure determines the behavior of firms in the market, which in turn determines the various aspects of market performance. So, the structure of the market (concentration or market share) affects conduct (behavior of firms) and both interact to determine the performance (profits). Recently, researchers in the bank market structure apply the structure performance framework to investigate the relationship between market structure and performance in the banking industry. The structure of the industry covers factors like industry maturity, product differentiation, elasticity of demand for output of the industry, barriers to entry, cost structure, diversification and economies of scale, and concentration, which Heggestad (1984) defined it as the number and size distribution of firms in the market.

The conduct of the firms covers pricing strategy, collusion product strategy, responsiveness to change, research and innovation, and advertising. The performance factor deals with output, growth in outputs, technological advance, employment, allocative efficiency, and profit.

Attempts have been made in the past to explain the correlation between the aforementioned variables. In this regard, there are two main hypotheses competing to explain the positive correlation between profitability of the banks and measures of market structure (either concentration or market share), those are the traditional structure conduct performance (SCP) paradigm introduced by Bain (1951), and the efficient structure hypothesis introduced by Demsetz (1973).

The traditional SCP paradigm deals with the relationship between the industry's structure and the firms' behavior and the impact of these behaviors on market performance. This paradigm states that market concentration (fewer firms in the market) encourages collusion amongst firms in the industry. The degree of concentration of a market exerts a direct influence on the degree of competition amongst its firms. The more concentrated the market, the less competitive will be the conduct policy in terms of a higher prices and lower output, and the less competitive will be the performance of banks in terms of higher ratios of price to cost and higher profits. Thus, more firms in more concentrated markets will earn higher profits (for collusive or monopolistic reasons) than firms operating in less concentrated ones, irrespective of their efficiency. Heggestad (1984) stated that increases in concentration, increase the ability of firms in the market to achieve and maintain the profit maximizing monopoly price. Consequently, as the structure of a market approaches monopoly, performance diverges from the competitive norm. Prices and profits level increase, and bank services become worse. Shaffer (1994) indicated that if the market is highly concentrated, it leads to poor performance (i.e. higher ratios of price to cost) and higher profit at the expense of consumer welfare.

This hypothesis is derived from the model of oligopolistic behavior of firms which implies that collusive arrangements are less costly to maintain in concentrated markets. The SCP paradigm is tested empirically by examining the relationship between profitability or loan and deposit interest rates and market concentration with a positive relationship indicating non-competitive behavior in concentrated markets (Goldberg and Rai, 1996).

There have been many empirical studies in the banking industry provided results that support the SCP paradigm. For example, Gilbert (1984) reported that out of 44 studies reviewed on the U.S. banking industry, 32 provide results supporting this paradigm.

The efficiency hypothesis, on the other hand, has emerged to challenge the SCP's paradigm interpretation of the structure performance relationship. According to this hypothesis, the explanation of the relation between market structure and performance of the individual firm is firm's efficiency. If a firm enjoys a higher comparative advantage in production than its competitors, i.e. if it has a superior management or production technologies and hence a relatively low cost structure, it can maximizes profits by reducing prices and expanding firm's size. Hence, this efficient firm is assumed to gain large market share that may results in high levels of concentration, and firm's efficiency will be the driving force behind the process of market concentration.

Thus, under the efficient structure hypothesis, the differences in firm-specific efficiencies in the market create unequal market shares and high levels of concentration. Hence, the higher profits are a result of lower costs from greater efficiency, rather than higher prices from the exercise of market power. If this hypothesis holds, such a result would minimize any anticompetitive concerns associated with bank mergers.

The empirical studies of the efficiency hypothesis such as Evanoff and Fortier (1988) and Smirlock (1985) found that firm's specific efficiency seems to be the dominant variable explaining profitability in studies of the U.S. banking industry.

Berger and Hannan (1989) in describing the abovementioned hypotheses stated that the SCP paradigm takes concentration as exogenous and maintains that high concentration allows for non-competitive behavior (collusion) that results in less favorable prices to consumers and higher profits to firms. On the other hand, the efficient structure hypothesis takes firm's specific efficiencies as exogenous and maintains that these efficiencies result in more concentrated markets and higher profits.

Following Evanoff and Fortier (1988) and Smirlock (1985), the aforementioned hypotheses can be tested by estimating the following profit equation:

$$P_i = a_0 + a_1 CR + a_2 MS + \sum a_i X_i \qquad (7)$$

Where P is a profit measure, CR is market structure measure (concentration measure), MS is market share measure, and X is a vector of control variables to account for firm specific and market specific characteristics. The traditional SCP paradigm is supported if $a_1 > 0$ and $a_2 = 0$, and the efficiency hypothesis is supported if $a_1 = 0$ and $a_2 > 0$.

The Importance of Investigating the Structure Performance Relationship in Banking

The SCP framework is a general statement on the determinants of market performance. It states that the conduct or rivalry in a market is determined by the conditions of the market structure, particularly the number and size distribution of firms (concentration) and the firm's market share. This rivalry delivers unique level of prices, advertising, and profits. The performance of the firms in the market is tied to the structure of the market through the link of conduct.

Investigating the SCP relationship in banking industry is used to help the regulators and policy makers to shape a banking structure that best serves the public in terms of the cost and the availability of banking services. In general the main objective has been sought is the attainment of an efficient banking system which, minimizes the possibility of bank failure.

Efficiency is associated with competition, the more competitive a market, the more efficient it is. Firms under the perfect competition market structure maximize profits and produce levels of output, which achieve an optimum allocation of resources. On the other hand, the monopoly market structure leads to a suboptimal allocation of resources.

In banking markets, it is difficult to choose between the objectives of efficiency and soundness. Under a competitive market structure, inefficient firms are not viable because they cannot maintain prices high enough to cover costs. On the other hand, under monopolistic conditions high cost firms are immune from competition which allows them to operate in an efficient manner and yet still survive. Hence a monopolistic industry is compatible with the policy objective of maintaining a failure proof banking system, while competition is consistent with the goal of efficiency (Molyneux et al, 1996).

Edwards (1965) indicated that the existence of substantial economies of scale makes the choice between the monopolistic competition and the competitive market structure more difficult. The presence of economies of scale in the banking market may well deliver a less competitive environment in the market, hence a judgment has to be made about the extent to which diminished competition is offset by the benefits of lower costs.

In general, there are two views concerning the application of the above issue to the problem of competition in banking markets. The first view believes that the failure of a bank should be avoided at all cost due to the serious negative consequences on the economy as a whole, hence this view sacrifice efficiency for soundness. The second view believes that the cost of bank failures is small in the presence of deposit insurance schemes and flexible monetary policy, hence this view sacrifice soundness for greater competition and therefore efficiency.

The Emergence of the SCP Debate in the Banking Market

The emergence of the structure performance debate, particularly in USA is based on the notion that the effectiveness of the banking system in serving the deposit and credit needs of the economy is related to its structure.

Chandler (1938) indicated that some aspects of the banking structure were inexplainable in terms of the theory of pure competition. Therefore, he applied the theory of oligopoly and monopolistic competition so as to investigate the competitive condition in banking markets. He stated that important elements of monopoly exist in the commercial banking system, and the theory of monopolistic competition, rather than the theory of pure competition is useful in explaining the credit and debit interest rates.

The average number of bank mergers and holding company formations in USA in 1950s and after 1960 was around 150 and 160 a year respectively (Philips, 1964).

The gradual public concern over decreasing competition due to mergers cases led to the Bank Holding Company Act of 1956 and the Bank Merger Act of 1960. These acts require regulators and policy makers to pay attention on the economic consequences of merger cases particularly, their anticompetitive consequences.

By early 1960s, competition in banking had emerged as a public policy issue, and this stimulated the academic interest in the problem of banking structure. Consequently, a huge number of bank market structure and competition studies were undertaken, and focused on the relationships among bank market structure, loan and deposit interest rates, and bank profitability as an indicator of how well or how poorly the public is being serviced by the banks (Rose, 1987).

Shaffer (1994) stated that between 1985 and 1991, more than 4000 mergers occurred amongst US commercial banks, a rate of consolidation more than four times greater than in previous decades. This consolidation has produced fears of market concentration and monopoly power in banking industry. Policy makers are suspicious of concentration and monopoly power, because of their anticompetitive consequences, i.e. the setting of prices that are unfavorable to consumers (lower deposit rates and higher loan rates), and restrictions on the quantity or quality of banking services that are made available to the public (including less available credit).

Bank Performance Measures

The performance of the banks can be measured in two ways, the first pertains to the price of loans and deposits (loan and deposit interest rates), the second is the profitability measure. Molyneux et al (1996) indicated that during the period 1964-1991, 73 SCP empirical studies were undertaken in USA, and the number of times the respective bank performance measure has been used were as follows: loan interest rates 30 times, deposit interest rates 25 times, and profitability measures 38 times.

Evanoff and Fortier (1988), Smirlock (1985), and Gilbert (1984) criticized the use of the loan and deposit interest rates as a proxy to banks performance for the following reasons: firstly, average measures combine flow variables (interest on loans over a one year period) with a stock variable (loans outstanding at the end of the year). It is unclear as to whether prices should be defined using average or year end values, depending on the criteria chosen, the value of the ratios will be different. Secondly, some studies have used average interest paid on deposits when regulation Q was effective. At the presence of these regulation, average interest rate paid on deposits is more likely to be a function of the maturity distribution of a bank's deposits and their denomination than a function of the market structure.

Gilbert (1984) stated that the average interest rates on loan and deposits are poor measures of bank performance, and the profitability measure have became a more widely adopted approach. He also stated that the only measures of bank performance derived from the income and profit statement account that do not have measurement problems are bank profit rates. If banks in areas with higher market concentration charge higher interest rates on loans, and pay lower interest rates on deposits, these conducts will be reflected in the pattern of bank profit rates.

Market Structure Measures

The empirical studies undertaken by Heggestad and Mingo (1977), Rhoades (1985a, b) have historically been in highly concentrated markets. For example, Rhoades (1985b) shows that in 1983 the 25 states that permitted state wide branching had, on average, five bank deposit concentration ratios (CR) of 72%. Rose (1987) indicated that across the United States as a whole the top three banks in each of the nation's urban centers (Standard Metropolitan Statistical Area) appear to control about 70% of total deposits.

The concentration ratio measure has been the most widely used as a measure of market structure. Gilbert (1984) stated that concentration in local market areas is the relevant measure of market structure. Molyneux et al (1996) reviewed 73 SCP studies and they showed that the number of times the concentration ratio measure used to proxy the market structure was 51 times.

However, this concentration ratio measure does not take into consideration the dispersion of bank size in the market and also does not reflect the number of competing firms in the market. The Herfindahl index is responsive to the number and dispersion of firms in the market and is therefore generally viewed as a superior measure. Moreover, it has been suggested that these measures are highly correlated that the choice of market structure measure is not of critical importance for testing the structure performance hypotheses (Rose and Fraser, 1976).

Empirical Studies of the Structure Performance Relationship

A very early structure performance study of banking markets was undertaken by Schweiger and McGee (1961). They incorporated the number of banks as a measure of market structure, and employed the loan interest rate to capture the banks' performance. They concluded that the smaller the number of banks in the market, the higher the level of loan rates.

The studies of Edwards (1965) and Fraser and Rose (1971) concluded that the market structure measure (concentration ratio) does have a significant effect on average loan rates. On the other hand, Rhoades (1985a) used a sample of 6500 banks to evaluate whether market share influence banks loan rates. His hypothesis was that some banks are so large compared to their competitors, and are able to force smaller banks to adopt the large banks pricing schemes. This predatory pricing thesis is supported in his study, especially for loan interest rates.

Heggestad and Mingo (1976) incorporated in their model the interest rate on passbook savings and the interest rate on 1 year $1000 CD as performance measures, which regressed separately on firm's efficiency measure (market share) and market structure measure (concentration). Their results show that the coefficient on the measure of market structure was insignificant. On the other hand, Rose and Fraser (1976) found a significant impact on bank prices (loans and deposits interest rates) from certain measures of bank market structure (Herfindahl index).

Berger and Hannan (1989) investigated the structure performance hypotheses using a sample of 470 banks for the period 1983-1985. They used as a performance measures, interest paid on money market deposit accounts (MMDAs), Super-Now (negotiable order of withdrawal) accounts, and 3, 6, 12, and 30 months CDs. They produced results that strongly support the SCP paradigm, and are robust with respect to model specifications, measurement of concentration, and econometric technique. They also found that banks in most concentrated markets pay less rates than those operating in least concentrated markets.

Calem and Carlino (1991) investigated the SCP relationship for 466 commercial banks and federal savings banks for the year 1985. They used MMDAs, and 3, and 6 month CD rates as a performance measures. They found that a 10% increase in concentration delivers a fall in MMDA rates by 5.9 basis points and for a 6 month CDs a fall of 3-4 basis points, whereas for the three month CDs the relationship was insignificant.

Ruthenberg and Elias (1996) conducted a regression analysis to test the structure performance relationship and explore the existence of economies of scale using 1989-1990 data for EC banking markets. They found that the expected changes in the structure of banking markets will have an impact only in countries which have a relatively low level of concentration and entry barriers. Berger and Humphrey (1994) stated that the academic studies have concluded that greater local market concentration results in slightly lower deposit rates and slightly higher loan rates for small borrowers.

The aforementioned studies used either the loan interest rates or the deposit rates to capture the banks performance. The following structure performance studies examined the relationship between the market structure and the profitability ratios, either using the return on assets (ROA) or return on capital (ROC). The reviewed articles show that ROA is the most popular profitability measure.

Edward (1965), and Fraser and Rose (1976) produced a statistically significant relationship between banks' ROA and market structure, suggesting that ROA is higher for banks operating in more concentrated markets. On the other hand, Fraser and Rose

(1971), and Fraser and Alvis (1975) found no such relationship, i.e. banks market structure is not strongly related to the performance of banks.

Smirlock (1985) models bank profitability as a function of market share (the efficiency measure), concentration (the market structure measure), an interaction term between market share and concentration, and other control variables. His sample covers 2700 unit state banks for the years 1973 and 1978. He found a significant positive relationship between profitability and market share while no such relationship exist between profitability and concentration. These results provide evidence in favor of the efficient structure hypothesis.

Evanoff and Fortier (1988) tested the traditional SCP paradigm and the efficient structure hypothesis using a sample of 6300 unit banks for the year 1984. They incorporated in their profit equation ROA as bank profit measure, concentration ratio (CR) to capture market structure, and market share to proxy the firm's efficiency. They found that when the market share variable is excluded from the profit equation, the coefficient on concentration measure was positive and statistically significant, a finding support the traditional SCP paradigm. When market share variable is included alongside the concentration measure and the rest of variables, market share measure is positive and statistically significant and concentration measure becomes insignificant, a finding that is consistent with the efficient structure hypothesis.

Williams, Molyneux, and Thornton (1994) examined the structure conduct performance and the efficiency hypotheses for Spanish banks for the period 1986-1988. Their results were consistent with the former hypothesis.

Berger (1995) explored the impact of market power (market concentration and market share) and efficient structure hypothesis on the profit concentration relationship. He regressed measures of bank profitability on variables measuring concentration, market share, X-efficiency, and scale efficiency. He found that non of the above hypotheses appear to overwhelmingly support the profit concentration relationship. His results show that these variables explain little of the variance of profitability, and a large increase in efficiency and market share is required to increase profitability by an economically significant amount.

Goldberg and Rai (1996) did not find a positive and significant relationship between concentration and profitability for a sample of banks across 11 European countries for the period 1988-1991. Their results, however, supported the efficient structure hypothesis, particularly for banks situated in countries with low concentration markets.

The previous SCP studies have examined the relationship between bank market structure and profitability. Some of these studies, (Edward 1965; Fraser and Rose 1976; and Williams et al, 1994), found a statistically significant relationship between concentration and profitability, suggesting that ROA for banks operating in more concentrated markets is higher. Other studies, (Fraser and Alvis, 1975; Smirlock 1985; Evanoff and Fortier, 1988; and Goldberg and Rai, 1996), however, found no such relationship. Therefore, there is no clear agreement in the literature on concentration-profitability relationship.

This chapter outlines the theoretical underpinnings of the empirical economies of scale and scope, and the structure performance studies. It provides a definition of scale and scope and them it focuses on the bank production and cost, as well as the bank output measures in the context of production and intermediation approaches. This chapter explains the functional form of the cost function to investigate scale and scope economies, it also examines the functional form of the profit equation to investigate the competitive conditions in the Jordanian banking system. This chapter enables me to outline the methodology which will be examined in the following chapter. This methodology is to be used to estimate scale and scope economies, and structure performance relationships in the Jordanian banking market.

CHAPTER 3: METHODOLOGY, DATA, AND DEFINITION OF VARIABLES

Introduction

This chapter seeks to outline the methodology, which is to be used by this study to estimate scale economies, scope economies, and structure performance relationship in the Jordanian banking market. It will explain the functional form of the models that are to be used. Both the translog cost functions and the profit equations will be analyzed. Then, it will discuss how to measure scale and scope economies, as well as how to test the SCP hypotheses. Finally, this chapter will explain the variables that are to be incorporated in the profit equations and the translog cost models.

