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The Effect of Economies of Scope on Iranian Banking Sector Structure: An Application of Multi-Product Function and Multi-Level Effect Approaches

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Abstract

This paper investigates, using a multi-product paradigm, the market structure of the Iranian banking sector to evaluate the role of scale. In so doing, we checked for economies of scope by multi-product cost function as well as the impact of potential economies on the banking sector structure including 18 banks during the period 2008–2014. The changes in Panzar-Rosse H-Statistic as a result of the variety in products reflect changes in the monopolistic power. The results show that an increase in the variety of offered products increases banks' monopolistic power.

Keywords: Iranian banking sector; variety-based economies; multi-level model; market structure; the generalized Panzar-Rosse model.

JEL classification: L1; G21; F36.

1. INTRODUCTION

The banking system plays an important role in the proper functioning of two main parts of the economy, namely money and actual markets. In this regard, a high degree of concentration in the banking industry has recently highlighted two questions: first, regarding a bank's large scales, is there an increase in these scales? If so, is this an advantage or obstacle for potential new banks to enter the industry? And secondly, whether the scope of this banking model has led to an increase in banking power? In order to examine the degree of competition in the banking industry, the existent literature is usually divided into two major streams, namely the structural and non-structural approaches. The former embraces the structure-conduct-performance (SCP) paradigm and efficiency hypothesis (EH), as well

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as a number of formal models with roots in the industrial organization theory (Bikker *et al.*, 2012 and Iwata, 1974). The traditional approach to competition is associated with larger number of firms in the industry, as more firms with low prices indicate more competition. (Bikker, 2003; Gutierres de Rozas, 2007). And, conversely, with a small number of firms, a large difference in price and marginal cost are the features of low-level competition. This approach to classic theories forms the SCP, which assumes that there is a causal relationship between market structure, pricing behavior, and market power, i.e. large number of firms lead to a kind of price competition which minimizes the degree of market power (Lau, 1982). The banking markets are undergoing unprecedented changes, caused by the deregulation of financial services, the establishment of economic and monetary union (EMU), and developments in information technology, which may well turn out to be dramatic (Bikker and Haaf, 2002; Coccorece, 1998). It is interesting to note that the theoretical and applied literature have hinted at the effect of competition on the international banking system. These large banks with competitive structures could be defined as institutions providing insurance and monetary services (Freixas *et al.*, 2007). Based on our knowledge, this article is the first attempt to assess the effect of economies of scope on market power in the Iranian banking sector. This paper is organized as follow: Section 2 discusses the various theories and methods used to measure competition and gives overview of the literature; Section 3 introduces and explains the multi-product approach of model of market structure in detail and its empirical application in the Iranian banking sector; Section 4 presents an explanation, analysis, and model estimation; and finally, in Section 5, concluding remarks and policy implications are included.

2. LITERATURE REVIEW

A multi-product structure, in essence, allows financial institutes to use economies of scope. In addition, it also provides more opportunities to spread risk over a wide range of financial packages and services. In fact, these large financial institutions and their multi-product activities have been a feature of the banking sector in recent decades, highlighted by financial analyzers after the global crisis in 2008 (Levine, 2011). The cost efficiency of international and state banks versus commercial ones have been assessed in some previous studies. Allen and Rai (1996) estimated economies of scale and scope for banks and large-sized financial institutes, considering state banks (and without these banks in other case). Vennet (2002) also evaluated the earning and cost efficiency of banks and large-sized financial institutes including state banks. Nevertheless, the only study which considered multi-product activities was conducted by Berger and Mester (1997) and Simbanegavi *et al.* (2012) as they analyzed the agent banks' behavior with big-sized companies and retail banking loans. The results show an asymmetry in degree of competition which is likely associated to consumer characteristics in each sector. Kim and Berger's work is special in some contexts as it discusses the descriptive relationship in banking and its variety of products, whereas the possible relationship between multi-product activities in international banks and competition has not been investigated yet. The current study addresses the theoretical gap between multi-product activities in international banking and measures the degree of competition both theoretically and empirically. Technically, if services merge, the operational costs of multi-product banking should be lower than specialized banks. Moreover, it is possible for large-sized international banks to perform better in traditional (or non-traditional) banking system, if there are other informational advantages such as a range of product offerings that can yield a positive spillover for them. Because these huge banks are able to change their organizational cost structure considerably, this could have noticeable effects on the degree of competition. This paper assesses the Iranian banking structure using a multi-product approach. In other words, we evaluate those financial institutions, which in addition to classic banking products (such as loans and bank credit), provide non-classic services (e.g. fee-based investments, insurance, and exchange rate activities) in comparison with those that just provide specialized and classic services. Unlike the others, the international banks offering both classic and non-classic services benefit from economies of scope. Factors such as workforce and technology get shared to represent several joint products, which are considered the main components of costs. The Vennet (2002) studies show that banks offering a wide range in products are more efficient when it comes to income and costs, and these economies of scope in international banks are one of the main tools to enhance promotion of cost efficiency.