Research Methodology

Economies of Scale and Scope

There are two likely questions of importance and interest to policy makers as well as to bankers, those are:

1) Do economies of scale and scope exist in the operation of the banks?

2) If so, what structure allows banks to reap most of scale and scope economies, at the same time, maintain enough competition?

Answering these questions requires the evaluation of the hypotheses outlined in chapter one, i.e. the evaluation of the incidence and magnitude of economies of scale and scope (cost complementarities) in the banking system. Benston (1972) stated that if economies of scale exist, banks that operate at a small scale would be at a cost disadvantage compared to the larger banks. Also, if cost complementarities exist, specialized banks would be at a cost disadvantage, and regulations that aim to restrict bank activities and the outputs they produce, may contribute to inefficiency in the system.

This section introduces the analytical approach adopted by this dissertation to investigate the previously stated hypotheses in chapter one. This methodology will enable me to characterize the production technology of the Jordanian banks; measure the incidence and magnitude of economies of scale and scope, whether such economies are similar across different size groups of banks, or different bank ownership, and finally how such economies have evolved over the period of the study 1990-2000. Though different criteria can be utilized to evaluate the financial institutions, such as efficiency, the ability to mobilize resources, financial stability, my focus will be restricted to an evaluation in terms of technical efficiency[10].

Two approaches have been employed by the previous studies to undertake an empirical analysis of the operations of the banks; those are the cost function approach and the profit function approach. Given the objectives of this dissertation, the cost

[10] Technical efficiency relates to banks that provide different quantities of services from a set of measured endowments of productive inputs.

function approach is chosen as the operational tool for the analysis for the following reasons[11]:

1) This approach assumes that banks behave as a cost minimizing decision units. This assumption is not as strong as that of profit maximization, which would be required for a profit function approach.

2) Cost function approach can be used directly to the estimation of economies of scale and cost complementarities, unlike the profit function, which can only be used indirectly to obtain such estimates. Further, the computation of the cost function is simple and economically convenient, allowing testing for wider classes of hypotheses.

3) The cost function approach requires data about input prices and output quantities, which are most likely to be observed. Also, factor prices are likely to be determined exogenously, making the estimation of the cost function relatively easier and more feasible.

4) Definition of output prices, which are required for the estimation of the profit functions are not easy to observe. Further, the profit function requires that banks be price takers in inputs and outputs markets, which is not the case in the Jordanian banking market, since certain banks have a market power. That is if banks are not price takers in both markets, it becomes very difficult to derive any meaning from the estimates obtained.

Within the cost function approach, the previous studies used either one of two approaches to evaluate the magnitude and incidence of economies of scale and cost

[11] For knowledge of the profit function approach, the reader is referred to Hancock (1985), Mullineaux (1978), Berger, Hancock, and Humphrey (1993), and Humphrey and Pulley (1997).

complementarities; those are the production approach and intermediation approach. The production approach measures output by the number of deposit and loan accounts, and considers only operating costs (Noulas, Ray, and Miller, 1990). The main limitation of this approach is that it excludes the interest expenses in the estimation of the cost function, consequently, to the extent that larger banks utilize a higher proportion of purchased funds, this approach is likely to find more scale than is actually the case (Berger, Hanweck, and Humphrey, 1987). Flannery (1983) indicated that the true scale economies in banking would be underestimated when operating costs are employed instead of the total costs, he argued that operating costs understates the true costs.

In the intermediation approach, the monetary values of loans and investments are taken as output variables; labor, capital, and deposits are inputs. Therefore, operating costs and interest costs are taken into account in the production process. Fields, Murphy, and Tirtiroglu (1993) indicated that the intermediation approach assumes that labor and capital are used to obtain deposits, and that deposits, labor, and capital are combined to produce loans and investments.

Given the availability of data, this study will follow the intermediation approach to calculate scale economies and cost complementarities. Consequently, I measure outputs as the JD value of loans and investments, and include the interest expenses of deposits in the cost measure. Mester (1987a) stated that "the intermediation approach has an advantage over the production approach in that it includes the total cost of banking and does not make a distinction between a bank's purchasing deposits from other institutions or producing its own deposits".

In choosing the cost function approach and within it the intermediation approach to empirically analyze the operations of banks in Jordan, this dissertation will employ the most widely used flexible form, which is the translog functional form. Lawrence (1989) stated that the earlier studies such as the study of Benston (1965), and Bell and Murphy (1968) estimated banks cost function using the Cobb-Douglas model which allows only to estimate increasing, decreasing, or constant cost curves.

The 1980's and 1990's studies used the translog cost function which is more generalized functional form, such as the studies of Benston, Hanweck, and Humphrey (1982), Murray and White (1983), Gilligan, Smirlock, and Marshall (1984), Kim (1985), Hunter and Timme (1986), Berger, Hanweck, and Humphrey (1987), Noulas, Ray, and Miller (1990), Gropper (1991), and Kolari and Zardkoohi (1991). Le Compte and Smith (1990) indicated that the translog function (presented in the following equation (8)) has been, and continues to be, the major functional form employed when testing for scale economies and cost complementarities. However, Clark and Speaker (1994) stated that the translog function specification is generally chosen by the recent studies because it allows for jointness in production by multiple product firm, its parameters can be easily estimated using standard statistical methods, and the parameter estimates have straightforward economic interpretations. Furthermore, this translog function allows us to incorporate more than one output as separate variable. It is also not restricted to the increasing or decreasing shapes imposed by the Cobb-Douglas specifications, i.e. it permits the estimates of U-shaped average cost curve. Therefore, following the track of the above-mentioned studies, this dissertation will estimate the following translog cost function, which allows estimation of the sensitivity of costs to proportional increase in all outputs (economies of scale), as well as the cost savings banks realize by producing several outputs jointly rather than specializing in the production of one (economies of scope). This translog cost function is a Taylor series expansion in output quantities and input prices, and can be written as follows:

$$\ln TC = B_0 + \sum_{i=1}^{n} B_i \ln Y_i + \sum_{j=1}^{m} C_j \ln P_j + \frac{1}{2}\sum_{i}^{n}\sum_{k}^{n} D_{ik} \ln Y_i \ln Y_k + \frac{1}{2}\sum_{j}^{m}\sum_{h}^{m} E_{jh} \ln P_j \ln P_h + \sum_{i}^{n}\sum_{j}^{m} F_{ij} \ln Y_i \ln P_j \quad (8)$$

Where:

lnTC = the natural logarithm of total costs;

$\ln Y_i$ = the natural logarithm of bank outputs;

$\ln P_j$: the natural logarithm of jth input prices; and

B, C, D, E, and F are coefficients to be estimated.

To increase the accuracy, the above cost function should be linearly homogenous in all input prices and symmetric. Zardkoohi, Rangan, and Kolari (1986) indicated that the correct specification of symmetry and homogeneity restrictions on the translog cost model can influence the empirical results. Cebenoyan (1988) received a higher degree of economies of scale when misspecified cost function is estimated. Therefore, the following restrictions will be placed upon the estimation of equation (8):

$\sum_{j}^{m} C_j = 1$, $\sum_{j}^{m} F_{ij} = 0$,and $\sum_{j}^{m} E_{jh} = 0$.

Or $\sum_{j}^{m} E_{jh} = \sum_{h}^{m} E_{jh} = \sum_{j}^{m}\sum_{h}^{m} E_{jh} = 0$ where the price response is symmetric, $E_{jh} = E_{hj}$.

All the variables appearing in equation (8) are entered in their logarithmic form, and since none of the banks included in the sample have zero output of one of the defined product, we will not face any problem when estimating the translog cost function in logarithmic form[12].

Murray and White (1983) indicated that this translog cost specification is quadratic in logarithms and linear in the unknown parameters, permitting easy estimation. It also can be reduced to restrictive technologies, such as the CD and CES specifications, by imposing zero restrictions on selected parameters. For example, the underlying production function becomes homothetic when $F_{ij} = 0$, $i = 1,\ldots\ldots,n$; $j = 1,\ldots\ldots,m$. This implies that the marginal rates of substitution in production are independent of the level of output (scale effects) and depend solely on relative prices, i.e., the isoquants are symmetric about the origin of the production space. By setting all $D_{ik} = 0$ and $F_{ij} = 0$, we can make the production function homogeneous of degree $\sum_{i=1}^{n} B_i$. If also we set $E_{jh} = 0$ j, h=1,....., m, the production function will have unitary elasticities of substitution among all the factor inputs.

Ordinary least squares coefficients will be obtained from estimating the total cost functions for the multi-product banking system, the domestic banks and foreign banks. Then, following Berger, Hanweck, and Humphrey (1987), and Noulas, Ray,

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[12] If one bank in the sample produces zero loan or investment in a given year, then ln (Y_i =0) is undefined.

and Miller, (1990), the overall scale economies (OSE) will be calculated by differentiating the previously mentioned total cost function (8) with respect to all outputs (Y_i), i.e.

$$\text{OSE} = \sum_{i}^{n} (\partial \ln TC / \partial \ln Y_i),\ \text{i} = 1, 2$$

$$OSE = \sum_{i}^{n} B_i + \sum_{i}^{n}\sum_{k}^{n} D_{ik} \ln Y_k + \sum_{i}^{n}\sum_{j}^{m} F_{ij} \ln P_j \qquad (9)$$

This equation (9) follows from the fact that partial derivatives of logarithmic equations represent percent changes. If the percent change in cost is less than the percent change in output, i.e. if OSE<1, then average cost declines as output increases, an indication that economies of scale exist. An elasticity greater than one, i.e. OSE>1, would indicate an upward slopping average cost curve and diseconomies of scale exist. An elasticity equal to one, i.e. OSE=1, imply a constant return to scale. The OSE is evaluated at the mean levels of the output and input variables.

To increase the efficiency of our estimates, and to test the robustness of the overall scale economies estimates computed from the single translog cost function (equation 8), the technique of Zellner's iterative seemingly unrelated regression (SUR) will be employed to obtain the estimates of the parameters (which are asymptotically equivalent to maximum likelihood estimates) of the single cost function simultaneously with the two input cost share equations (labor and financial capital cost share equations). Since the input cost share equations sum to unity by definition (linear homogeneity in input prices), one cost share equation is omitted from the estimated system of equations. Zellner's iterative SUR technique will only be made operational (solving the problem of singular disturbance covariance matrix) by deleting one of the cost share equations. Hence the following system of equations will be estimated:

$$\ln TC = B_0 + \sum_{i=1}^{n} B_i \ln Y_i + \sum_{j=1}^{m} C_j \ln P_j + \frac{1}{2}\sum_{i}^{n}\sum_{k}^{n} D_{ik} \ln Y_i \ln Y_k + \frac{1}{2}\sum_{j}^{m}\sum_{h}^{m} E_{jh} \ln P_j \ln P_h$$

$$+ \sum_{i}^{n}\sum_{j}^{m} F_{ij} \ln Y_i \ln P_j$$

$$\ln S_j = \sum_{j=1}^{m} C_j + \sum_{j}^{m}\sum_{h}^{m} E_{jh} \ln P_h + \sum_{i}^{n}\sum_{j}^{m} F_{ij} \ln Y_i \qquad (10)$$

where S_j is the share of the jth input in the total costs, and derived by partially differentiating the translog cost function (8) with respect to input prices P_j and using Shephard's lemma.

Generally speaking, the employment of the translog cost function in this study is valuable for several reasons. First, the results obtained from this translog cost function can be used as a benchmark for comparison with results obtained from other studies or other functional forms in the future. Second, the translog provides a second -order local approximation to an arbitrary cost function that is valid at any data points other than those at zero output levels for some of the products. Third, it enables me to examine a number of interesting properties of the production and cost function, those are the multi product scale economies, inter-product cost complementarities (economies of scope), and marginal costs of the two outputs produced by the banks.

With regard to inter-product cost complementarities or economies of scope, they are determined by the relative values of B_i and D_{ik} parameters of equation (8). Panzar and Willig (1977), Clark (1988), Kim (1986), and Benston, Berger, Hanweck, and Humphrey (1983) have shown that a multi-product cost function exhibits economies of scope if:

$$\frac{\partial^2 TC}{\partial y_i \partial y_k} = \left(\frac{TC}{y_i y_k}\right)\left[\frac{\partial^2 \ln TC}{\partial \ln y_i \partial \ln y_k} + \left(\frac{\partial \ln TC}{\partial \ln y_i}\right)\left(\frac{\partial \ln TC}{\partial \ln y_k}\right)\right] < 0 \qquad (11)$$

Where TC is total costs and y_i, y_k are banks outputs. Expressing equation (11) in terms of the parameters from equation (8) yields $\frac{TC}{Y_1 Y_2}[D_{ik} + B_i B_k] < 0$ (Benston, Berger, Hanweck, and Humphrey, 1983), and Denny, and Pento, 1978).

Output combinations satisfying $\frac{TC}{Y_1 Y_2}[D_{ik} + B_i B_k] < 0$ enjoy cost complementarities and suggest efficiencies from their joint production. This implies that an increase in the level of production of y_k reduces the marginal cost of producing product y_i. The production function, which is subject to economies of scale and cost complementarities displays subadditivity, which in turn precludes efficient competition amongst banks (natural monopoly).

Marginal costs for Y_1 and Y_2 are computed from (9) as: $MCY_i = \left(\frac{\partial \ln TC}{\partial \ln Y_i}\right)\frac{TC_i}{Y_i}$, where TC_i is the proportion of costs devoted to the production of output Y_i. The expression is evaluated at the mean values of the output and input variables.

The Structure Performance Relationships

The banking system in Jordan is quite concentrated and tightly regulated and protected from foreign competition. The monetary authority in Jordan started during the 1990's to adopt reform measures to promote greater banking competition and to preserve the Jordanian banks and their domestic market by encouraging the creation of larger national banks through merger policy. In pursuing such reform efforts, the Central Bank of Jordan sought to make the Jordanian banking system more efficient.

In the light of the above circumstances, investigating the competitive conditions in the Jordanian banking market becomes important. Heggestad and Mingo (1977) indicated that knowledge of the form of the structure performance relationships is very important for public policy in determining the social benefits and costs of mergers as well as the impact of structural changes on performance. The competitive conditions of the banking system can be investigated by undertaking an empirical test of the SCP paradigm and the efficiency hypothesis. The methodology to be adopted in this dissertation will enable me to provide evidence on how market structure influences the profitability of banks in Jordan.

Following Smirlock, Gilligan, and Marshall (1984), Smirlock (1985), and Evanoff and Fortier (1988), the SCP paradigm and the efficiency hypothesis will be tested by estimating the following profit function:

$$P_i = a_0 + a_1 CR + a_2 MS_i + \sum_{i=1}^{21} a_i X_i, \qquad (12)$$

Where P_i is a profit measure, CR is a measure of market structure (concentration), MS_i is a measure of market share, and X_i is a vector of control variables that prior studies have found to affect bank profitability. However, this dissertation will empirically estimate the following reduced form profit equation to test the competing hypotheses for the Jordanian banking industry:

$$P_i = a_0 + a_1 CR + a_2 MS_i + a_3 CAR_i + a_4 LTD_i + a_5 ASSET_i + a_6 THREE \qquad (13)$$

where:

P_i: bank i's profits measure.

CR: concentration measure.

MS_i: market share measure.

CAR_i: capital to asset ratio.

LTD_i: loans to deposit ratio.

$ASSET_i$: bank assets.

$THREE$: binary value equal to 1 if a big three bank, 0 otherwise.

With regard to the measure of bank performance, Gilbert (1984) stated that some studies incorporated a price of a certain banking products, while others used return on assets (ROA) or return on equity (ROE) to capture the performance of the bank. The former measure of the bank performance is problematic, because banks are multi-product firms and cross subsidization among products and services often occur. The latter measure is considered more suitable because it overcomes the problem of cross-subsidization. Berger (1995) stated that the measures of ROA and ROE to proxy the performance of banks are standards in banking research. However, this dissertation will use the measure of return on assets (ROA).

The independent variables include both market specific and firm specific variables and are similar to those used in the previous studies. To capture the market structure measure, and to test for the robustness of the results, this study will use the Herfindahl index (H) and the three banks concentration ratio (CR3) as a concentration measures. The Herfindahl index is an excellent measure of the structure of a market in that it is sensitive to the size and distribution of all firms and incorporates both the number of firms and the variations of the sizes of firms. An increase in the value of the index indicates a larger degree of concentration or a greater degree of inequality amongst banks. On the other hand, firm specific market share (MS) measure will be my proxy to capture the firm efficiency.

Since the profit measure is not risk adjusted, the study will employ two variables to account for firm specific risk: the capital to asset ratio (CAR) and loan to deposit ratio (LTD). The asset size of banks (ASSET) will be incorporated to take account of differences between banks induced by size such as scale economies. A binary value (THREE) will be included to take account for specific characteristics of the Jordanian banking market, i.e. to take account for the largest three banks that operate in the market which have traditionally dominated commercial banking business in Jordan. A value of one is used if the bank is one of the big three, and zero otherwise.