This paper is built upon developing the Panzar and Rosse (1987) model and extracting a theoretical model to pursue behavior and moving direction of multi-product banking, using economies of scope, from classic and non-classic service offerings. Panzar and Rosse (1987) developed a model which indicates the discrimination between perfectly competitive, monopolistically competitive, and oligopolistic markets. This model is widely used in literature as it does not require much information or data. It is possible to measure the degree of competition by imposing simple restrictions on price elasticity in the revenue equation. They illustrate how changes in output prices affect income and market power in the banking sector. The Panzar-Rosse H-Statistic obtained from the sum of revenue elasticities in respect to price of inputs, shows the level of competition. According to Panzar and Rosse (1987), the H-statistic ranges from negative infinity to unity. A negative H appears when the competitive structure is a case of monopoly or a perfect colluding oligopoly; where in both situations, an increase in input prices will translate into higher marginal costs, a reduction of equilibrium output, and eventually, a fall in total incomes. If H lies between zero and unity, the market structure is characterized by monopolistic competition. Under perfect competition, the H is equal to unity; in which case, an increase in input prices induces a change in incomes without distorting the optimal output of any individual firm. Here, we first calculate the generalized H-statistic of the multi-product banking system and economies of scope. Then we will indicate how these economies of scope affect the H-statistic. Based on this process with using economies of scope in multi-product banks, it is observed that the higher the economies of scope, the lower is the generalized H-statistic. The economies of scope reduce the marginal cost of services, leading to an increase in the markup gap of the banking sector. As a result, banks benefiting from economies of scope, have larger markups in comparison with those that just offer classic products. The question then arises as to whether the economies of scope strategy creates monopolistic power. Ideally, the answer to this should affect the entire banking industry. Hence, we study the effect of economies of scope on the structure of Iranian banking sector as an application of multi-product function and multi-level effect approaches. Barbosa *et al.* (2015) investigated the competitive nature of multi-product operations with a new dataset in the Brazilian banking industry. They found that the banks that offer multiple products, substantially have higher market power than the banks that offer only classic products. Clerides *et al.* (2015) estimated the degree of competition in the banking sectors of 148 countries worldwide over the period 1997–2010. They employed three methods and all three indices show that the competitive conditions in banking had, on average, deteriorated during the period 1997–2006. This trend reversed until 2008, while in 2009 and 2010 market power again increased. Khodad Kashi *et al.* (2015) analyzed the competitive condition of the Iranian banking industry over the period 2005-2010 using the Panzar-Rosse H-statistic. Their calculated H-statistics for the entire sample period was 0.7101. This article has at least some advantages over their study, in terms of: attempting to assess the effect of economies of scope on market power in the Iranian banking sector; and estimating the multi-level paradigm of presented types of ownership and their activity in the banking industry.

3. METHODOLOGY

In this section, first we generalize the Panzar-Rosse model associated with scope of production, and then we extract the H-statistic from the generalized model to use it in a multi-product approach. Finally, we indicate that an increase in economies of scope leads to a decrease in the Panzar-Rosse H-statistic.

Consider a bank faces negative slope of demand function for classic products (loans and credit cards) q_c (p_c) and non-classic services (e.g. fee-based investments, insurance, and exchange rate activities) q_0 (p_0).

Here we illustrate the demand curves with the following demand functions: q_c (p_c) q_0 (p_0) where the price of p_i is related to the amount of product q_i.

For $i = c,o$ we obtain the bank’s demand elasticity in the market for classic and other non-classic products $e = \frac{\partial q_0}{\partial p_0}\frac{p_0}{q_0}$ and $e = \frac{\partial q_c}{\partial p_c}\frac{p_c}{q_c}$, respectively.

The banking technology with cost function are represented as: $C(q_c, q_0; w_1, w_2, \gamma)$, For simplicity reasons, we assume that the bank uses just two inputs (labor and capital) with prices of w_1 and w_2 to produce its services. We also assume that the cost function is convex and second degree derivation continuously exists in points of $q_c and q_0$.

$$\frac{\partial c_{(0)}}{\partial q_i} \geq 0 \quad 2) \left[\frac{\delta^2 C}{\delta q_i^2}\right] \geq 0 \text{ and } \frac{\delta^2 C}{\delta q_c^2}\frac{\delta^2 C}{\delta q_0^2} - \left[\frac{\delta^2 C}{\delta q_c q_0}\right] \geq 0$$

The important point here is that the cost function is dependent on γ parameter. This parameter shows the economic size and scale provided by both classic and other non- classic products for banks. We explain in detail how economic size and scale emerge with multi-product banking, the role of γ in multi-product banking technology also follows. Banking technology shows the size and scale of economic production for classic and other non-classic products, thus we assume that $\frac{\delta^2 C}{\delta q_c q_0} \leq 0$. By this condition, we show that an increase in q_c leads to a decrease in marginal cost of production q_0 and vice versa. This presentation is defined as the weak complementary condition of cost and indicates that economic size and scale creates more efficiency in multi-product banking than in those that just offer specialized services. For simplicity, we assume that banking technology (i.e. economic size and scale) is fixed, i.e. $\frac{\delta^2 C}{\delta q_c q_0} = -\gamma, \gamma \geq 0$ (Barbosa *et al.*, 2015). Regarding this assumption, we can obtain the effect of change in economic size and scale by the Panzar-Rosse H-statistic. Thus, we can extract the cost function as follows:

$$\pi = \pi(q_0, q_1; w_1, w_2, \gamma) = p_c(q_c) + p_0(q_0) - C(q_0, q_1; w_1, w_2, \gamma) \quad (1)$$

The first two equations are incomes gained from classic and other non- classic products, respectively, and the third and fourth equations are total cost of classic and non-classic services, respectively. Here it should be noted that the economic size and scale is presented by γ in Equation (1) for both classic and non-classic. For a bank with multi-product approach, it is likely for the profit function to be affected by its cost function. The bank's decision- making variables are q_c (the amount of classic products) and q_0 (the amount of non-classic products) and we maximize the revenue function (presented in Equation (1)) by selecting between different amounts of q_c and q_0. The first-order condition for maximizing the bank's income is:

$$\begin{aligned} \frac{\delta \Pi}{\delta q_C} &= p_C\left[\frac{e_C - 1}{e_C}\right] - \left[\frac{\delta C}{\delta q_C}\right] = 0 \\ \frac{\delta \Pi}{\delta q_0} &= p_0\left[\frac{e_0 - 1}{e_0}\right] - \left[\frac{\delta C}{\delta q_0}\right] = 0 \end{aligned} \quad (2)$$

The second order condition for bank's revenue function is as follow:

$$\frac{\delta^2 \Pi}{\delta q_c^2} = \frac{p_c}{q_c}\left[\frac{1 - e_c}{e_c}\right] + \frac{p_c}{e_c^2}\frac{\delta e_c}{q_c^2} \le 0 \quad (3)$$

$$\left[-\frac{p_c}{q_c}\left[\frac{e_c - 1}{e_c^2}\right] + \frac{p_c}{e_c^2}\frac{\delta e_c}{q_c^2} - \frac{\delta^2 C}{\delta q_c^2}\right]\left[-\frac{p_0}{q_0}\left[\frac{e_0 - 1}{e_0^2}\right] + \frac{p_0}{e_0^2}\frac{\delta e_0}{q_0^2} - \frac{\delta^2 C}{\delta q_0^2}\right] - \left[\frac{\delta^2 C}{\delta q_c q_0}\right]^2 \ge 0 \quad (4)$$

The left side of Equation (4) is second order partial differentiation of revenue function presented in Equation (1) which is the Hessian matrix. Moreover, the demand elasticity is constant for both markets ($\frac{\partial e_i}{\partial q_i} = 0$) and the bank's cost function is linear ($\frac{\partial^2 C(0)}{\partial q_i} = 0$).

If the banking technology is constant, we define economic scale as $\frac{\partial^2 C^*}{\partial q_0 q_c} = (-\gamma)$, substituting reciprocal second order differentiation by γ^2 in the last equation, so that Equations (3) and (4), after introducing new assumptions, are rewritten as follows:

$$\frac{\delta^2 \Pi}{\delta q_c^2} = \frac{p_c}{q_c}\left[\frac{1 - e_c}{e_c^2}\right] \le 0 \quad (5)$$

$$\frac{p_c p_0}{q_c q_0}\left[\frac{e_c-1}{e_c^2}\right]\left[\frac{e_0-1}{e_0^2}\right]-\gamma^2\geq 0 \tag{6}$$

Equations (5) and (6) indicate that the amount of elasticity for both presented products are larger or equal to unity. This means that the multi-product bank faces a negative slope for the demand function curve of both q_0 and q_c products and always produces in the elastic areas of its demand curve.

Again for the sake of simplicity, we show the left side of Equation (7) which is the Hessian matrix with D.

$$D=\frac{p_c p_0}{q_c q_0}\left[\frac{e_c-1}{e_c^2}\right]\left[\frac{e_0-1}{e_0^2}\right] \tag{7}$$

Equations (2) and (3) denote the banking products' classic and non-classic (q^*_c and q^*_0) optimum supply function, respectively. Banking products are a function of exogenous variables, input prices w_1 and w_2, and economic size and scale parameter γ. In the next section, we explain how the banking supply function for both classic and non-classic products changes when there is a change in exogenous variables. Notice that from the revenue function, we have $q^*_c = (q_c, w_1, w_2, \gamma)$ and $q^*_0 = (q_0, w_1, w_2, \gamma)$ which are supply functions for both classic and non-classic products, respectively. If technology changes is assumed to be constant, we have economies of scope as $\frac{\partial^2 c^*}{\partial q_0 q_c} = (-\gamma)$, assuming demand elasticity as constant in both markets ($\frac{\partial e_i}{\partial q_i}$=0)and then linear cost function for bank $\frac{\partial^2 C(_0)}{\partial q_i} =$ 0 is estimatable, since the optimum supply of classic and non-classic products changes with changes in price of inputs w_1 and w_2, and economies of scope γ :

$$\frac{\partial q_i}{\partial w_1}=\frac{1}{D}\left[\frac{p_j}{q_j}(\frac{1-e_j}{e_j^2})\right]\frac{\partial^2 C(0)}{\partial q_i \partial w_1}-\gamma\frac{\partial^2 C(0)}{\partial q_i \partial w_1}=0 \tag{8}$$

$$\frac{\partial q_i}{\partial w_2}=\frac{1}{D}\left[\frac{p_j}{q_j}\left(\frac{1-e_j}{e_j^2}\right)\right]\frac{\partial^2 C(0)}{\partial q_i \partial w_2}-\gamma\frac{\partial^2 C(0)}{\partial q_i \partial w_2}=0 \tag{9}$$

$$\frac{\partial q_i}{\partial \gamma}=\frac{1}{D}\left[\frac{p_j}{q_j}\left(\frac{1-e_j}{e_j^2}\right)\right]\frac{\partial^2 C(0)}{\partial q_i \partial \gamma}-\gamma\frac{\partial^2 C(0)}{\partial q_i \partial \gamma}=0 \tag{10}$$

Equations (8)–(10) show that the banking optimum supply function will change if both prices of inputs w_1 and w_2, and economic scale (γ) changed. The above relation is the most important part to measure competition (H-statistic) in multi-product banking using the Panzar-Rosse model. The above equations are also important since they help investigate the effect of economic size and scale on H-statistic. If we assume that the economic size and scale decreases the marginal cost $\frac{\delta^2 C}{\delta q_c \delta\gamma}\leq 0$ then optimum supply of both classic and non-classic products will increase if economies of scale increase $\frac{\delta C}{\delta\gamma}\geq 0$.