Cross section time series regressions will be computed for the entire period of the study and for two separate periods: 1990-1996, and 1997-2000 so as to test for the stability of the result during the overall period. Consequently, the traditional SCP paradigm will be supported if the regression results of equation (13) reveal that $a_1 > 0$ and $a_2 = 0$; and the efficiency hypothesis will be supported by a finding that $a_1 = 0$ and $a_2 > 0$.

As a first step, this dissertation will regress the profitability measure on each of the market structure variables separately by estimating the following two equations:

$$P_i = a_0 + a_1 CR + a_2 CAR_i + a_3 LTD_i + a_4 ASSET_i + a_5 THREE \tag{14}$$

$$P_i = a_0 + a_1 MS_i + a_2 CAR_i + a_3 LTD_i + a_4 ASSET_i + a_5 THREE$$

$$P_i = a_0 + a_1 MS_i + a_2 CAR_i + a_3 LTD_i + a_4 ASSET_i + a_5 THREE \tag{15}$$

Then, profitability measure will be regressed on both of market structure measures simultaneously. Smirlock, Gilligan, and Marshall (1984) indicated that the correct test of the competing hypotheses would be one that takes both market share and concentration variables into account at the same time. A straightforward way to do this is to estimate equation (13).

Data and Estimation Procedures

The data (in nominal terms) used in this dissertation were collected for 21 banks operating in Jordan. Data were collected for 11 years 1990-2000 for a total of 231 observations. The primary source of data was from the audited year-end income statements and balance sheets reports that all banks are required to submit annually with the Central Bank of Jordan. Supplementary information on number of employees in each bank, to calculate the price of labor, was obtained from other sources.

To increase the number of degrees of freedom available to estimate the parameters of the functions, and to reduce the collinearity amongst explanatory variables, hence, improving the efficiency of the econometric estimates, data for eleven years are pooled to estimate the profit function and the cost functions. The pooled data are stacked by cross-section, i.e. the data for different cross sections are stacked on top of one another, with each column representing a variable.

The cost equations and the profit equations will be estimated using the Ordinary Least Squares (OLS) technique. OLS assumes that the error terms are not correlated across observations or over time. Seemingly Unrelated Regression (SUR) technique will also be used to estimate a full system of cost equations.

The rationale behind choosing the above period is the availability of the variables needed for the study, and this period came after the financial crisis in 1989, as well as the failure of two banks in Jordan. During this period, the government adopted an adjustment program to reform the various sectors of the economy including the banking sector.

Definition of Variables

Economies of Scale and Scope

Choices of cost concept, inputs, and output metric were consistent with the intermediation approach, which is supported theoretically by Sealy and Lindley (1977). Given this approach, I will use two categories of outputs, and three variable inputs. Output can be defined as:

Y_1: Total loans;

Y_2: Investments (securities).

The three factor inputs I considered in this study are labor, capital, and deposits. Each can be defined as:

P_1: Price of labor, calculated by dividing staff expenses by total number of employees;

P_2: Price of capital, calculated by summing the capital expenses and dividing by total fixed assets;

P_3: Price of deposits, calculated by dividing total interest paid by total deposits plus borrowed funds.

The dependent variable is total costs (TC). It includes all labor and capital expenses, as well as the interests paid to depositors, i.e., it comprises of both operating and financial costs (interest paid on total deposits).

Structure Performance Relationship

Three models will be estimated to investigate the competitive conditions in the Jordanian banking system. The dependent variable for these three models is the return on assets (ROA), calculated by dividing net income before tax by total assets.

Two popular measures of market concentration will be employed: the three bank concentration ratio CR3, and the Herfindahl index (H). CR3 is defined as the ratio of the total deposits of the three largest banks to the total deposits of all banks in the market. On the other hand, H (which reflects one market in this study) is defined as the sum of squared market shares of deposits of all banks in the market, i.e., $H = \sum_{i=1}^{21} (MS_i)^2$ (Fraser and Rose, 1976). The H in a totally monopolized market is equal to 10000. In USA, the Justice Department doesn't like H > 1800.

To capture the firm's efficiency, market share (MS) measure will be utilized, and calculated by dividing bank's deposit by total market deposits. Other independent variables will be included in the models to account for risk and size characteristics, those are CAR, LTD, and ASSET. CAR is calculated by dividing capital by total assets of the bank, LTD is defined as loans divided by total deposits of the bank, and ASSET is the asset size of the bank. I expect CAR to be negatively related to ROA since lower ratios indicate a relatively risky position, and LTD to be positively related to ROA. I used a binary value (THREE) to account for the largest three banks in

Jordan, a value of one is used if a bank is one of the big three, zero otherwise. I expect positive coefficients if the largest three banks are more profitable than others.

The following chapter is the empirical analysis. It utilizes the methodology and data described in this chapter to further investigate the presence and magnitudes of scale and scope economies, as well as the structure performance relationships in the Jordanian banking market for the period 1990-2000.

CHAPTER 4: THE EMPIRICAL RESULTS

Introduction

This chapter presents the empirical evidence of scale economies, scope economies, and structure performance relationships in the Jordanian banking market for the period 1990-2000. In doing so, this chapter tests empirically whether the Jordanian banking production technology can be characterized by translog cost function, and whether scale and scope economies do exist in the Jordanian banking market. This chapter also tests the hypotheses related to the structure performance relationships in the Jordanian banking system.

The following section of this chapter is economies of scale. It provides the results on various structural tests regarding the functional form of the estimated cost functions. And provides the estimates of the translog cost model outlined in chapter three. These estimates are used to compute partial and overall economies of scale for the Jordanian banking system as a whole, for groups of banks, and for domestic and foreign banks. Section three provides the marginal costs of the two outputs (Y_1 and Y_2). Section four reports the results on cost complementarities between the two output variables incorporated in the translog cost function. Finally, section five presents the empirical results of the profit function estimation, and reveals which hypothesis explains the performance of banks in Jordan.

Economies of Scale

This section presents findings on the incidence and magnitudes of economies of Scale in the Jordanian banking system obtained from three different analyses. First, economies of scale estimates were obtained through the estimation of cost functions for the entire banking system for the periods 1990-2000, 1990-1993, 1994-1997, and 1998-2000. Second, the same estimates were derived by estimating a cost function for each of the three groups of banks into which the Jordanian banking system can be classified. Third, scale economies estimates were also derived for the domestic banks and foreign banks.

Structural Test Results for the Translog Cost Function

Hypothesis 1: can banking production technology utilized by the Jordanian banks be characterized by the translog function? Table 4.1 below reports the structural test results (F tests) for homotheticity, Cobb-Douglas, and non-jointness for the translog cost model employed in this dissertation. Following Kolari and Zardkoohi (1990), the tests were conducted by imposing certain restrictions on equation (8) and comparing the restricted models to the unrestricted model using the F ratio test.

Structural tests of the cost functions all rejected the more restrictive specifications. There is no statistical support for a production structure which is homothetic, Cobb Douglas, and non-joint. That implies that cost complementarities between products probably exist. It also implies that the use of the flexible function form to estimate the cost structure of the Jordanian banking system is appropriate.

Table 4.1

Structural Test Results for Jordanian Banks Translog Cost Function (1990-2000)

	Small	Medium	Large	Foreign	Domestic
Homotheticity					
F Ratios	3.31	3.66	8.50	3.25	14.80
$F_{0.05}$	2.61	2.53	2.53	2.61	2.45
$F_{0.10}$	2.09	2.04	2.04	2.09	1.99
Decision	Reject	Reject	Reject	Reject	Reject
Cobb-Douglas.					
F Ratios	5.88	2.44	3.40	4.90	8.88
$F_{0.05}$	2.08	1.99	1.99	2.08	1.91
$F_{0.10}$	1.76	1.71	1.71	1.76	1.65
Decision	Reject	Reject	Reject	Reject	Reject
Non-jointness					
F Ratios	3.24	3.25	5.67	6.54	29.60
$F_{0.05}$	2.84	2.76	2.76	2.84	2.68
$F_{0.10}$	2.23	2.18	2.18	2.23	2.13
Decision	Reject	Reject	Reject	Reject	Reject

Homotheticity implies separability of the cost function in outputs and all other variables. In terms of parameter restrictions for the translog cost function, separability in the production process would require that $F_{ij} = 0$ for all i, j. The above table shows that the homotheticity constraints are rejected at 5% and 10% levels. This rejection shows that the unspecified transformation function underlying the cost functions are not separable in output and input prices. Therefore, the empirical study of economies of scale and of scope using the translog procedure should account for the multi-product, multi-input nature of banks.

The test for a general Cobb-Douglas entails that all second order parameters in the translog specification be 0, i.e. in terms of our translog model, $D_{ik} = 0, E_{jh} = 0, and F_{ij} = 0$. The test for Cobb-Douglas functional form is rejected at both 5% and 10% level. As for the test for non-jointness in production, if the Jordanian banks have separate production function for each output, then this can be tested by imposing non-jointness on their production process. In terms of the parameter restriction on the translog cost function, this is equivalent to $D_{ik} = 0$. The non-jointness is rejected; this suggests that the marginal cost of one output depends on the level of production of the other output.

Overall and Partial Scale Economies for the Banking System as a Whole

Hypotheses 2 and 3: does the Jordanian banking market, as a whole, show any evidence of economies or diseconomies of scale? and **did the estimates of scale economies or diseconomies change during the period of the study 1990-2000?** To test these hypotheses, translog cost functions (equation 8 in chapter 3), containing two banking outputs and three input prices, were estimated for the periods 1990-2000, 1990-1993, 1994-1997, and 1998-2000. With linear homogeneity and symmetry restrictions imposed on the estimated functions, fourteen parameters were estimated excluding the constant term.

Overall, the results are quiet satisfactory. Most of the parameters estimates are statistically significant and exceed the critical t-values (with 17 degrees of freedom, these critical values are $t_{0.05}=1.98$ and $t_{0.10}=1.658$). And the high explanatory power supports the appropriateness of modeling banks as multi-product firms. The coefficients from the estimated equations are reported in Tables 9-12 in the Appendix. These tables report the parameter estimates and their asymptotic t ratios along with measures of overall goodness of fit. Tables 1-4 in the Appendix present the summary statistics on values of selected variables for the Jordanian banking system for the previously mentioned four periods.

The Table 4.2 below summarizes the main findings of the study on measuring overall economies of scale for the Jordanian banking system as a whole and for the individual banks for each of the eleven years. Increasing returns to scale are observed in all of the Jordanian banks, except for the last two banks. Those two banks exhibit diseconomies of approximately 17 and 26 percent in year 2000. The scale economies estimates for the total sample of banks are also found to be less than unity, providing strong evidence for the presence of unexploited scale economies in Jordanian banking market.

The results below suggest that the Jordanian banks have U - shaped cost curves with minimum cost up until JD 890.0 million in assets in year 2000. That is economies of scale were obtained up until about JD 890.0 million in assets, and diseconomies of scale occurred beyond JD 1573.0 million in assets in year 2000. Thus, efficiency gains

Table 4.2
Overall Scale Economies (OSE) in Jordanian Banks 1990-2000

Banks	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	Na	na	na	Na	na	na	na	na	0.62	0.46	0.59
2	Na	na	na	Na	na	na	0.17	0.61	0.74	0.78	0.82
3	na	na	na	0.60	0.65	0.75	0.74	0.74	0.78	0.69	0.66
4	na	na	na	0.65	0.71	0.74	0.73	0.73	0.76	0.77	0.80
5	0.45	0.41	0.48	0.43	0.44	0.48	0.50	0.60	0.62	0.48	0.56
6	0.69	0.73	0.71	0.84	0.87	0.91	0.92	0.88	0.90	0.91	0.94
7	0.64	0.84	0.83	0.87	0.91	0.96	0.92	na	na	na	Na
8	0.71	0.72	0.76	0.78	0.83	0.85	0.92	0.93	0.92	0.91	0.92
9	0.78	0.86	0.88	0.88	0.84	0.82	0.83	0.87	0.87	0.90	0.96
10	0.81	0.73	0.71	0.65	0.89	0.91	0.88	0.90	0.89	0.90	0.94
11	0.68	0.71	0.71	0.81	0.88	0.92	0.93	0.96	0.94	0.95	0.94
12	0.84	0.77	0.77	0.79	0.79	0.79	0.79	0.79	0.84	0.85	0.86
13	0.78	0.74	0.69	0.77	0.68	0.73	0.83	0.88	0.89	0.85	0.84
14	0.76	0.76	0.72	0.68	0.65	0.74	0.77	0.83	0.81	0.82	0.76
15	0.93	0.85	0.88	0.86	0.86	0.92	0.93	1.00	0.96	0.97	1.01
16	0.92	0.92	0.89	0.95	0.98	1.00	0.97	0.98	0.97	0.96	0.97
17	0.93	0.96	0.91	0.91	1.01	0.98	0.99	0.97	0.97	0.96	0.95
18	0.97	0.92	0.98	0.97	1.00	0.99	0.97	0.98	0.97	0.98	0.96
19	0.91	0.92	0.93	0.91	0.95	0.95	0.94	1.00	0.94	0.93	0.91
20	1.14	1.13	1.12	1.16	1.19	1.19	1.21	1.20	1.20	1.18	1.17
21	1.23	1.17	1.18	1.19	1.21	1.21	1.22	1.23	1.24	1.26	1.26
Total	0.91	0.91	0.90	0.91	0.94	0.97	0.97	0.99	0.98	0.97	0.96

Numbers were computed for equation (9) based on estimated coefficients reported in Table (9). For the individual bank, we used the own bank data, whereas for the total sample of banks, we used the sample average values of the variables.

appear to accompany increases in size up to approximately JD 890.0 million of total assets.

The yearly findings for the total banks as well as for the individual banks exhibit a trend towards dissipation of scale economies over time but continue throughout the entire period. Figure 4.1 below shows that the scale economies estimates for the total banks have improved after 1997, i.e. decreased from 0.99 in 1997 to 0.98, 0.97, and 0.96 in 1998, 1999, and 2000 respectively.

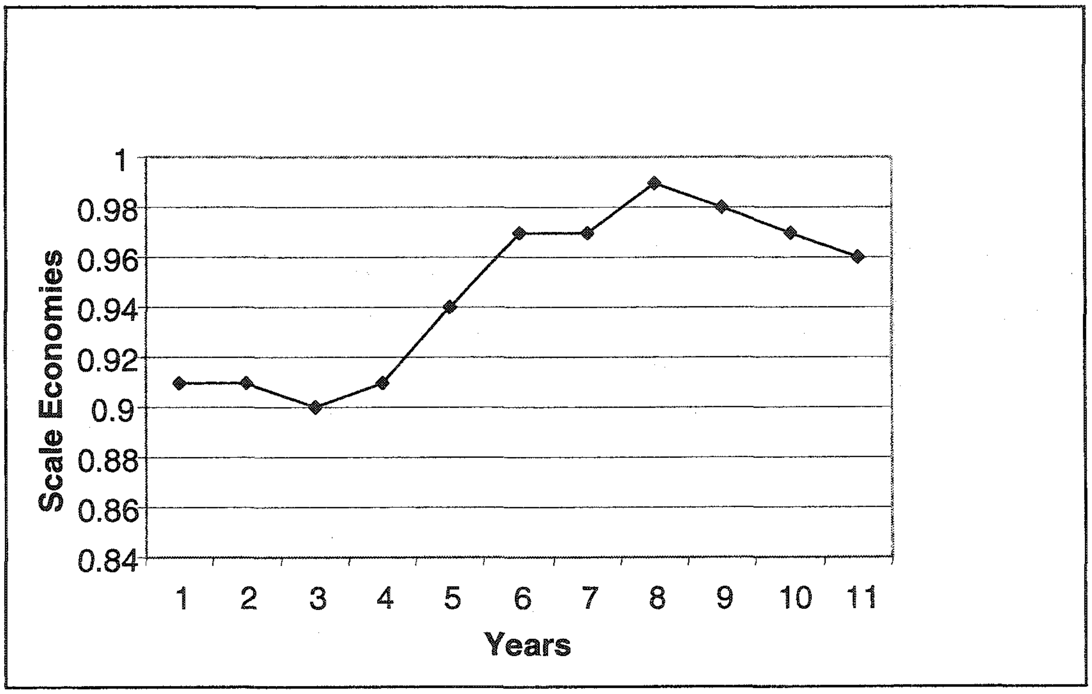

Figure 4.1: Overall Scale Economies for the Total Sample of Banks in Jordan.

Table 4.3 below shows the partial scale economy measures, which reflect the elasticity of total cost with respect to any individual output when other output and input prices are held constant. They thus reflect each output's contribution to the overall scale economies, since the sum of the partial scale elasticity specifies the overall scale economies.

Table 4.3

Overall and Partial Scale Economies for Jordanian Banks 1990-2000

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Y_1	0.83	0.82	0.81	0.82	0.85	0.89	0.88	0.90	0.88	0.87	0.85
Y_2	0.08	0.09	0.09	0.09	0.09	0.08	0.09	0.09	0.10	0.10	0.11
OSE	0.91	0.91	0.90	0.91	0.94	0.97	0.97	0.99	0.98	0.97	0.96

Numbers were computed for equation (9) based on estimated coefficients reported in Table (9). For the total sample of banks, we used the sample average values of the variables. Numbers were computed from a single cost function 1990-2000.