3.1 Economic scale and Panzar-Rosse H-Statistic in banking products' market

Panzar and Rosse (1987) proposed an approach based on the so-called H-statistic, which is the sum of elasticities of the reduced-form revenues with respect to the input prices that indicate the differences between perfectly competitive, monopolistically competitive, and oligopolistic markets. This model measures the level of competition by establishing how each of the individual bank's revenue reacts to proportionate changes in input prices. Regarding the above presented model, the H-statistic for a multi-product bank is defined as follows:

$$H = \frac{W_1}{R(W_1,W_2)}\frac{\delta R(W_1,W_2)}{\delta W_1} + \frac{W_2}{R(W_1,W_2)}\frac{\delta R(W_1,W_2)}{\delta W_2} \quad (11)$$

Here $R(W_1,W_2,\gamma) = p_C q_c + p_0 q_0$ is a multi-product bank's total income and classic and non-classic supply functions are $q_c = q(W_1,W_2,\gamma)$ and $q_0 = q(W_1,W_2,\gamma)$, respectively. These relations are implicitly defined in Equations (2) and (3). Also note that:

$$\frac{\delta R(W_1,W_2)}{\delta W_i} = \frac{\delta R(_0)}{\delta q_c}\frac{\delta q_c}{\delta w_i} + \frac{\delta R(_0)}{\delta q_0}\frac{\delta q_0}{\delta w_i} \quad (12)$$

Using Equations (11) and (12), the multi-product H-statistic extract is as follows:

$$H = \theta H_C + (1-\theta)H_0 \quad (13)$$

where $\theta = \frac{p_c q_c}{p_c q_c + p_0 q_0}$ is a function of obtained revenue from classic products. Furthermore, Equation (13) implies that the multi-product H-statistic is equal to the sum of H-statistics for all products, calculated by considering the share of each product in the bank's total income. Since our aim here is to assess the multi-product competition in banking, considering the scale effect, measuring the effects from economies of scope and providing different products on degree of competition in the banking industry via the Panzar-Rosse H-statistic is practically possible; in which H_C is the value of the Panzar-Rosse H-statistic in the case of providing classic products only and is defined as follows:

$$H_c = \frac{\delta R(_0)}{\delta q_c}\left[\frac{W_1}{R_c}\frac{\delta q_c(_0)}{\delta w_1} + \frac{W_2}{R_c}\frac{\delta q_c(_0)}{\delta w_2}\right] \quad (14)$$

where $R_c = p_c q_c$ is total income of the classic bank. Note that in this case, the H-statistic for a single-product bank is regarded as zero. If we substitute $\frac{\delta q_c}{\delta w_1}$ and $\frac{\delta q_c}{\delta w_2}$ in Equation (14) which is shown in Proposition 1, we will have:

$$H_c = \frac{\delta R_c(_0)}{\delta q_c}\frac{W_1}{R_c}\left[\frac{1}{D}\left[\frac{p_c}{q_0}(\frac{1-e_0}{e_0^2})\frac{\delta^2 c(_0)}{\delta q_c \delta w_1} - \gamma\frac{\delta^2 c(_0)}{\delta q_0 \delta w_1}\right]\right] + \frac{\delta R_c(_0)}{\delta q_c}\frac{W_2}{R_c}\left[\frac{1}{D}\left[\frac{p_c}{q_0}(\frac{1-e_0}{e_0^2})\frac{\delta^2 c(_0)}{\delta q_c \delta w_2} - \gamma\frac{\delta^2 c(_0)}{\delta q_0 \delta w_2}\right]\right] \quad (15)$$

By arranging the common relations and factorization respect to $\frac{1}{D}\frac{\delta R_c(_0)}{\delta q_c}$ from Equation (15), it is possible to obtain H-statistic for classic banking products in the market:

$$H_c = \frac{1}{DR_c}\frac{\delta R_c(_0)}{\delta q_c}\left[\left[\frac{p_c}{q_0}(\frac{1-e_0}{e_0^2})\left[w_1\frac{\delta^2 c(_0)}{\delta q_c \delta w_1} + w_2\frac{\delta^2 c(_0)}{\delta q_c \delta w_2}\right]\right]\right] - \gamma\left[w_1\frac{\delta^2 c(_0)}{\delta q_c \delta w_1} + w_2\frac{\delta^2 c(_0)}{\delta q_c \delta w_2}\right] \quad (16)$$

To reach favorable results, we assume that the multi-product bank is price-taker for (X_1, X_2) inputs and the cost function is defined as $(q_0, q_1; w_1, w_2)$, and so we have:

$$C(q_c, q_0; w_1, w_2) = \min w_1 x_1 + w_2 x_2$$
$$(q_0, q_C; w_1, w_2) \in Y \quad (17)$$

where y is production set. Then:

$$\left[w_1\frac{\delta^2 c(_0)}{\delta q_c \delta w_1} + w_2\frac{\delta^2 c(_0)}{\delta q_c \delta w_2}\right] = \frac{\delta R_i(_0)}{\delta q_i} \quad (18)$$

If we substitute the Equation (18) in Equation (16), we will have:

$$H_c = \frac{1}{DR_c}\frac{\delta R_c(_0)}{\delta q_c}\left[\frac{p_c}{q_0}(\frac{1-e_0}{e_0^2})\frac{\delta R_c(_0)}{\delta q_c} - \gamma\frac{\delta R_0(_0)}{\delta q_0}\right] \quad (19)$$

From Equations (2) and (3) and first-order condition we have $\frac{\delta R_c(_0)}{\delta q_i} = p_i\left[\frac{e_i - 1}{e_i}\right]$, now if we substitute it into Equation (6) we will have:

$$H_c = \frac{1}{D}\left[\frac{p_c}{q_0}\frac{p_0}{q_0}\frac{(1-e_0)^2}{e_0^2}\frac{(1-e_0)}{e_0^2} + \gamma\frac{p_0}{q_c}\frac{(e_0-1)}{e_0}\frac{(e_0-1)}{e}\right] \quad (20)$$

Since this study aims to investigate the effect of economic scale on the H-statistic of multi-product banks in comparison to banks with only classic products in the market, it is important to understand how the change in γ parameter affects the H_C-statistic. It is not simple to take a derivative of H_C when the parameter of γ exists. Moreover, based on Equations (3)-(12), the H_C-statistic directly depends on γ and indirectly on p_c, q_c, p_0, q_0 and D. Finally, it is possible to show that in the presence of γ , the H_c statistic will decrease. Further, as we assumed that demand elasticity in both markets are constant ($\frac{\partial e_i}{\partial q_i}$=0) and linear cost function for bank is $\frac{\partial^2 C(_0)}{\partial q_i} = 0$, we can derive:

$$\frac{dH_c(\gamma)}{d\gamma}\Big|_{\gamma=0} = -\frac{q_c}{p_c} e_c e_0 \prec 0 \tag{21}$$

If size and scale of γ decreases marginal costs $\frac{\delta^2 C(_0)}{\delta q_i \delta\gamma} \le 0$, then we will have:

$$\frac{dH_c(\gamma)}{d\gamma} \le 0, \forall\gamma \tag{22}$$

Equation (21) in Proposition 2 shows that the calculated Panzar-Rosse H-statistic for the case of classic products in the market must be higher than its corresponding value in case of a multi-product market. Moreover, from Equation (22) in Proposition 2, we understand that the higher the variety-based economies in the multi-product banking system, the fewer the generalized Panzar-Rosse H-statistics. It is probable due to economies of scope for baking system offering both types of products. These economies of scope reduce the bank's marginal costs and this issue alone increases the gap between the price and cost in the multi-product banking industry. As a result, a multi-product bank faces higher markup than that of a single-product one. We assessed the empirical generalized Panzar-Rosse H-statistic for the case of multi-product banks as well as how economies of scope affect single-product H-statistic in later studies. We also presented an econometric model for estimation of generalized Panzar-Rosse H-statistic in the case of multi-product banks.

The presence of economies of scope in banking activities is one of the most important assumptions in this paper. It is necessary to develop a macroeconomic model to estimate the effects of economies of scope on multi-product banking in relation to degree of competition. Allen and Rai (1996) and Vennet (2002) used the translog-function to estimate the multi-product cost function (providing both classic and non-classic products). The main advantage of flexibility allows for the translog cost function to be used in calculating economies of scope. The specification of this model is as follow:

$$\begin{aligned} Ln\, TC_{bt}(q_{cbt}, q_{obt}; w_{1bt}, w_{2bt}) = {} & \alpha_0 + \sum_{i=c,o} \ln(q_{ibt}) + \sum_{i=1,2} \ln(w_{ibt}) + \frac{1}{2}\sum_{i=c,o}\sum_{j=c,o} \alpha_{ij} \ln(q_{ibt})\, ln(q_{jbt}) \\ & + \frac{1}{2}\sum_{i=c,o}\sum_{j=c,o} \delta_{ij}\, ln(w_{ibt})\, l\,n(w_{jbt}) + \frac{1}{2}\sum_{i=c,o}\sum_{j=c,o} \rho_{ij}\, ln(q_{ibt})\, l\,n(w_{jbt}) + \mu_b + €_t + \upsilon \end{aligned} \tag{23}$$

where $\mathrm{TC_{bt}}(.)$ is total cost of bank b ; t refers to period . q_{ibt} is total income gained from classic (traditional) activities, q_{obt} is total income obtained from non-classic activities. w_{1bt} and w_{2bt} are the bank's input prices. v_{bt} , $€_t$, and μ_b represent constant time effects, white noise, and fixed effects of lags, respectively. From this specification, measuring economies of scope of multi-product activities is possible using the below relation:

$$\mathrm{scope}_{bt} = \left[\frac{\mathrm{TC_{bt}(q_{cbt}, 0; w_{1bt}, w_{2bt}) + TC_{bt}(0, q_{obt}; w_{1bt}, w_{2bt}) - TC_{bt}(q_{cbt}, q_{obt}; w_{1bt}, w_{2bt})}}{\mathrm{TC_{bt}(q_{cbt}, q_{obt}; w_{1bt}, w_{2bt})}}\right] \tag{24}$$

where $\mathrm{TC_{bt}}(.)$ is a function determined by the econometric model estimation (a multi-product translog-function). In addition, we implicitly assume that in case of a single-product bank, the economies of scope are zero. Baumol *et al.* (1982) indicates that a sufficient condition for economies of scope is the presence of weak cost complementarities between used inputs.

According to Baumol *et al.* (1982), the weak cost complementarities indicate that the production cost of a product will increase as a result of increase in production of another product. The weak cost complementarities can be seen in the below relation: $\frac{\delta^2 C}{\delta q_c \delta q_0} \leq 0$ .We entered the actual assumption of economies of scope as an assumption in the previous section. The weak cost complementarities and economies of scope are possible using Equation (24).