Total loans (Y_1) have higher cost elasticity than investment (Y_2) for all banks because the volume of these loans is larger than the volume of investments. It is also noteworthy that for total loans, the values of the partial scale economies increase with bank size. This is because banks invest more heavily in loans compared to their investments in stocks and securities. On the other hand, the partial scale elasticity of investments for the 19 banks was below 0.09 during 1990-2000, whereas the partial scale elasticity of investments for the other two largest banks ranged 0.14-0.17 during the same period.

The estimated values of overall scale economies appear to differ by cost definition. When the cost function is estimated using the operating costs (OC) instead of total costs (TC), the resulting overall economies of scale magnitudes were lower in all of the eleven years. This result is comparable to the results of other studies, such as the study of Berger, Hanweck, and Humphrey (1987), and the study of Hunter and Timme (1986), which incorporated OC and TC separately in their cost function estimation.

Dietsch (1993) stated that the fact that OSE magnitudes are higher when TC is considered instead of OC demonstrates that use of financial capital does not favor the extraction of economies of scale, and the use of labor and capital could favor the extraction of such economies. The below Table 4.4 and Figure 4.2 present a comparison of overall scale economies (OSE) produced from operating costs (OC) and total costs (TC).

Table 4.4

Overall Scale Economies (OSE) from Operating Costs (OC) and Total Costs (TC) in Jordanian Banks 1990-2000

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
OSE_{OC}	0.87	0.87	0.86	0.87	0.92	0.93	0.95	0.95	0.97	0.95	0.94
OSE_{TC}	0.91	0.91	0.90	0.91	0.94	0.97	0.97	0.99	0.98	0.97	0.96

Numbers were computed for equation (9) based on estimated coefficients reported in Table (13). For the total sample of banks, we used the sample average values of the variables. Numbers were computed from a single cost function 1990-2000.

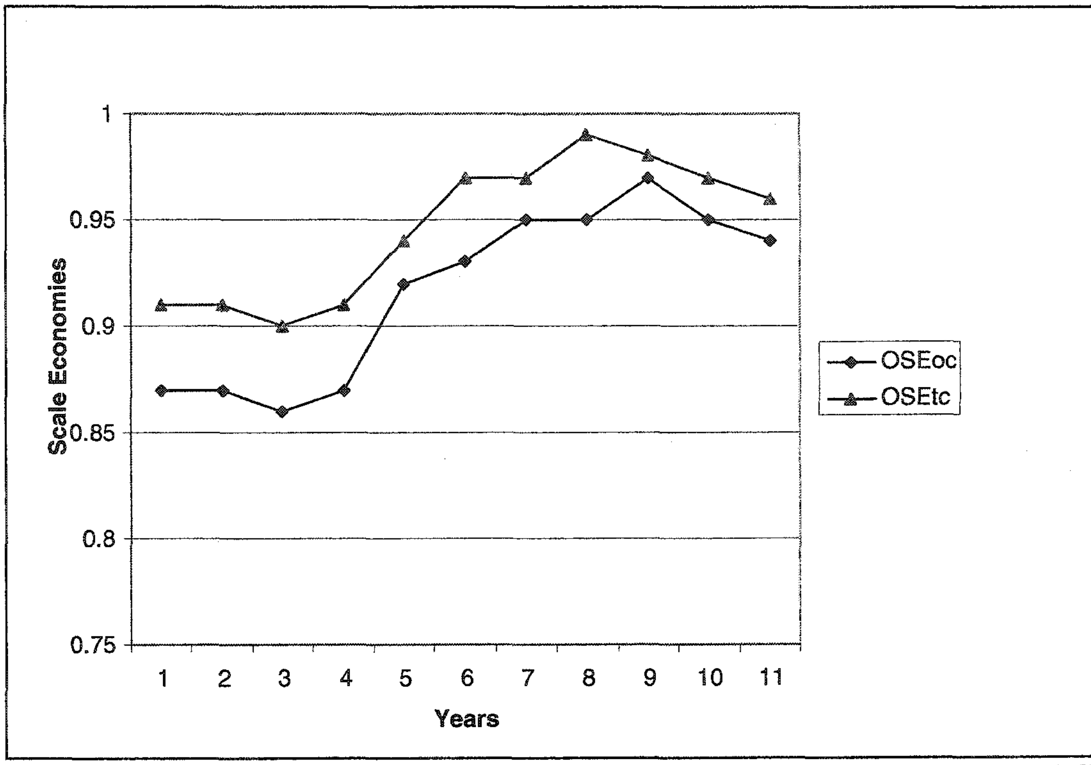

Figure 4.2: Overall scale Economies from Total Costs (TC) and Operating Costs (OC).

To check the robustness of our 1990-2000 scale economies results, three translog cost functions have been estimated for the periods 1990-1993, 1994-1997, and 1998-2000. Overall and partial scale economies have been computed from each period's cost function. Table 4.5 reports the economies of scale measures which are highly comparable to those computed from 1990-2000 cost function. These results provide strong evidence that the Jordanian banking system experienced economies of scale during the period 1990-2000.

Table 4.5

Overall and Partial Scale Economies for Jordanian Banking System 1990-2000

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Y_1	0.85	0.85	0.84	0.85	0.93	0.92	0.90	0.89	0.87	0.93	0.92
Y_2	0.07	0.07	0.08	0.08	0.01	0.04	0.04	0.06	0.09	0.05	0.05
OSE	0.92	0.92	0.92	0.93	0.94	0.96	0.94	0.95	0.96	0.98	0.97

Results for 1990-1993 are based on coefficients reported in Table (10). Results for 1994-1997 are based on coefficients reported in Table (11). Results for 1998-2000 are based on coefficients estimated in Table (12). Results for each year are based on the sample average variable values for that year. Y1 is loans, and Y2 is investments.

Overall and Partial Scale Economies for the Three Groups of Banks

Hypothesis 4: are there differences in the extent to which the various banks are able to exploit economies of scale based on their size? Humphrey (1987) stated that accurate cost economy estimates are likely to be obtained if banks are disaggregated by size class, or more importantly, if analyses are performed over time so that interest rate changes do not unduly bias the scale economy estimates obtained. Therefore, three classes of bank size were considered here: small banks, medium banks, and large banks. The overall and partial economies of scale are calculated using equation (9) outlined in chapter three.

Economies of scale are observed in all classes of banks size (see Table 4.6); implying robust scale economies results when compared to those computed from the entire banking system cost functions. The values of OSE in each class are lower than unity, which indicates the presence of overall economies of scale. In addition, the magnitudes of OSE increase with the size of banks, i.e. scale economies generally diminish as banks get larger within each yearly sample.

Table 4.6

Overall and Partial Scale Economies for Three Groups of Jordanian Banks 1990-2000

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Small											
Y_1	0.42	0.65	0.57	0.55	0.59	0.72	0.63	0.62	0.64	0.59	0.60
Y_2	0.04	0.03	0.05	0.02	0.01	0.05	0.05	0.02	0.08	0.07	0.12
OSE	0.46	0.68	0.62	0.57	0.60	0.77	0.68	0.64	0.72	0.66	0.72
Medium											
Y_1	0.78	0.94	0.95	0.88	0.82	0.71	0.67	0.65	0.65	0.64	0.63
Y_2	0.02	0.01	0.05	0.07	0.10	0.09	0.11	0.13	0.14	0.14	0.15
OSE	0.80	0.95	1.00	0.95	0.92	0.80	0.78	0.78	0.79	0.78	0.78
Large											
Y_1	1.06	0.99	0.94	0.89	0.88	0.85	0.80	0.70	0.74	0.79	0.75
Y_2	0.08	0.08	0.08	0.08	0.09	0.09	0.10	0.11	0.10	0.10	0.11
OSE	1.14	1.07	1.02	0.97	0.97	0.94	0.90	0.81	0.84	0.89	0.86

Results for small banks are based on coefficients reported in Table (14). Results for medium banks are based on coefficients reported in Table (15). Results for large banks are based on coefficients reported in Table (16). Results for each year are based on the sample average variable values for that year. Y1 is loans, Y2 is investments, and OSE is overall scale economies.

The operations of small banks (with assets below JD 270.0 million) are characterized by increasing returns to scale in all years, with magnitudes ranging from 0.46 in 1990 to 0.72 in 2000. All the individual banks in this group display sizable overall scale economies with magnitude less than 0.78. The scale economy measure for the medium size banks (JD 270 million< assets <JD 550 million) for each of the eleven years is found to be less than one (except for the year 1992 where banks

experienced constant returns to scale), providing evidence for the existence of significant economies of scale.

For banks in large size group (with assets above JD 550.0 million), diseconomies of scale are evident in the early years 1990-1992, and significant economies of scale prevailed during 1993-2000 with magnitudes ranging from 0.97 in 1993 to 0.86 in year 2000. The overall pattern appears to be one of increasing overall economies of scale over the entire time period.

It is worthy to mention that only one bank in the large size group experienced diseconomies of scale in each of the eleven years. Its scale economy magnitude ranged from 1.19 in 1990 to 1.15 in year 2000. This implies that it would be cost inefficient for this bank to expand its operation, and that if this bank do develop a strategy to become larger, customers would probably have to pay a higher price for the services. Lack of scale economies beyond a certain size is a common finding in conventional average cost studies. Clark (1988) reports in his survey only two studies found significant overall economies of scale above $100 million of deposits. However, some studies based on samples of large banks found economies of scale at much larger banks (e.g. Hunter and Timme, 1986; Noulas, Ray, and Miller; 1990, and Shaffer and David, 1991).

Figure 4.3 below shows that the small size group estimations appear to reveal economies of scale measures that are lower than those computed from the medium size group estimation, and the latter size group estimation produces economies of scale measures that are lower than those computed from the large size group estimation.

This implies that as the asset size of the bank rises, the scale economy magnitude rises as well (see below figure 4.3).

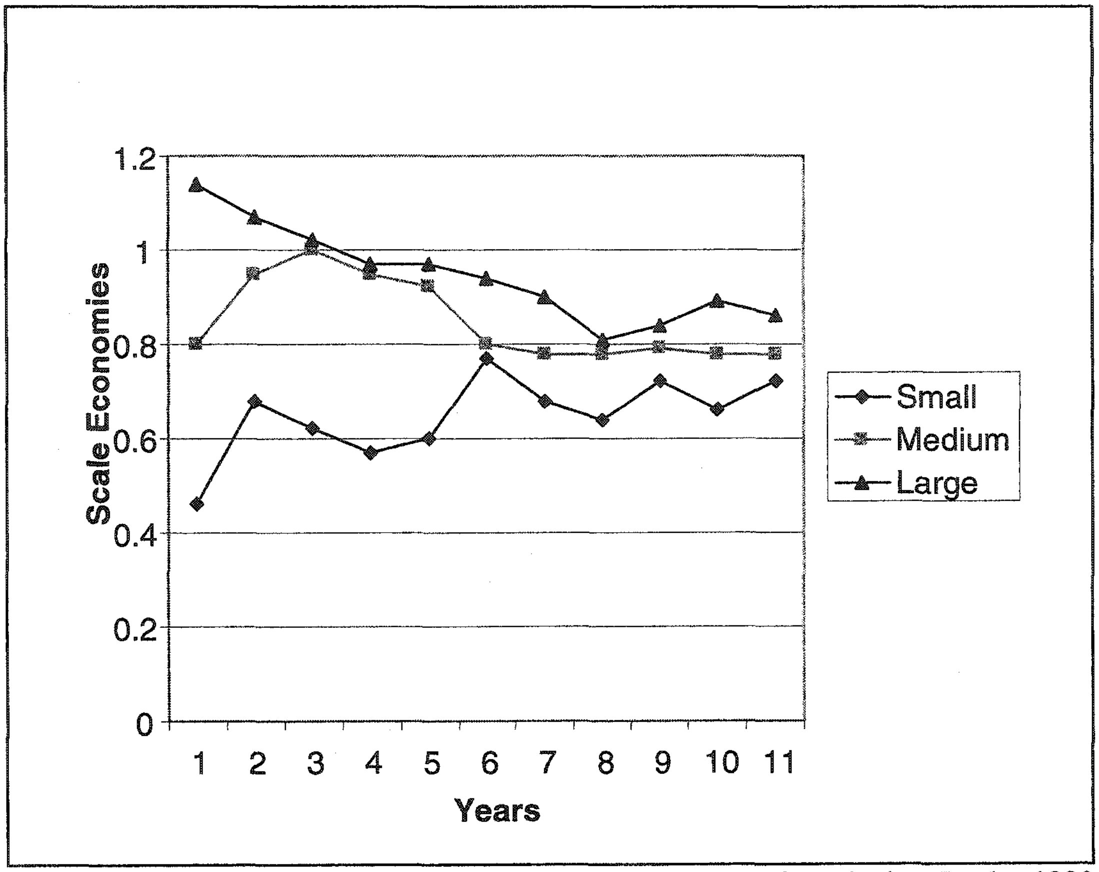

Figure 4.3: Overall Scale Economies for Three Groups of Jordanian Banks 1990-2000.

The presence of significant scale economies in the small, medium, and large banks suggests that banks could become more efficient by increasing their production, and that expansion or mergers amongst banks (excluding the largest bank) would result in a more efficient banking industry, and hence could benefit society by reducing costs.

Overall and partial Scale Economies for Domestic and Foreign Banks

Hypothesis 5: do economies of scale characterize to the same degree the production of financial services by domestic banks, and foreign banks? Table 4.7 reports the overall and partial scale economies for both the domestic and foreign banks during 1990-2000. Figure 4.4 below shows that the overall scale economies magnitudes for the foreign banks are lower than those computed for the domestic banks in all of the eleven years except for the year 1997, where foreign and domestic banks have the same scale economy magnitude of (0.94). The domestic banks experienced increasing returns to scale for the period 1990-2000, with scale economy magnitudes ranged from 0.92 in 1990 to 0.96 in year 2000. The foreign banks also enjoyed increasing returns to scale for the entire period, with scale economies ranged from 0.74 in 1990 to 0.91 in year 2000.

Table 4.7

Overall and Partial Scale Economies for Domestic and Foreign Banks 1990-2000

Domestic	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Y_1	0.83	0.86	0.87	0.89	0.85	0.79	0.80	0.80	0.82	0.88	0.89
Y_2	0.09	0.08	0.09	0.07	0.09	0.11	0.11	0.14	0.15	0.08	0.07
OSE	0.92	0.94	0.96	0.96	0.94	0.90	0.91	0.94	0.97	0.96	0.96
Foreign											
Y_1	0.72	0.67	0.72	0.67	0.70	0.70	0.74	0.74	0.77	0.76	0.78
Y_2	0.02	0.14	0.06	0.16	0.07	0.12	0.14	0.20	0.16	0.14	0.13
OSE	0.74	0.81	0.78	0.83	0.77	0.82	0.88	0.94	0.93	0.90	0.91

Results for the domestic banks are based on coefficients estimated in Table (18). Results for foreign banks are based on coefficients reported in Table (17). Results for each year are based on the sample average Y1 is Loans, Y2 is Investments, and OSE is Overall Scale Economies.

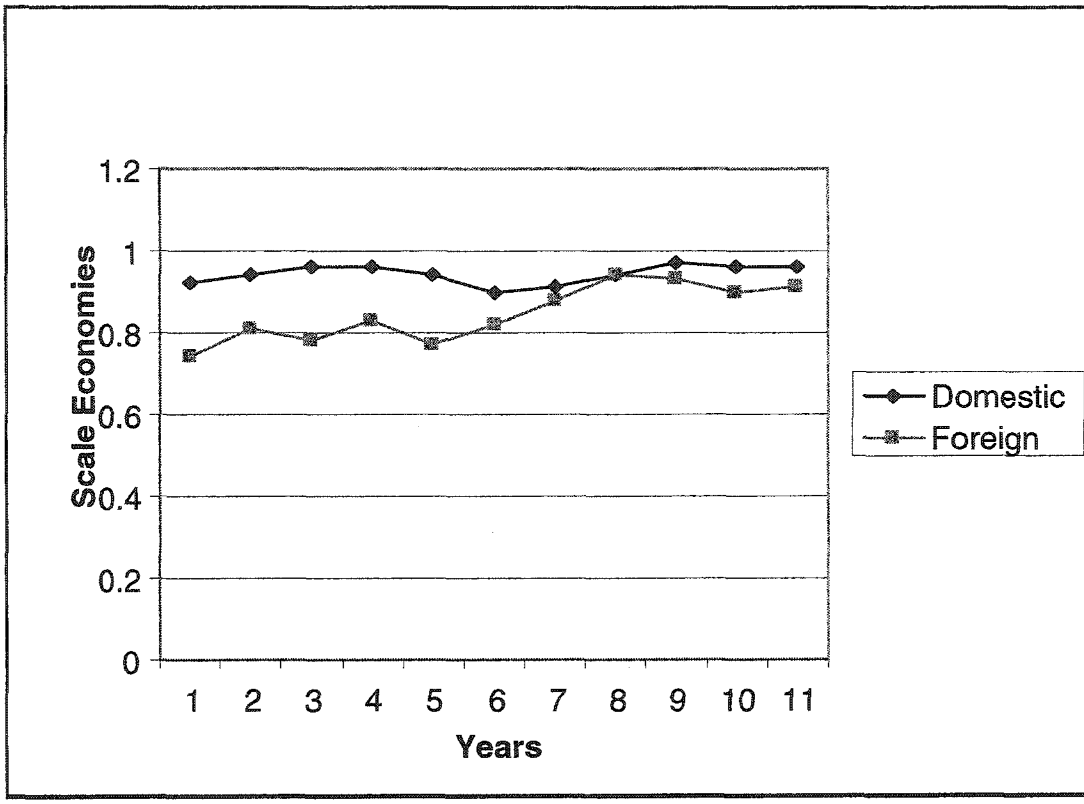

Figure 4.4: Overall Scale Economies for Jordanian Domestic and Foreign Banks 1990-2000.