4. DATA AND MODEL ESTIMATION

Based on the theoretical results obtained above, this section provides an empirical illustration of the Iranian banking sector, using a multi-product function approach as well as a multi-level paradigm for the deposit market. Following other studies, we collected data from the Bankscope site for 18 Iranian banks by extracting bank performance reports for the period 2008-2014. First, we estimated the multi-product translog cost function, followed by assessing the economies of scope of the selected banks. The translog function form is widely used in literature because it has advantages of flexibility and efficiency. Therefore, it is possible to infer economies of scope via this function. In other words, here the translog function is used to extract the most important variable of model which is economies of scope. In Equation (23), $TC_{bt}(.)$ denotes the total expenditure cost of 18 banks during the period of 2008-2014; q_{ibt} is total income from traditional services; $\boldsymbol{q_{obt}}$ is total income from other banking activities (such as fee-based investments, insurance, and exchange rate services). And finally, w_{1bt} and w_{2bt} are the input prices. The results of statistical estimation based on the model specification of previous section are provided in Table no. 1.

Table no. 1 –The results of multi-product translog cost function estimation in the Iranian banking industry

Var	Pro	Co
C	0.0000	14.01083
Ln(RC)	0.0002	-0.350346
Ln(RO)	0.0000	-0.571773
Ln (cost of capital)	0.0000	-0.370498
Ln (wage)	0.0156	0.309865
$Ln(RC)^2$	0.0341	0.042267
Ln(RC) ×Ln(RO)	0.0721	-0.061092
$Ln(RO)^2$	0.0052	0.068711
Ln (cost of capital)^2	0.0000	0.003755
Ln (cost of capital) × Ln (wage)	0.0533	-0.020135
Ln (wage)^2	0.2471	0.011104
Ln(RC) ×Ln (wage)	0.0278	0.038328
Ln(RC) × Ln (cost of capital)	0.0000	0.038668
Ln(RO) ×Ln (wage)	0.0048	-0.058072
Ln(RO) × Ln (cost of capital)	0.5905	0.001969
R^2 0.957096	Adjust R^2 0.882222	
Hausman 4.39	P-Value : 0/0000	

The estimation results of multi-product translog function for total costs of 18 selected banks in the period 2008-2014, considering the banks' investment incomes (interest income) as non-interest incomes, is displayed in Table no. 1. From the translog function, it can be seen that model variable's squares with their intercept effects are used in statistical estimation and all other variables are used in their square form and intercept effects, as well. Of course the coefficient of determination and Durbin-Watson statistic ranges in acceptable position for use in panel data. In some context, the results of the translog multi-product cost functions are similar with those of the present study. Nevertheless, regarding the estimated negative coefficient of income intercept effects, the obtained coefficient for intercept effects of loan funds, non-interest, and investment incomes secure the weak cost complementarities. Baumol *et al.* (1982) indicates that a sufficient condition for economies of scope is presence of weak cost complementarities between used inputs. According to him, the weak cost complementarities indicate that the production cost of a product will increase as a result of increase in production of another product. The weak cost complementarities can be seen in the below relation: $\frac{\delta^2 \ln C}{\delta \ln q_c \delta \ln q_0} \leq 0$.

The actual assumption associated with economies of scope has been inserted into a specified model in the previous section. The weak cost complementarities and economies of scope are possible using Equation (24). Using an econometric model, we estimated the multi-product function to find out the economies of scope's impacts. The results for Iranian specialized-state banks is illustrated in Table no. 2.

Table no. 2 – The trend of economies of scope variables for specialized-state banks

Banks	2008	2009	2010	2011	2012	2013	2014
bank Post	1.17922	1.19039	1.16044	1.13411	1.12643	1.11147	1.09386
Export Development Bank	1.21807	1.20324	1.15033	1.14221	1.14391	1.10756	1.09937
Bank of Industry and Mine	1.18574	1.13193	1.06392	1.03022	1.03387	0.971074	0.97632
Agricultural Bank	0.98141	0.958778	0.934049	0.92557	0.916989	0.829851	0.79781
Maskan Bank	0.918787	0.948027	0.905095	0.833662	0.802874	0.828742	0.817395

The surveyed trend for five specialized-state banks covering 2008–2014 shows a slightly ordered and decreasing direction over the time which is expected due to the fact that these banks have directory-presented facilities and have being active in specialized areas only. The results for Iranian commercial- state banks is illustrated in Table no. 3.

Table no. 3 – The trend of economies of scope variables for commercial-state banks

	2008	2009	2010	2011	2012	2013	2014
MEALI BANK	0.8358	0.845984	0.803439	0.831396	0.73394	0.755294	0.794375
Sepah Bank	0.943485	0.951439	0.959255	0.90772	0.878167	0.86556	0.84629
Refah Bank	1.23167	1.13201	1.12039	1.09936	1.00489	1.05608	0.919931

This trend has been assessed for three commercial-state banks covering 2008-2014, which indicate a slightly ordered and decreasing direction (but in a rather lax manner in comparison with the specialized-state banks). This may be due to their restricted activity for a specific area as well as because, as expected and justifiable, these specialized-state banks operate under strict governmental regulations. The results of investigation for economies of scope in private-commercial banks are shown in Table no. 4.