Overall Scale Economies Computed from Cost system of Equations

To test the robustness of our OSE computed from the single translog cost function, a system of cost equations have been estimated simultaneously using Zellner's iterative seemingly unrelated regression (SUR) technique for the period 1990-2000 for all banks, groups of banks, and foreign and domestic banks. The efficiency of the estimated parameters has been significantly improved when compared to those obtained from a single translog cost function. Most of the estimated coefficients are statistically significant. The R^2 values of the cost equations range from 0.71 to 0.93 and indicate strong goodness of fit (see Tables 9-14 in the Appendix).

Table 4.8 below reports the OSE results. The total sample of banks experienced significant scale economies in each of the eleven years. All individual banks experienced scale economies except for two banks. This result is similar to the result obtained from the single translog cost function.

Table 4.8

Overall Scale Economies for Jordanian Banks Computed from cost system of Equations 1990-2000

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Total	0.94	0.92	0.91	0.92	0.94	0.96	0.95	0.97	0.95	0.96	0.95
Small	0.47	0.52	0.61	0.65	0.68	0.61	0.61	0.61	0.63	0.70	0.72
Medium	0.79	0.92	0.90	0.89	0.82	0.79	0.76	0.82	0.83	0.87	0.89
Large	1.05	1.01	1.00	0.98	1.01	1.04	1.00	0.92	0.91	0.92	0.88
Foreign	0.78	0.77	0.81	0.79	0.69	0.69	0.75	0.80	0.87	0.85	0.89
Domestic	0.95	0.94	0.91	0.90	0.89	0.87	0.86	0.88	0.89	0.90	0.92

Results of this table are based on coefficients reported in Tables (19-24). Results for each year are based on the sample average variable values for that year.

The small banks experienced significant increasing returns to scale in all years, with OSE magnitudes ranging from 0.47 in 1990 to 0.72 in year 2000. The medium size banks scale economy measures are found to be significantly different from one for each of the eleven years, implying the presence of overall scale economies. Large banks on the other hand, experienced diseconomies of scale in the years 1990 and 1995, constant returns to scale in the years 1991, 1992, 1994, and 1996, then significant increasing returns to scale prevailed during 1997-2000. It is noteworthy to mention that the significant improvement of the large banks scale economy measures occurred after 1996, which is the year when the Central Bank of Jordan implemented many measures to reform the banking market.

In general, the Jordanian banks have downward slopping long run average cost curves, i.e., banks in all three size categories, as well as domestic and foreign banks are operating with relatively large scale economies. Thus, there appear to be a noticeable improvement in efficiency that can be obtained by banks able to increase their scale. Under such circumstances, the Central Bank policy of encouraging banks to merge will enhance the soundness of the Jordanian banks, and improve the efficiency of the banking market as a whole. Overall, Figure 4.5 shows that the OSE results computed from the cost system of equations are highly comparable with those obtained from the single translog cost equation, this implies that our results are robust to the methods used to estimate the parameters of the cost function and the OSE.

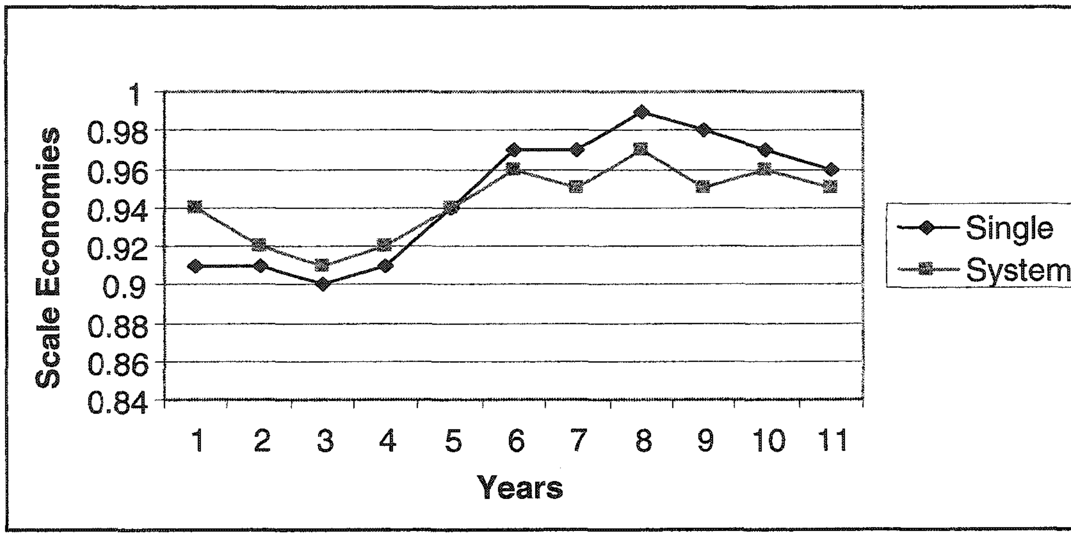

Figure 4.5: Overall Scale Economies from Single Cost Equation and System of Equations for Jordanian Banks 1990-2000.

Marginal Costs

Knowing the marginal costs of loans and investments is important for banks' manager, such knowledge would provide those managers with information that would help them make better decisions. Benston (1972) stated that estimates of scale economies and marginal costs in terms of specific homogeneous types of output are required for managerial and economic intelligence purposes. Table 4.9 below lists marginal costs (on an annual basis) in terms of total costs per JD 1000 of loans or investments. The computed marginal costs for the groups of banks as well as for the foreign and domestic banks are low and are consistent with the strong indications of economies of scale mentioned above.

Table 4.9

Marginal Costs of Jordanian Banks Outputs 1990-2000

Small	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Y_1	0.016	0.020	0.024	0.022	0.021	0.030	0.025	0.025	0.026	0.024	0.045
Y_2	0.022	0.028	0.023	0.025	0.023	0.027	0.028	0.029	0.050	0.089	0.090
Medium											
Y_1	0.028	0.031	0.032	0.037	0.024	0.024	0.020	0.020	0.020	0.021	0.024
Y_2	0.002	0.005	0.011	0.016	0.034	0.042	0.027	0.021	0.026	0.031	0.030
Large											
Y_1	0.023	0.021	0.021	0.018	0.016	0.015	0.014	0.010	0.012	0.018	0.016
Y_2	0.033	0.033	0.037	0.060	0.078	0.084	0.074	0.023	0.020	0.021	0.022
Foreign											
Y_1	0.034	0.019	0.029	0.023	0.023	0.027	0.028	0.029	0.043	0.030	0.038
Y_2	0.009	0.014	0.008	0.027	0.043	0.049	0.052	0.057	0.059	0.060	0.066
Domestic											
Y_1	0.028	0.029	0.032	0.038	0.030	0.030	0.032	0.030	0.030	0.044	0.039
Y_2	0.020	0.016	0.024	0.015	0.039	0.060	0.079	0.052	0.057	0.052	0.068

Results of this table are based on coefficients reported in Tables (14-18). Results for each year are based on the sample average variable values for that year. Y1 is Loans, and Y2 is Investments.

Moreover, for groups of banks, foreign and domestic banks, the marginal costs of investments are higher than the marginal costs of loans in most of years. This may be due to the fact that banks devote little amount of the available resources to investment output (economies of scale effect). Besides, the ceilings imposed on banks loans during the first half of nineties might contribute to higher marginal costs of investments.

With the exception of large banks, the marginal costs of servicing loans for small, medium, domestic, and foreign banks display a rising trend in most of the years. This general rise in the marginal costs is consistent with the U-shaped cost curve mentioned above.

For groups of banks, large banks exhibit the lowest marginal costs for loans in most of the years, particularly, in year 1997. Hughes and Mester (1997) received this result, i.e. the largest group of banks achieved the lowest marginal cost of capital compared to those of the other groups. After 1994, the medium banks' marginal costs for loans become lower than those for small banks (Figure 4.6). As for foreign and domestic banks, Figure 4.7 below shows that the marginal costs for loans of the former are lower than those of the latter for most of the years, excluding 1990 and 1998.

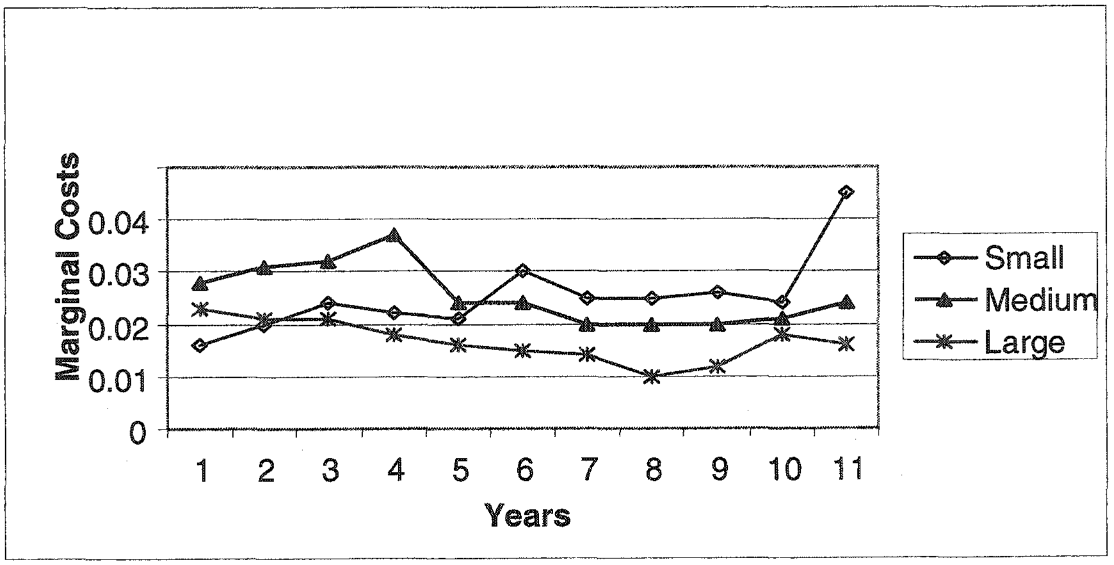

Figure 4.6: Marginal Costs of Loans for Three Groups of Jordanian Banks 1990-2000.

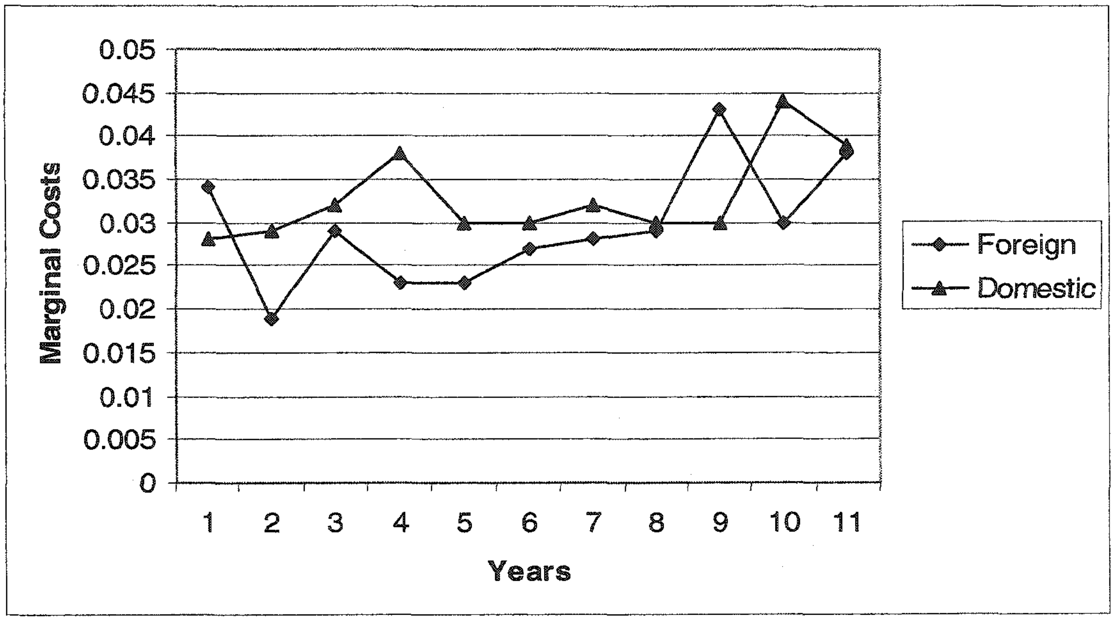

Figure 4.7: Marginal Costs of Loans for Foreign and Domestic Banks in Jordan 1990-2000.

Cost Complementarities

Hypothesis 6: does the Jordanian banking market as a whole, group of banks, domestic banks, and foreign banks show any evidence of scope economies. To well understand the cost structure of the banking system in Jordan, it is necessary however to also look at the other side of multi-output production, namely the returns from joint production. One measure of efficiency in joint production is cost complementarities between loans (Y_1) and investments (Y_2).

One advantage of the translog cost function compared to other models, such as Cobb-Douglas model, is that it permits estimation of any cost complementarities which might appear amongst the products in a multi-product firm. The estimation of the cost complementarities is an appropriate test for the existence of economies of scope.

Non-jointness implies that the cost of an output vector may be specified as the sum of separate functions of individual outputs and common input price vectors. Individual outputs could be treated as independent production processes, so that the change in cost for the total output vector of changing one output depends only on that output. If the production technology is non-joint, then the marginal cost of each output is independent of the level of any output.

Table 4.10 below displays the pair-wise cost complementarity measures at the whole banking system level for the periods 1990-2000, 1990-1993, 1994-1997, and 1998-2000. If the value of cost complementarity measure is negative, then cost complementarities are said to be present, implying economies of scope; a positive value indicates diseconomies of scope.

Table 4.10

Cost Complementarities for the Whole Banking System in Jordan

Y_1 and Y_2	1990-2000	1990-1993	1994-1997	1998-2000
All Banks	0.0001	0.0001	-0.0004	0.0001

Results are based on coefficients reported in Tables (9-12). Y1 is Loans, and Y2 is Investments.

The estimates for the whole banking system show that there were cost disadvantages associated with the joint production of Y_1 and Y_2 except for the period 1994-1997. Hence, the results suggest that pair-wise combinations of outputs are found to be cost substitutes. That is, an increase in the level of one output results in the marginal cost of the other output increasing. In the absence of cost complementarities between Y_1 and Y_2 and if the objective of the regulator is to influence banks to move to a socially efficient minimum marginal cost production function, then allowing banks to expand output Y_1 results in higher marginal cost of Y_2. This might require that the regulator constrain the banks level of output Y_1. On the other hand, if cost complementarity exists between Y_1 and Y_2, then marginal cost of Y_2 would fall if any constraint on Y_1 is loosened.

The cost complementarity measures were also computed for the groups of banks, and for foreign and domestic banks. Table 4.11 suggests that the domestic banks group is the only group that experienced economies of scope in all of the previously mentioned four periods, i.e. the production of this group is characterized by jointness and that the costs are lowered by servicing both Y_1 and Y_2. On the other hand, small banks group experienced economies of scope in all periods but 1998-2000. Medium and large banks groups experienced economies of scope in 1990-2000, and 1994-1997. Foreign banks experienced diseconomies of scope in all periods but 1990-1993.

Table 4.11

Cost Complementarities for Groups of Banks in Jordan

Y_1 and Y_2	1990-2000	1990-1993	1994-1997	1998-2000
Small	-0.0004	-0.0002	-0.0002	0.0002
Medium	-0.0002	0.0002	-0.0002	0.0006
Large	-0.0005	0.0009	-0.0006	0.0003
Foreign	0.0003	-0.0006	0.0002	0.0009
Domestic	-0.0004	-0.0003	-0.0006	-0.0002

Results are based on coefficients reported in Tables (14-18). Y1 is Loans, and Y2 is Investments.

It is worth mentioning that all groups of banks enjoyed economies of scope for the period 1990-2000 except the foreign banks which experienced diseconomies of scope. This may well explain the absence of economies of scope for the entire banking system for the periods 1990-2000, 1990-1993, and 1998-2000.

The Tables 4.12 and 4.13 report cost complementarities estimates computed from operating costs. Dietsch (1993) stated that cost complementarities are more related to the use of labor and physical capital than to the use of financial capital. Results of the above two tables show that cost complementarities exist between the two outputs for the whole banking system, and for the groups of banks, as well as for domestic and foreign banks. Mester (1987) indicated that a finding of economies of scope would imply that firms that were specialized would be at a cost disadvantage and that regulations that restrict the outputs a firm is allowed to produce may lead to inefficient production.

Table 4.12

Operating Cost Complementarities for the Whole Banking System in Jordan

Y_1 and Y_2	1990-2000	1990-1993	1994-1997	1998-2000
All Banks	-0.0008	-0.0001	-0.0002	-0.0001

Results are based on coefficients reported in Table (13). Y1 is loans, and Y2 is investments.

Table 4.13

Operating Cost Complementarities for Groups of Banks in Jordan

Y_1 and Y_2	1990-2000	1990-1993	1994-1997	1998-2000
Small	-0.0009	-0.0002	-0.0004	-0.0009
Medium	-0.0001	-0.0004	-0.0005	-0.0006
Large	-0.0003	-0.0003	-0.0003	-0.0002
Foreign	-0.0003	-0.0004	-0.0007	-0.0003
Domestic	-0.0002	-0.0002	-0.0003	-0.0004

Results are based on coefficients reported in Table (13). Y1 is loans, and Y2 is investments. .

To check the robustness of the preceding results, cost complementarities are also computed from the cost system of equations estimates for the whole banks, groups of banks, and for foreign and domestic banks during 1990-2000. Table 4.14 reports the results which indicate that cost complementarities does exist between Y_1 and Y_2 in the Jordanian banking system.

Table 4.14

Cost Complementarities Computed from cost system of Equations for 1990-2000

	All Banks	Small	Medium	Large	Foreign	Domestic
Y_1 and Y_2	-0.0006	-0.0007	-0.0008	-0.0002	-0.0005	-0.0006

Results are based on coefficients reported in Tables (19-24). Y1 is Loans, and Y2 is Investments.

Structure Performance Relationships

Hypothesis 7: does the efficiency hypothesis explain the performance of banks, or does the SCP hypothesis explain the performance of banks in Jordan? to do so, three profit equations (equations 13, 14, and 15 outlined in chapter 3) containing market specific and firm specific independent variables were estimated for the periods 1990-2000, 1990-1993, 1994-1997, and 1998-2000. In all the equations, the R^2 values are comparable to results from other SCP studies mentioned in Gilbert's (1984) survey, and substantially higher than those reported by Smirlock (1985), Evanoff and Fortier (1988), Bourke (1989), and Berger (1995) who report R^2 values less than 10%.

Following Evanoff and Fortier (1988), and Smirlock (1985), the analysis of the SCP relationships is conducted as followed: the profitability measure (ROA) is regressed on each of the market structure variables separately, i.e. regression 1 in the following tables includes a concentration measure (either CR3 or H), and regression 2 includes the MS variable. Then profitability measure is regressed on both of market structure measures simultaneously, i.e. regression 3 contains both the concentration measure and MS measure.

The regression results for the period 1990-2000 are shown in the following Table 4.15. In regression 1A, the profitability measure (ROA) is regressed on H, a measure of market concentration, and the rest of the variables. The concentration variable (H) is found to be positive and statistically significant.

Table 4.15

OLS Estimation of the SCP Paradigm and Efficiency Hypothesis in Jordanian Banks (1990-2000)

	Regression 1A	Regression 1B	Regression 2	Regression 3A	Regression 3B
Constant	-0.036 (-3.18)	-0.05 (-3.44)	0.009 (7.34)	-0.041 (-3.33)	-0.063 (-3.66)
H	0.00003* (3.96)			0.00003* (4.04)	
CR3		0.001* (4.01)			0.001* (4.17)
MS			0.0002 (0.63)	-0.0003 (-1.03)	-0.0004 (-1.29)
CAR	0.028* (3.99)	0.028* (4.05)	0.023* (3.23)	0.028* (3.94)	0.028* (4.02)
LTD	1.11E-10 (0.28)	9.05E-11 (0.227)	1.36E-10 (0.32)	3.54E-11 (0.08)	-9.60E-12 (-0.023)
TA	8.89E-13 (0.38)	1.18E-12 (0.51)	-3.40E-12 (-0.80)	5.00E-12 (1.09)	6.51E-12 (1.37)
Binary	-0.002 (-0.49)	-0.002 (-0.58)	0.009 (0.026)	-0.0006 (-0.18)	-0.0008 (-0.22)
Adjusted R^2	0.11	0.11	0.05	0.12	0.12
F	5.4	5.5	2.2	4.7	4.9

*: Coefficient Significant at the 5% Level (Two Tail Test). Figures Between Brackets Represent t-Ratios.

To check the robustness of our results with respect to measurement of market concentration, ROA is regressed (regression 1B) on another market concentration variable which is (CR3). This concentration variable is also found to be positive and statistically significant, i.e. CR3 does, however, have a significant positive impact on bank profits, suggesting that the traditional SCP hypothesis holds true in the Jordanian banking market. Overall, the finding of regression (1) supports the traditional SCP paradigm, and indicates that the profit - concentration relationship is positive.

In regression (2), ROA is regressed on the market share variable (MS) and the rest of the variables. (MS) variable is found to be positive, but not statistically significant. In Regressions (3A, and 3B), ROA is regressed on both market structure variables (H or CR3 and MS). The coefficient of (MS) variable is found to be negative and statistically insignificant (found negative and statistically significant coefficient in specifications not mentioned here). Market concentration variables (H or CR3), on the other hand, were both found to be positive and statistically significant at 5% level of significance. These results resemble those obtained by Smirlock (1985), and indicate that once market concentration (CR3 or H) is properly considered, market share variable (MS) adds nothing to explaining bank profitability (ROA). The findings of regression (3A, and 3B), therefore, support the traditional structure-conduct-performance (SCP) paradigm and reject the competing efficiency hypothesis.

In all of the regressions, the capital to asset ratio (CAR) is positive and statistically significant. This is somewhat surprising given that lower capital ratios are associated traditionally with greater risk taking. LTD is found to be positive and statistically insignificant in regressions (1), (2), and (3). The coefficient for the asset size (TA) is positive, but statistically insignificant, in regressions (1) and (3) indicating that size-induced differences between banks may leads to higher profits.

The following Tables (4.16, 4.17, and 4.18) show the empirical results of estimating the profit equations 13, 14, and 15 for the periods 1990-1993, 1994-1997, and 1998-2000. These profit equations have been estimated for the aforementioned three periods so as to check the robustness of 1990-2000 empirical results. The results also support the traditional SCP paradigm. In regression 3A, and 3B of Table 4.18 for example, the market share variable is negative and statistically insignificant, whereas the two measures of market concentration (H and CR3) are positive and statistically significant.

Table 4.16

OLS Estimation of the SCP Paradigm and the Efficiency Hypothesis in Jordanian Banking (1990-1993)

	Regression 1A	Regression 1B	Regression 2	Regression 3A	Regression 3B
Constant	0.009 (0.34)	-0.01 (0.19)	0.022 (6.12)	0.009 (0.35)	-0.01 (-0.16)
H	0.000007 (0.54)			0.0007 (0.48)	
CR3		0.0005 (0.59)			0.0005 (0.53)
MS			-0.0002 (-0.26)	-0.0005 (-0.085)	-8.35E-06 (-0.012)
CAR	0.02* (2.16)	0.02* (2.17)	0.014* (2.09)	0.016* (2.12)	0.016* (2.14)
LTD	-0.02* (-2.79)	-0.02* (-2.76)	-0.021* (-3.05)	0.019* (-2.75)	0.019* (-2.69)
TA	-8.50E-12** (-1.85)	-8.58E-12** (-1.87)	-5.63E-12 (-0.47)	-7.51E-12 (-0.59)	-8.43E-12 (-0.64)
Binary	0.003 (0.64)	0.003 (0.65)	0.004 (0.68)	0.003 (0.63)	0.003 (0.63)
Adjusted R^2	0.25	0.25	0.25	0.26	0.26
F	4.7	4.7	4.6	3.9	3.9

*: Coefficient Significant at the 5% Level (Two Tail Test).
**: Coefficient Significant at the 10% Level (Two Tail Test).

Table 4.17

OLS Estimation of the SCP Paradigm and Efficiency Hypothesis in Jordanian Banking (1994-1997)

	Regression 1A	Regression 1B	Regression 2	Regression 3A	Regression 3B
Constant	-0.032 (-0.68)	-0.025 (-0.52)	0.023 (4.71)	-0.04 (-0.84)	-0.042 (-0.79)
H	0.00003 (1.18)			0.00004 (1.33)	
CR3		0.0008 (0.99)			0.001 (1.23)
MS			-0.0003 (-0.32)	-0.0008 (-0.70)	-0.001 (-0.80)
CAR	0.011 (0.81)	0.011 (0.86)	0.009 (0.66)	0.010 (0.72)	0.011 (0.80)
LTD	-0.021* (-3.09)	-0.02* (-3.00)	0.022* (-3.08)	0.023* (-3.16)	0.022* (-3.10)
TA	-2.76E-12 (-0.75)	-2.60E-12 (-0.70)	1.50E-12 (0.099)	7.89E-12 (0.50)	1.04E-11 (0.62)
Binary	0.004 (0.77)	0.004 (0.73)	0.005 (0.86)	0.005 (0.82)	0.004 (0.77)
Adjusted R^2	0.16	0.16	0.15	0.17	0.17
F	2.9	2.8	2.6	2.5	2.4

*: Coefficient Significant at the 5% Level (Two Tail Test).
**: Coefficient Significant at the 10% Level (Two Tail Test).

Table 4.18

OLS Estimation of the SCP Paradigm and the Efficiency Hypothesis in Jordanian Banking (1998-2000)

	Regression 1A	Regression 1B	Regression 2	Regression 3A	Regression 3B
Constant	-0.05 (-2.68)	-0.07 (-2.79)	0.005 (2.77)	-0.05 (-2.41)	-0.07 (-2.51)
H	0.0003* (3.0)			0.0003* (2.68)	
CR3		0.001* (3.03)			0.001* (2.71)
MS			0.0009 (1.32)	-0.0001 (-0.17)	-0.0002 (-0.28)
CAR	0.039* (2.96)	0.04* (3.02)	0.04* (2.71)	0.039* (2.93)	0.04* (2.98)
LTD	2.53E-11 (0.058)	3.37E-12 (0.008)	1.12E-10 (0.24)	7.84E-12 (0.017)	-2.59E-11 (-0.06)
TA	1.86E-12 (0.64)	2.01E-12 (0.69)	-9.75E-12 (-1.18)	3.43E-12 (0.36)	4.55E-12 (0.47)
Binary	-0.0005 (-0.09)	-0.0006 (-0.13)	0.0009 (0.20)	-0.0004 (-0.08)	-0.0005 (-0.12)
Adjusted R^2	0.11	0.11	0.06	0.11	0.11
F	3.2	3.3	1.7	2.7	2.7

*: Coefficient Significant at the 5% Level (Two Tail Test).
**: Coefficient Significant at the 10% Level (Two Tail Test).

The above findings suggest that concentration in the Jordanian banking market has lowered the cost of collusion between banks and resulted in higher than normal profits for market participants. However, it should be mentioned that the coefficients of market concentration variables suggest that very large increases in concentration would be needed to raise expected profits significantly. Such increases would be achieved by mergers. As no evidence is found supporting the efficiency hypothesis, the further concentration that might occur in the Jordanian banking market, due to the merger policy, may decrease the level of competition in the banking system in Jordan.

Scale economies magnitudes, computed for the banking system as a whole, have been incorporated as an additional independent variable (scale) influencing the profitability of banks as stated in chapter one. I expect a negative relationship between scale and return on assets (ROA), i.e. the lower the scale magnitudes, the greater is the cost savings when output expands, and the higher is the profit. The results of regression 3 in the following Table 4.19 below shows that the scale variable is negatively related with ROA (the expected sign), but statistically insignificant. It also shows that the coefficients of market structure (H or CR3) and MS strongly support the traditional SCP paradigm and reject the efficient structure hypothesis. When market share (MS) variable is included in the regression alongside the concentration (H or CR3) measure, H or CR3 variables are positively related with ROA and statistically significant, whereas MS variable is negatively related with ROA and statistically significant. Such results, which support the traditional SCP paradigm, are robust with respect to model specifications and measurement of market concentration.

This chapter concludes that scale economies do exist in the Jordanian banking market. All bank size groups as well as foreign and domestic banks experienced increasing returns to scale during 1990-2000. These results are robust with respect to the methodology utilized to estimate and compute the overall scale economies. Scope economies results were less clear cut compared to scale results. The single translog cost function produces diseconomies of scope, whereas the system of cost equations produces economies of scope. As for the structure performance relationships, the results indicate that the SCP paradigm holds true in the Jordanian banking market. These results are robust with respect to model specifications and measurement of market concentration.

Table 4.19

OLS Estimation of the SCP Paradigm and the Efficiency Hypothesis in Jordanian Banking (1990-2000)

	Regression 1A	Regression 1B	Regression 2	Regression 3A	Regression 3B
Constant	-0.031 (-2.13)	-0.05 (-2.52)	0.02 (3.23)	-0.04 (-2.62)	-0.07 (-3.17)
H	0.00003* (3.52)			0.00003* (3.89)	
CR3		0.001* (3.55)			0.001* (4.08)
MS			0.0001 (0.15)	-0.001** (-1.65)	-0.001** (-1.96)
CAR	0.030* (4.15)	0.031* (4.20)	0.025* (3.45)	0.03* (4.1)	0.03* (4.19)
LTD	6.63E-11 (0.15)	4.44E-11 (0.10)	1.20E-10 (0.26)	1.08E-10 (0.24)	8.69E-11 (0.20)
TA	-1.87E-13 (-0.06)	1.92E-13 (0.06)	-4.81E-12 (-0.77)	1.04E-11 (1.45)	1.37E-11** (1.82)
Binary	0.0006 (0.13)	0.0001 (0.034)	0.004 (0.92)	0.003 (0.73)	0.003 (0.73)
Scale	-0.005 (-0.91)	-0.005 (-0.84)	-0.009 (-1.49)	-0.004 (-0.70)	-0.003 (-0.55)
Adjusted R^2	0.13	0.14	0.08	0.15	0.15
F	5.0	5.0	2.8	4.7	4.9

*: Coefficients Significant at the 5% Level (Two Tail Test).
**: Coefficients Significant at the 10% Level (Two Tail Test).

CHAPTER 5: SUMMARY AND CONCLUSION

Conclusion and Policy Recommendation

The purpose of this dissertation has been to investigate evidence of economies of scale and scope, and to analyze the competitive conditions in the Jordanian banking market during the period 1990-2000. The analysis has been prompted by the CBJ's claims that cost savings could be expected from the merger policy, which in turn promotes the efficiency of banks in Jordan.

Economies of scale and scope, and structure performance relationship have been widely examined in USA and European banking systems, although no empirical work to date has been undertaken on Jordanian banking market. This dissertation aimed to rectify this imbalance in the literature by providing a detailed and in-depth analysis of scale and scope economies as well as investigating the structure performance relationship in the Jordanian banking system.

This dissertation adopted the cost function approach to analyze the operational efficiency of the banks in Jordan. Within the cost function approach, the study employed the intermediation approach to evaluate the magnitude and incidence of economies of scale and scope.

Different functional forms could be utilized to estimate the cost function of the Jordanian banks. To avoid the specification error related to the form of the cost function, an F test was conducted to determine whether the functional form of the cost function is of Cobb-Douglas technology or a translog form. The result of the test showed that the flexible translog cost function specification was found to be adequate representation of the data. Hence, this flexible cost function was utilized by the study to investigate the presence of economies of scale and scope in the banking system.

The study estimated cost functions for the entire banking system, small banks, medium banks, large banks, domestic banks, and foreign banks for the periods 1990-2000, 1990-1993, 1994-1997, and 1998-2000. Then the estimated coefficients of the translog cost functions have been utilized to compute the magnitudes of scale and scope economies.

To test the robustness of our scale and scope economies results computed from the single translog cost function, the same measures were also computed from a system of cost equations by using the technique of Zellner's iterative seemingly unrelated regression (SUR) to obtain the estimates of the parameters of the single cost function simultaneously with the two input cost share equations (labor and financial capital cost share equations). Finally, the study analyzed the competitive conditions in the Jordanian banking market by estimating different specifications of profit equations for the aforementioned periods.

The main findings of the study on measure of overall economies of scale for the individual banks for each of the eleven years show declining average costs, i.e.

increasing returns to scale are observed in all of Jordanian banks, except for two banks which are classified as large banks.

The yearly findings of scale economy measure for the total sample of banks is also found to be less than unity, and persists over the eleven years, providing strong evidence for the presence of unexploited scale economies in Jordanian banking market, i.e. banking production in Jordan over these years has not been undertaken at the most efficient scale. The overall scale economy measure for the total sample of banks is found to be 0.91 in 1990, increased to 0.97 and 0.99 in 1996 and 1997 respectively, and then declined to reach 0.96 in year 2000. This implies that a 10 percent increase in the output at the average bank, in year 2000 for example, is accompanied by a 9.6 percent increase in total costs.