Table no. 4 – The trend of economies of scope variable for private-commercial banks

Banks	2008	2009	2010	2011	2012	2013	2014
Eghtesad Noven Bank	1.09707	1.15297	1.23046	1.31278	1.17858	1.08555	1.09748
Parsian Bank	1.03396	1.06567	1.0246	0.97375	0.969077	1.13041	1.04866
Pasargad Bank	1.13217	1.12529	1.10825	1.05652	1.00868	0.970138	0.937926
Tejarat Bank	0.80155	0.855479	0.921577	0.894546	0.89912	0.897724	0.905242
Saman Bank	1.21768	1.11966	1.07949	1.02808	1.01777	0.985647	0.986434
Sina Bank	1.28838	1.26346	1.14781	1.18099	1.69262	1.32497	1.34007
Sarmayeh Bank	1.17741	1.1392	1.16111	1.14309	1.01138	0.977454	0.951502
Sadrat Bank	0.777627	0.801934	0.831622	0.852318	0.809449	0.875978	0.873973
Karafarin Bank	1.23111	1.21686	1.46491	1.33149	1.3408	1.2591	1.18831
Mellat Bank	0.706508	0.733807	0.788995	0.818474	0.852662	0.880892	0.875717

The surveyed trend for five private-commercial banks during the period 2008-2014 indicate a focused direction over the time which is as expected owing to their directory-provided facilities and conducting business in just a specialized area, therefore these results were predictable and justifiable. As can be seen, these economies of scope appear to be more in private-commercial banks and private banks based on variety of financial products and its economies. We assessed changes in market power resulting from multi-product activity based on the suggested Panzar-Rosse empirical approach. To do so, first the revenue equation (from the financial intermediary which is a function of input prices) is estimated to calculate H-statistic and its variation (as a result of emergence of economies of scope), i.e. ΔH_c calculates the generalized H-statistic for a case of multi-product banking. In this section, we have classified data of 18 banks based on their type of activity and ownership, comprising nine commercial-private banks, five specialized-state banks, and three commercial-state banks. This type- and ownership-based categorization plays a key role in econometric estimations which (thereafter shown by *j*) is calculated with the below algebraic relation:

$$\ln(\mathrm{RT_{jit}}) = \alpha + \ln(\mathrm{w_{jit}})'\beta + \ln(\mathrm{w_{jit}}) \times \mathrm{Scope_{jit}}\theta + \mathrm{Z_{jit}}\theta + \mu_{\mathrm{ji}} + \delta_{\mathrm{\,jit}} + \varepsilon_{\mathrm{jit}} \quad (25)$$

where $ln(RT_{jit})$ is total intermediation income for bank i , with type of activity j at the time of t; w_{it} is input prices vector for bank i, with type of activity j at the time of t. $Scope_{jit}$ is size of bank i , with type of activity j at the time of t. The economies of scope are also calculable by Equation (24). Additionally, we have $Z_{jit}\theta,\ \mu_{jit}, \delta_{\,jit}$ vectors which form the model's control variables and mean time's fixed effects, white noise and lag's (bank's) fixed effects. ε_{jit} is white noise of Equation (25). In this study, we use a multi-level approach with effective variables (i.e. bank size, asset quality, risk of bank activities) on the first level and the type of activity and ownership of the bank at the second level. Thus, the estimation results contain both the sum of fixed effects from explanatory variables and indirect effects of the second layer. Here, the one-to-one relation could be regarded as a research model:

$$I_{ijt} = W_{it} + X_{ijt} + Z_{ijt}^{(1)}U_{it}^{(1)} + Z_{ijt}^{(2)}U_{ijt}^{(2)} + E_{ij} \quad \forall: i = 1, \dots, M$$
$$j = 1, \dots, M_i \tag{26}$$
$$u^{(1)} \sim N\left(0, \sum 1\right) u^{(2)} \sim N\left(0, \sum 2\right) \qquad E \sim N(0, \sigma_E^2 I)$$

To explain this model, two points must be noted: the first one is related to I_{it} which is normally distributed and discrete at level (W_{it}) as $(X_{it}\delta, \sigma_E^2 I)$. Then, we add random variables to the paradigm and express the discreteness surface of the normal distribution function with mean of zero and variance of σ_E^2 , such that $W_{it} \geq -X_{it}\delta$. The second point to be considered is the levels in the paradigm. In this step, adding $Z_{ijt}^{(1)}U_{it}^{(1)} + Z_{ijt}^{(2)}U_{ijt}^{(2)}$ to the model transformed it to a multi-level one. More precisely, the $Z_{it}^{(1)}$ (random effect matrix) is $n_{it} \times q_1$ matrix at the first level random effect ($u_{it}^{(1)}$), and $Z_{it}^{(2)}$ is a $n_{it} \times q_2$ matrix contained at the second level random effect ($u_{it}^{(2)}$). Further, $\sum$ indicates the variance-covariance matrix of Z . Other variables such as I_{ij} (technical inefficiency for each bank), X_{ij} (explanatory variables), and E_{ij} (residual term) all have n_{ij} rows. Moreover, this section evaluates the econometric model with modifications, i.e. H_C -statistic emerging as a result of economies of scope in multi-product banking. Thus, it is possible to pursue changes in the H-statistic. Degryse *et al.* (2009) used this approach for the first time.

Now, we assess the change in market power as result of multi-product activities based on empirical approach suggested by Panzar and Rosse (1987). In so doing, first we estimate the revenue equation of a financial intermediary as a function of input prices to obtain Panzar-Rosse H-statistic with its changes due to economies of scope (or multi-product banking technology), i.e. ΔH_C provides the generalized Panzar-Rosse H-statistic for multi-product banking.

The revenue equation is calculated using the below relation:

$$ln(RT_{it}) = \alpha + ln(w_{it})'\beta + ln(w_{it}) \times Scope_{it}\theta + Z_{it}\theta + \mu_i + \delta_{it} + \varepsilon_{it} \tag{27}$$

where:

- $ln(RT_{it})$ is total income respect to intermediary activities for bank i at the time t;
- w_{it} is bank's input prices vector; $Scope_{it}$ is size of bank i at the time t, and economies of scope which is estimable via Equation (24).
- $Z_{it}\theta$, μ_i, δ_{it} are the control variables of model indicating fixed effects of time, white noise, and lag's (bank's) fixed effects. ε_{jit} is white noise of Equation (27).