The findings of the study indicated that the computed values of overall economies of scale differ by cost definition. When the cost function of the total sample of banks is estimated using the operating costs instead of total costs, the resulting magnitudes of overall economies of scale were lower in all of the eleven years by 3.2% on average. This implies a further reduction in costs when banks expand their operations.

The findings also show that the overall scale economies magnitudes for the total sample of banks, computed from three translog cost functions for the periods 1990-1993, 1994-1997, and 1998-2000 are highly comparable and close to those OSE magnitudes computed from 1990-2000 cost function. This result provide strong evidence that the Jordanian banking system experienced increasing returns to scale during the period 1990-2000.

The operational efficiency of banks was also analyzed by classifying twenty one banks into a total of three different groups according to their levels of assets; those are small, medium, and large size banks. Economies of scale are observed in all groups, implying robust scale economies results when compared to those computed from the entire banking system cost functions. While the findings suggest that the economies tend to be greater in the smaller size classes, they persist across the medium and larger classes as well.

Small banks experienced increasing returns to scale in all years, with OSE magnitudes ranging from 0.46 in 1990 to 0.72 in year 2000. All the individual banks in this group display sizable overall economies of scale with magnitudes less than 0.78. The scale economy measure for the medium size banks for each of the eleven years is found to be less than one, except for the year 1992 where banks in this group experienced constant returns to scale.

Large banks experienced diseconomies of scale in the early years (1990-1992), and significant scale economies prevailed during 1993-2000, with magnitudes ranging from 0.97 in 1993 to 0.86 in year 2000. Only one bank in the large size group experienced diseconomies of scale in each of the eleven years. Hence it would be cost inefficient for this bank to merge with another bank or expands its operation. Customers in such circumstances would probably have to pay a higher price for the services they receive.

The findings of the study indicate that the small size group estimation reveal economies of scale measures that are lower than those computed from the medium size group estimation, and the latter size group estimation produces economies of scale measures that are lower than those computed from the large size group estimation. This implies that as the asset size of the bank rises, the scale economy magnitude rises as well.

The operational efficiency of banks was also analyzed by classifying banks into foreign and domestic banks. The overall scale economies magnitudes for the foreign banks are lower than those computed for the domestic banks in all of the eleven years, except for the year 1997, where foreign and domestic banks have the same scale economy magnitude of 0.94. The domestic banks experienced increasing returns to scale for the period 1990-2000, with scale economy magnitudes ranged from 0.92 in 1990 to 0.96 in year 2000. Foreign banks also enjoyed increasing returns to scale for the entire period of the study, with scale economy magnitudes ranged from 0.74 in 1990 to 0.91 in year 2000.

The preceding findings indicate that the operational efficiency of the foreign banks is higher than that of the domestic banks, i.e. the foreign banks will enjoy a greater cost reduction when they expand their operation. Hence, the study encourages merger between foreign and domestic banks, and also suggests the removal of any barriers hindering foreign direct investments in the Jordanian banking sector.

The findings of the cost system of equations also indicate similar results. The total sample of banks experienced significant scale economies in each of the eleven years. All individual banks enjoyed scale economies, except for the two largest banks. This result resembles the result obtained from the estimation of the single translog cost functions.

The findings of the cost system of equations show that small banks enjoyed increasing returns to scale in all years, with OSE magnitudes ranged from 0.47 in 1990 to 0.72 in year 2000. The medium size banks scale economy measures are found to be significantly different from unity for each of the eleven years, implying the presence of overall scale economies. Large banks on the other hand, experienced diseconomies of scale in the years 1990 and 1995, constant returns to scale in the years 1991, 1992, 1994, and 1996, then significant increasing returns to scale prevailed during 1997-2000.

Since the Jordanian banks have downward slopping long run average cost curves, there appear to be a noticeable improvement in efficiency that can be obtained by banks able to increase their scale. Therefore, the findings of the study support the CBJ's policy of encouraging banks to merge, such policy will enable banks to fully exploit economies of scale, and would likely to lead to improved cost efficiency, which in turn will enhance the soundness of the Jordanian banks and improve the efficiency of the banking market as a whole. Since the small size banks have lower scale economies magnitudes compared to the medium and large banks, then the findings of the study do indicate that mergers among smaller banks, however, should be preferred to mergers among larger banks, such merger could benefit society as cost savings may well be obtained in the former instance.

The empirical evidence of cost economies resulting from the multi-product nature of banks' business appears less clear-cut than the scale economy findings. The findings of the single translog cost function show that the banking system experienced diseconomies of scope during 1990-2000. On the other hand, when economies of scope measure were computed from the cost system of equations, the findings suggest that cost complementarities do exist between loans and investments in the Jordanian banking system. The preceding scale and scope economies results do not provide support for the existence of natural monopoly in the Jordanian banking market.

The results obtained from investigating the competitive conditions in the Jordanian banking system show that the traditional SCP paradigm holds true in the Jordanian banking market. In regression 1, the profitability measure (ROA) is regressed on a measure of market concentration (H), the concentration variable (H) is found to be positive and statistically significant. To determine whether the preceding result is sensitive to the choice of market concentration measure, ROA is also regressed on another measure of market concentration (CR3). CR3 is also found to be positive and statistically significant. The above results support the traditional SCP hypothesis, and indicate that the profit-concentration relationship is positive.

In regression 2, ROA is regressed on market share variable (MS). MS variable is found to be positive, but statistically insignificant. In regression 3, ROA is regressed on both of market structure variables (H or CR3 and MS). The coefficient of MS variable is found to be negative and statistically significant, and market concentration variables (H or CR3) were both found to be positive and statistically significant. These results resemble those obtained by Smirlock (1985) and indicate that once market concentration variable is properly considered, market share variable has no effect on bank profitability; such results are robust with respect to model specifications and measurement of market concentration. Hence, these findings again support the traditional SCP hypothesis and reject the competing efficiency hypothesis.

The findings of the study reveal that economies of scale do exist in the Jordanian banking market. This implies that there will be an improvement in efficiency when banks increase their scale. Merger policy increases the scale of banks, and increases the concentration of the market which in turns increases the profitability of banks as indicated by the results of the SCP relationship. At the same time, merger policy also reduces the number of banks (competitors) in the market, and may decrease the level of competition in the market which in turn negatively influences the efficiency of banks in the long run. Hence, to enhance competition in the Jordanian banking system, the study suggests to permit easier entry into the market and to remove any barriers of entry to the industry.

The policy maker in Jordan has to make a judgment about the extent to which diminished competition, that may arises from merger policy, is offset by the benefits of lower costs. I.e. the amount of the expected savings in total costs should be compared to an estimate of the disadvantages, if any, of favoring large banks. However, Humphrey (1990) indicated that if scale economies were large, such as the magnitudes found in this study, then fears of concentration might not outweigh any perceived benefits of expansion. Also, Shaffer (1994) indicated that an important implication of the new industrial organization studies is that consolidation in the banking industry, although it will likely increase concentration in some banking markets, will not necessarily lead to less competition in banking markets.

Suggestions for Future Research

There are five major directions in which the research in this dissertation can be extended. The first is along the same lines as is pursued here but to estimate the cost function for each bank. Despite of the findings of this study such an exercise would be worthwhile for two reasons. First, it would provide an opportunity to reinforce the findings presented here. Second, cost function estimations for each bank are very rare because of the obvious confidentiality of the information required to pursue such a study and therefore the lack of availability of a sufficient time series. The Jordanian case is an exception to this rule and the availability of data is not a problem.

The second direction, in which one could continue, is to investigate the same issues as done by this dissertation but within a different analytical framework, i.e. to investigate the incidence and magnitudes of scale and scope economies by employing the profit function approach, and the production approach within the cost function approach. The results of such a study can be compared to the findings of this dissertation which uses the cost function approach and within it the intermediation approach. The results of such a study can also be used to test the robustness of the findings in this dissertation.

A third direction for future research would be to utilize an alternative functional form to evaluate scale and scope economies, such as the hybrid translog cost function which allows zero level of output. This function enables us to use the direct method of investigating the presence of economies of scope.

The forth direction would be to undertake an empirical study of the cost implications of a hypothetical bank mergers. Such a study would examine the potential for improvements in efficiency and cost savings resulting from hypothetical bank mergers.

The fifth direction for future research would be to incorporate direct measures of efficiency, such as the X-efficiency, in the estimated profit equations. Such a study would test the efficient structure hypothesis in an alternative way, and examine the robustness of our results which show that the traditional SCP hypothesis holds true in the Jordanian banking market.

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Appendix

Table (1)

Summary Statistics of Selected Variables (1990-2000)

	Mean	Minimum	Maximum
Total Costs (TC)	25409633	700000	215000000
Operating costs (OC)	9135780	400000	63400000
Loans (Y_1)	143000000	1400000	883000000
Investments (Y_2)	28574771	100000	350000000
Price of Labor (P_1)	7383	2985	19048
Price of Capital (P_2)	1.210	0.03	7.4
Price of Deposits (P_3)	0.05	0.007	0.08

Source: Calculated by the author from data from Central Bank of Jordan.
The numbers are in Jordan Dinar.

Table (2)

Summary Statistics of Selected Variables (1990-1993)

	Mean	Minimum	Maximum
Total Costs (TC)	16554054	900000	105000000
Operating Costs (OC)	5045588	400000	31000000
Loans (Y_1)	98510811	1500000	582000000
Investments (Y_2)	23875676	200000	214000000
Price of Labor (P_1)	5743	2985	14286
Price of Capital (P_2)	1.36	0.18	5.5
Price of Deposits (P_3)	0.05	0.007	0.08

Source: Calculated by the author from data from Central Bank of Jordan.
The numbers are in Jordan Dinar.

Table (3)

Summary Statistics of Selected Variables (1994-1997)

	Mean	Minimum	Maximum
Total Costs (TC)	26211111	700000	188000000
Operating Costs (OC)	8858333	400000	43400000
Loans (Y_1)	160000000	1900000	829000000
Investments (Y_2)	20485185	100000	132000000
Price of Labor (P_1)	7527	3721	15873
Price of Capital (P_2)	0.94	0.03	5.5
Price of Deposits (P_3)	0.05	0.01	0.08

Source: Calculated by the author from data from Central Bank of Jordan.
The numbers are in Jordan Dinar.

Table (4)

Summary Statistics of Selected Variables (1998-2000)

	Mean	Minimum	Maximum
Total Costs (TC)	34780952	1800000	215000000
Operating Costs (OC)	12957692	600000	63400000
Loans (Y_1)	175000000	1400000	883000000
Investments (Y_2)	44495238	100000	350000000
Price of Labor (P_1)	9126	4444	19048
Price of Capital (P_2)	1.37	0.22	7.4
Price of Deposits (P_3)	0.05	0.05	0.08

Source: Calculated by the author from data from Central Bank of Jordan.
The numbers are in Jordan Dinar.

Table (5)

Summary Statistics of Selected Variables (1990-2000)

	Mean	Minimum	Maximum
Return on Assets (ROA)	0.010	-0.068	0.058
Herfindahl Index (H)	1675.650	1488.081	1901.426
Three Firm Concentration Ratio (CR3)	57.775	54.510	62.102
Market Share (MS)	5.056	0.205	37.991
Capital to Asset Ratio (CAR)	0.077	0.010	0.391
Loan to Deposit Ratio (LTD)	0.623	0.010	0.842
Total Assets (TA)	375000000	26100000	3530000000

Source: Calculated by the author from data from Central Bank of Jordan.
The numbers are in Jordan Dinar.

Table (6)

Summary Statistics of Selected Variables (1990-1993)

	Mean	Minimum	Maximum
Return on Assets (ROA)	0.012	-0.006	0.057
Herfindahl Index (H)	1790.235	1674.760	1901.426
Three Firm Concentration Ratio (CR3)	60.932	59.017	62.103
Market Share (MS)	4.899	0.378	37.991
Capital to Asset Ratio (CAR)	0.045	0.011	0.273
Loan to Deposit Ratio (LTD)	0.469	0.054	0.805
Total Assets (TA)	232000000	29300000	1940000000

Source: Calculated by the author from data from Central Bank of Jordan.
The numbers are in Jordan Dinar.

Table (7)

Summary Statistics of Selected Variables (1994-1997)

	Mean	Minimum	Maximum
Return on Assets (ROA)	0.010	-0.031	0.053
Herfindahl Index (H)	1719.414	1628.417	1766.251
Three Firm Concentration Ratio (CR3)	58.905	55.828	60.505
Market Share (MS)	5.253	0.205	36.661
Capital to Asset Ratio (CAR)	0.080	0.013	0.391
Loan to Deposit Ratio (LTD)	0.550	0.056	0.872
Total Assets (TA)	371000000	26100000	2710000000

Source: Calculated by the author from data from Central Bank of Jordan.
The numbers are in Jordan Dinar.

Table (8)

Summary Statistics of Selected Variables (1998-2000)

	Mean	Minimum	Maximum
Return on Assets (ROA)	0.007	-0.068	0.037
Herfindahl Index (H)	1536.167	1488.081	1628.417
Three Firm Concentration Ratio (CR3)	53.993	52.510	55.828
Market Share (MS)	5.012	0.443	34.804
Capital to Asset Ratio (CAR)	0.103	0.012	0.295
Loan to Deposit Ratio (LTD)	0.532	0.030	0.860
Total Assets (TA)	503000000	58600000	3530000000

Source: Calculated by the author from data from Central Bank of Jordan.
The numbers are in Jordan Dinar.

Table (9)
OLS Estimated Parameters of the Multi-product Cost Function (1990-2000)

Dependent Variable: Total Costs

Variable	Coefficient	T-Statistics
Intercept(B_0)	-15.21	-1.08
Loans(B_1)	-0.53 **	-1.66
Investments(B_2)	-0.48	-0.92
Price of Labor(C_1)	5.90 *	3.35
Price of Capital(C_2)	-0.32 **	-1.88
$(\text{Loans})^2$ (D_{11})	0.12 *	4.00
Loans*Investments(D_{12})	0.01 *	2.00
$(\text{Investments})^2$ (D_{22})	0.02	1.00
Price of Labor*Price of Capital (E_{12})	0.06	1.20
Price of Labor*Price of Deposits (E_{13})	0.29 *	2.57
Price of Capital*Price of Deposits (E_{23})	-0.11 *	-2.2
Loans*Price of Capital(F_{12})	-0.03	-0.75
Loans*Price of Deposits(F_{13})	0.12 *	3.00
Investments*Price of Capital (F_{22})	0.004	0.13
Investments*Price of Deposits (F_{23})	0.0006	0.02
Number of Observation (N)	218	
Adjusted R^2	0.94	

*: Coefficient Significant at 5% Level (Two Tail Test).
**: Coefficient Significant at 10% Level (Two Tail Test).

Table (10)

OLS Estimated Parameters of the Multi-product Cost Function (1990-1993)

Dependent Variable: Total Costs

Variable	Coefficient	T-Statistics
Intercept(B_0)	-26.36	-1.04
Loans(B_1)	-0.42**	-1.75
Investments(B_2)	-0.53	-0.45
Price of Labor(C_1)	8.2*	2.36
Price of Capital(C_2)	-2.21**	-1.9
$(\text{Loans})^2$ (D_{11})	0.11**	1.83
Loans*Investments(D_{12})	0.01	0.33
$(\text{Investments})^2$ (D_{22})	0.01	0.25
Price of Labor*Price of Capital (E_{12})	0.27*	2.25
Price of Labor*Price of Deposits (E_{13})	0.39**	1.95
Price of Capital*Price of Deposits (E_{23})	-0.22*	-2.44
Loans*Price of Capital(F_{12})	-0.03	-0.50
Loans*Price of Deposits(F_{13})	0.10**	1.66
Investments*Price of Capital (F_{22})	-0.003	-0.06
Investments*Price of Deposits (F_{23})	-0.02	-0.33
Number of Observation (N)	74	
Adjusted R^2	0.94	

*: Coefficient Significant at 5% Level (Two Tail Test).
**: Coefficient Significant at 10% Level (Two Tail Test).

Table (11)

OLS Estimated Parameters of the Multi-product Cost Function (1994-1997)

Dependent Variable: Total Costs

Variable	Coefficient	T-Statistics
Intercept(B_0)	-74.96*	-2.91
Loans(B_1)	-0.59	-0.41
Investments(B_2)	0.81**	1.76
Price of Labor(C_1)	14.94*	4.55
Price of Capital(C_2)	-2.68**	-1.98
$(\text{Loans})^2$ (D_{11})	0.21*	4.73
Loans*Investments(D_{12})	-0.03**	-1.88
$(\text{Investments})^2$ (D_{22})	0.02	1.00
Price of Labor*Price of Capital (E_{12})	0.11	1.10
Price of Labor*Price of Deposits (E_{13})	0.83*	3.90
Price of Capital*Price of Deposits (E_{23})	-0.21**	1.91
Loans*Price of Capital(F_{12})	0.16*	2.67
Loans*Price of Deposits(F_{13})	0.04	0.57
Investments*Price of Capital (F_{22})	-0.10*	-2.00
Investments*Price of Deposits (F_{23})	0.11*	2.20
Number of Observation (N)	81	
Adjusted R^2	0.97	

*: Coefficient Significant at 5% Level (Two Tail Test).
**: Coefficient Significant at 10% Level (Two Tail Test).

Table (12)

OLS Estimated Parameters of the Multi-product Cost Function (1998-2000)

Dependent Variable: Total Costs

Variable	Coefficient	T-Statistics
Intercept(B_0)	30.07	0.68
Loans(B_1)	-1.51**	-1.67
Investments(B_2)	-1.72**	-1.89
Price of Labor(C_1)	1.38*	4.75
Price of Capital(C_2)	0.26*	2.00
$(\text{Loans})^2$ (D_{11})	0.32*	3.20
Loans*Investments(D_{12})	-0.07**	1.75
$(\text{Investments})^2$ (D_{22})	0.09*	2.25
Price of Labor*Price of Capital (E_{12})	0.03	0.17
Price of Labor*Price of Deposits (E_{13})	-0.008	-0.02
Price of Capital*Price of Deposits (E_{23})	-0.04	-0.26
Loans*Price of Capital(F_{12})	0.09**	1.80
Loans*Price of Deposits(F_{13})	0.11	0.65
Investments*Price of Capital (F_{22})	-0.14*	-2.0
Investments*Price of Deposits (F_{23})	-0.02	-0.29
Number of Observation (N)	63	
Adjusted R^2	0.93	

*: Coefficient Significant at 5% Level (Two Tail Test).
**: Coefficient Significant at 10% Level (Two Tail Test).

Table (13)

OLS Estimated Parameters of the Multi-product Cost Function from Operating costs (1990-2000) Dependent Variable: Operating Costs

Variable	Coefficient	T-Statistics
Intercept(B_0)	-0.98	-0.05
Loans(B_1)	-0.57 **	-1.74
Investments(B_2)	-0.55 **	-1.85
Price of Labor(C_1)	1.08 *	2.75
Price of Capital(C_2)	1.61 *	2.50
$(\text{Loans})^2$ (D_{11})	0.12 *	2.30
Loans*Investments(D_{12})	0.05 *	2.09
$(\text{Investments})^2$ (D_{22})	-0.04	-1.42
Price of Labor*Price of Capital (E_{12})	-0.01	-0.17
Price of Labor*Price of Deposits (E_{13})	0.13	0.78
Price of Capital*Price of Deposits (E_{23})	-0.05	-0.72
Loans*Price of Capital(F_{12})	-0.07 **	1.69
Loans*Price of Deposits(F_{13})	0.16 *	2.37
Investments*Price of Capital (F_{22})	-0.01	-0.15
Investments*Price of Deposits (F_{23})	-0.01	-0.20
Number of Observation (N)	218	
Adjusted R^2	0.86	

*: Coefficient Significant at 5% Level (Two Tail Test).
**: Coefficient Significant at 10% Level (Two Tail Test).

Table (14)

OLS Estimated Parameters of the Multi-product Cost Function for Small Banks (1990-2000) Dependent Variable: Total Costs

Variable	Coefficient	T-Statistics
Intercept(B_0)	11.63	1.25
Loans(B_1)	0.57**	1.70
Investments(B_2)	-0.59**	-1.79
Price of Labor(C_1)	-2.08*	-2.05
Price of Capital(C_2)	2.11*	2.20
$(Loans)^2$ (D_{11})	0.10	0.92
Loans*Investments(D_{12})	0.01*	2.19
$(Investments)^2$ (D_{22})	0.10**	1.95
Price of Labor*Price of Capital (E_{12})	0.05	0.50
Price of Labor*Price of Deposits (E_{13})	-0.20	-0.84
Price of Capital*Price of Deposits (E_{23})	0.03	0.36
Loans*Price of Capital(F_{12})	-0.13**	-1.68
Loans*Price of Deposits(F_{13})	0.24*	2.17
Investments*Price of Capital (F_{22})	-0.05	-0.74
Investments*Price of Deposits (F_{23})	-0.16	-2.31
Number of Observation (N)	64	
Adjusted R^2	0.87	

*: Coefficient Significant at 5% Level (Two Tail Test).
**: Coefficient Significant at 10% Level (Two Tail Test).

Table (15)

OLS Estimated Parameters of the Multi-product Cost Function for Medium Banks (1990-2000) Dependent Variable: Total Costs

Variable	Coefficient	T-Statistics
Intercept(B_0)	8.10	0.25
Loans(B_1)	0.21**	1.88
Investments(B_2)	-0.19	-1.37
Price of Labor(C_1)	1.36*	2.25
Price of Capital(C_2)	-0.23*	-2.04
$(\text{Loans})^2$ (D_{11})	-0.41	-1.57
Loans*Investments(D_{12})	0.007	0.09
$(\text{Investments})^2$ (D_{22})	0.05**	1.85
Price of Labor*Price of Capital (E_{12})	0.11	0.86
Price of Labor*Price of Deposits (E_{13})	0.53**	1.83
Price of Capital*Price of Deposits (E_{23})	-0.22**	-1.80
Loans*Price of Capital(F_{12})	-0.04**	-1.78
Loans*Price of Deposits(F_{13})	-0.22*	-2.70
Investments*Price of Capital (F_{22})	-0.05	-0.87
Investments*Price of Deposits (F_{23})	-0.07	-0.81
Number of Observation (N)	88	
Adjusted R^2	0.81	

*: Coefficient Significant at 5% Level (Two Tail Test).
**: Coefficient Significant at 10% Level (Two Tail Test).

Table (16)

OLS Estimated Parameters of the Multi-product Cost Function for Large Banks (1990-2000) Dependent Variable: Total Costs

Variable	Coefficient	T-Statistics
Intercept(B_0)	-3.6	-1.25
Loans(B_1)	0.41^{**}	1.81
Investments(B_2)	-0.46	-1.42
Price of Labor(C_1)	0.36^{*}	2.15
Price of Capital(C_2)	-0.28^{*}	-2.34
$(Loans)^2$ (D_{11})	0.05	0.57
Loans*Investments(D_{12})	0.01	0.33
$(Investments)^2$ (D_{22})	0.02^{**}	1.75
Price of Labor*Price of Capital (E_{12})	-0.07	-0.32
Price of Labor*Price of Deposits (E_{13})	-0.67	-1.07
Price of Capital*Price of Deposits (E_{23})	0.01^{**}	1.68
Loans*Price of Capital(F_{12})	0.20^{*}	2.00
Loans*Price of Deposits(F_{13})	0.23^{*}	2.88
Investments*Price of Capital (F_{22})	-0.02	-0.36
Investments*Price of Deposits (F_{23})	0.03	0.47
Number of Observation (N)	66	
Adjusted R^2	0.95	

*: Coefficient Significant at 5% Level (Two Tail Test).
**: Coefficient Significant at 10% Level (Two Tail Test).

Table (17)

OLS Estimated Parameters of the Multi-product Cost Function for Foreign Banks (1990-2000) Dependent Variable: Total Costs

Variable	Coefficient	T-Statistics
Intercept(B_0)	-1.6	-1.45
Loans(B_1)	-0.5**	1.71
Investments(B_2)	-0.36	-1.52
Price of Labor(C_1)	0.09	1.17
Price of Capital(C_2)	0.21*	2.04
$(\text{Loans})^2$ (D_{11})	0.21	2.08
Loans*Investments(D_{12})	-0.05	-1.00
$(\text{Investments})^2$ (D_{22})	0.13*	2.16
Price of Labor*Price of Capital (E_{12})	-0.09	-0.52
Price of Labor*Price of Deposits (E_{13})	0.50	1.36
Price of Capital*Price of Deposits (E_{23})	-0.25*	-2.05
Loans*Price of Capital(F_{12})	0.11	1.06
Loans*Price of Deposits(F_{13})	0.05	0.34
Investments*Price of Capital (F_{22})	-0.18**	-1.79
Investments*Price of Deposits (F_{23})	0.09	0.67
Number of Observation (N)	54	
Adjusted R^2	0.95	

*: Coefficient Significant at 5% Level (Two Tail Test).
**: Coefficient Significant at 10% Level (Two Tail Test).

Table (18)

OLS Estimated Parameters of the Multi-product Cost Function for Domestic Banks (1990-2000) Dependent Variable: Total Costs

Variable	Coefficient	T-Statistics
Intercept(B_0)	0.32	1.90
Loans(B_1)	0.51**	1.79
Investments(B_2)	-1.34*	-2.82
Price of Labor(C_1)	0.08**	1.70
Price of Capital(C_2)	-0.41	-1.59
$(\text{Loans})^2$ (D_{11})	-0.04	-0.87
Loans*Investments(D_{12})	0.02**	1.74
$(\text{Investments})^2$ (D_{22})	0.05*	2.89
Price of Labor*Price of Capital (E_{12})	-0.08	-0.96
Price of Labor*Price of Deposits (E_{13})	0.41*	3.88
Price of Capital*Price of Deposits (E_{23})	-0.16**	-1.97
Loans*Price of Capital(F_{12})	0.09**	1.97
Loans*Price of Deposits(F_{13})	-0.13**	-1.74
Investments*Price of Capital (F_{22})	-0.06**	-1.94
Investments*Price of Deposits (F_{23})	0.03	0.94
Number of Observation (N)	163	
Adjusted R^2	0.95	

*: Coefficient Significant at 5% Level (Two Tail Test).
**: Coefficient Significant at 10% Level (Two Tail Test).

Table (19)

Iterated Zellner Parameter Estimates of Cost System of Equations for all Banks (1990-2000) Dependent Variable: Total Costs

Variable	Coefficient	T-Statistics
Intercept(B_0)	-1.57	-87.29
Loans(B_1)	-1.18*	-3.38
Investments(B_2)	0.48	1.54
Price of Labor(C_1)	3.9*	10.26
Price of Capital(C_2)	-1.2*	-3.33
$(\text{Loans})^2$ (D_{11})	0.17*	7.02
Loans*Investments(D_{12})	-0.006	-0.43
$(\text{Investments})^2$ (D_{22})	0.02	1.34
Price of Labor*Price of Capital (E_{12})	-0.01	-0.31
Price of Labor*Price of Deposits (E_{13})	0.11*	4.18
Price of Capital*Price of Deposits (E_{23})	-0.09*	-5.35
Loans*Price of Capital(F_{12})	0.02	1.20
Loans*Price of Deposits(F_{13})	0.07*	5.36
Investments*Price of Capital (F_{22})	0.04*	2.84
Investments*Price of Deposits (F_{23})	0.02*	2.23
Number of Observation (N)	218	
Adjusted R^2	0.92	

*: Coefficient Significant at 5% Level (Two Tail Test).
**: Coefficient Significant at 10% Level (Two Tail Test).

Table (20)

Iterated Zellner Parameter Estimates of Cost System of Equations for Small Banks (1990-2000) Dependent Variable: Total Costs

Variable	Coefficient	T-Statistics
Intercept(B_0)	-1.59	-49.04
Loans(B_1)	-1.65**	-1.88
Investments(B_2)	0.80	0.92
Price of Labor(C_1)	4.53*	6.51
Price of Capital(C_2)	-1.53*	-2.26
$(\text{Loans})^2$ (D_{11})	0.27*	3.43
Loans*Investments(D_{12})	-0.05	-1.32
$(\text{Investments})^2$ (D_{22})	0.03	0.73
Price of Labor*Price of Capital (E_{12})	-0.009	-0.21
Price of Labor*Price of Deposits (E_{13})	0.11*	2.94
Price of Capital*Price of Deposits (E_{23})	-0.07*	-2.27
Loans*Price of Capital(F_{12})	0.05	1.50
Loans*Price of Deposits(F_{13})	0.11*	4.15
Investments*Price of Capital (F_{22})	0.04	1.48
Investments*Price of Deposits (F_{23})	0.006	0.33
Number of Observation (N)	64	
Adjusted R^2	0.82	

*: Coefficient Significant at 5% Level (Two Tail Test).
**: Coefficient Significant at 10% Level (Two Tail Test).

Table (21)

Iterated Zellner Parameter Estimates of Cost System of Equations for Medium Banks (1990-2000) Dependent Variable: Total Costs

Variable	Coefficient	T-Statistics
Intercept(B_0)	-1.62	-57.59
Loans(B_1)	4.36 *	2.76
Investments(B_2)	-1.77	-1.23
Price of Labor(C_1)	-2.23 **	-1.67
Price of Capital(C_2)	1.16	1.02
$(\text{Loans})^2$ (D_{11})	-0.38 *	-2.20
Loans*Investments(D_{12})	0.09	1.09
$(\text{Investments})^2$ (D_{22})	0.09 **	1.78
Price of Labor*Price of Capital (E_{12})	-0.08 **	-1.67
Price of Labor*Price of Deposits (E_{13})	0.01	0.24
Price of Capital*Price of Deposits (E_{23})	-0.07 *	-3.12
Loans*Price of Capital(F_{12})	-0.10	-1.47
Loans*Price of Deposits(F_{13})	-0.08 *	-2.02
Investments*Price of Capital (F_{22})	0.09 *	2.35
Investments*Price of Deposits (F_{23})	0.04 **	1.82
Number of Observation (N)	83	
Adjusted R^2	0.71	

*: Coefficient Significant at 5% Level (Two Tail Test).
**: Coefficient Significant at 10% Level (Two Tail Test).

Table (22)

Iterated Zellner Parameter Estimates of Cost System of Equations for Large Banks (1990-2000) Dependent Variable: Total Costs

Variable	Coefficient	T-Statistics
Intercept(B_0)	-1.53	-64.61
Loans(B_1)	0.97	1.43
Investments(B_2)	0.61	1.09
Price of Labor(C_1)	-0.01	-0.02
Price of Capital(C_2)	-1.48*	-2.61
$(\text{Loans})^2$ (D_{11})	0.20*	3.15
Loans*Investments(D_{12})	-0.003	-0.12
$(\text{Investments})^2$ (D_{22})	-0.03*	-2.11
Price of Labor*Price of Capital (E_{12})	-0.21*	-5.64
Price of Labor*Price of Deposits (E_{13})	-0.43*	-9.38
Price of Capital*Price of Deposits (E_{23})	-0.003	-0.15
Loans*Price of Capital(F_{12})	0.17*	6.18
Loans*Price of Deposits(F_{13})	0.19*	8.54
Investments*Price of Capital (F_{22})	0.008	0.70
Investments*Price of Deposits (F_{23})	-0.007	-1.12
Number of Observation (N)	67	
Adjusted R^2	0.93	

*: Coefficient Significant at 5% Level (Two Tail Test).
**: Coefficient Significant at 10% Level (Two Tail Test).

Table (23)

Iterated Zellner Parameter Estimates of Cost System of Equations for Foreign Banks (1990-2000) Dependent Variable: Total Costs

Variable	Coefficient	T-Statistics
Intercept(B_0)	-1.46	-38.70
Loans(B_1)	0.71	0.95
Investments(B_2)	-1.66*	-2.23
Price of Labor(C_1)	3.68*	4.67
Price of Capital(C_2)	-0.23	-0.31
$(\text{Loans})^2$ (D_{11})	0.16*	2.78
Loans*Investments(D_{12})	-0.03	-1.21
$(\text{Investments})^2$ (D_{22})	0.12*	2.78
Price of Labor*Price of Capital (E_{12})	-0.20*	-3.14
Price of Labor*Price of Deposits (E_{13})	-0.18*	4.14
Price of Capital*Price of Deposits (E_{23})	-0.09*	-2.33
Loans*Price of Capital(F_{12})	0.13*	3.61
Loans*Price of Deposits(F_{13})	0.10*	3.98
Investments*Price of Capital (F_{22})	-0.02	-0.72
Investments*Price of Deposits (F_{23})	-0.02	-1.13
Number of Observation (N)	55	
Adjusted R^2	0.91	

*: Coefficient Significant at 5% Level (Two Tail Test).
**: Coefficient Significant at 10% Level (Two Tail Test).

Table (24)

Iterated Zellner Parameter Estimates of Cost System of Equations for Domestic Banks (1990-2000) Dependent Variable: Total Costs

Variable	Coefficient	T-Statistics
Intercept(B_0)	-1.64	-83.38
Loans(B_1)	2.09*	4.21
Investments(B_2)	-0.47	-1.27
Price of Labor(C_1)	-0.48	-0.87
Price of Capital(C_2)	0.27	0.71
$(\text{Loans})^2$ (D_{11})	-0.11*	-2.81
Loans*Investments(D_{12})	0.06*	3.42
$(\text{Investments})^2$ (D_{22})	0.006	0.39
Price of Labor*Price of Capital (E_{12})	-0.04	-1.46
Price of Labor*Price of Deposits (E_{13})	-0.08*	-2.21
Price of Capital*Price of Deposits (E_{23})	-0.07*	-4.43
Loans*Price of Capital(F_{12})	-0.04**	-1.74
Loans*Price of Deposits(F_{13})	0.04*	2.33
Investments*Price of Capital (F_{22})	0.05*	2.95
Investments*Price of Deposits (F_{23})	0.02*	2.75
Number of Observation (N)	164	
Adjusted R^2	0.91	

*: Coefficient Significant at 5% Level (Two Tail Test).
**: Coefficient Significant at 10% Level (Two Tail Test).