The standard Panzar-Rosse H-statistic is as follows:

$$\text{Standard H} = \sum_{k=1}^{m} \acute{\beta}_k \ .$$

Therefore, there are different H-statistics for each of the presented competitive products in the banking sector (both classic and non-classic). We estimated the multi-level paradigm as presented in Section 3 via the maximum likelihood method. Of course for modeling of each observation, we will have three elements. For instance if we aim to model RT_{jit} variable, it is formed as follows: $(RT_{jit}) = \mu + u_{i..} + u_{jt.} + \varepsilon_{jit}$ where μ is the intercept value and $u_{i..}$ shows the panel data second level's explanatory power of RT_{jit}

modification or just that of bank i variable; $u_{jt.}$ indicates the explanatory power of third level of panel data regarding RT_{jit} modification or bank's type of activity j. Finally, ε_{jit} is the error terms of multi-level observations.

The research hypothesis states that as the range of products increases, the Panzar-Rosse H-statistic decreases, and consequently monopolistic power rises. Therefore, size and economic scale in the banking sector brings greater market power and those (banks) with more variety in their product offerings enjoy higher monopolistic power in the market. The variety in products (credits and deposits) leads to a decrease in Panzar-Rosse H-statistic. An important point worth noting here is the use of econometric technique to show types of activity and ownership in the selected banks. In other words, the multi-level paradigm used to assess the structure of Iranian banking sector makes it possible to do this more accurately due to the ability to insert ownership structure and type of activities as an innovation of the current study. The results of multi-product paradigm estimation through assessment of the Iranian banking sector structure for the period 2008-2014 are illustrated in Table no. 5.

Table no. 5 – The multi-product paradigm estimation results for Iranian banking sector structure

Var	**Co**	**Pro**
C	2/13	0/032
Ln (cost of capital)	0/1844	0/026
Ln (wage)	1/2107	0/000
Ln (Cost of loan)	-0/5563	0/050
Scop × Ln (cost of capital)	-0/1512	0/050
Scop × Ln (wage)	-0/8702	0/000
L Scop × Ln (Cost of loan)	0/4842	0/050
Scop	-2/0216	0/050
HHI	-56/71	0/000
Market share	132/43	0/000
Maximum Likelihood -40/105		
Chi-square statistics 146/10 P-Value		0/0000

The results of estimating random effects of parameters for multi-level paradigm show that it positively affected the Iranian banking sector in all three periods. Generally, the values of Chi-square distribution and model's total probabilities lie in favorable position. The Panzar-Rosse H-statistic to assess the Iranian banking structure using multi-level paradigm results are presented in Table no. 5 as follows:

$$Standard - H = \sum_{k=1}^{m} \acute{\beta}_k = -0/5563+0/1844+1/2107=0/8388$$

We have different H-statistics for each competitive product as mentioned before. Here the aim is to pursue how the market power increases when there is multi-product competition in banking. Thus, it is possible to assess this theory using the hypothesis tests below:

$$H_0 : \Delta H_C \geq 0$$
$$H_a : \Delta H_C < 0$$

We estimate changes in Panzar-Rosse H-statistic as a result of economies of scope in multi-product circumstance, ΔH_c , by $\Delta H_C = \sum_{k=1}^{m} \acute{\theta}_k$.

$$\Delta H_C = \sum_{k=1}^{m} \acute{\theta}_k = \text{-0/8702+0/4842-0/1512} = -0/5372$$

Here, we aim to investigate the Iranian banking sector structure based on multi-product function and effect of scale. To do so, we make it possible to calculate economies of scope in banking products by estimation of the translog of multi-product cost function. As economies of scope get calculated, we estimate the generalized Panzar-Rosse H-statistic and its changes because of economies of scope, ΔH_C , by $\Delta H_C = \sum_{k=1}^{m} \acute{\theta}_k$. We show that the estimated Standard H is between -1 and 1, which supports the empirical model of the Iranian banking sector structure. This observation is consistent with previous work by of Khodad Kashi *et al.* (2015). However, we observe that the estimated ΔH is negative, the negative Adjusted-H shows that banks supplying a wide range of financial products operate in an environment with little competition.

5. CONCLUSION

Using the translog cost function, we calculate the economies of scope as rooted in banks offering a variety of financial products. Based on the results, although, the economies of scope for each bank separately show a decreasing trend, the general trend for all banks is increasing. The economies of scope in the banking industry during the said period have been 1/02 on average. Thus, there are economies of scope in the Iranian banking sector. In case of estimation of a parameter's random effect by multi-level paradigm, we conclude that they have a positive effect on the Iranian banking structure. Moreover, to measure the competition, we estimate the Panzar-Rosse H-statistic using a multi-level model and finally arrive at a H-statistic value of 0/8388. Furthermore, to find out how market power increases when there are multi-product banks in the market (ΔH_C), we follow the changes in traditional Panzar-Rosse H-statistic by $\Delta H_C = \sum_{k=1}^{m} \acute{\theta}_k$, and according to the results there have been -0/5372 unit changes in H-statistic which dictates an increase of monopolistic power over the period. The generalized Panzar-Rosse H-statistic is estimated by the sum of generalized H-statistics and its changes in form of the traditional Panzar-Rosse H-statistic as a result of economies root in variety of provided products (ΔH_C) via $\Delta H_C = \sum_{k=1}^{m} \acute{\theta}_k$, where an increase in variety of products offered by the Iranian banking sector leads to decrease in the Panzar-Rosse H-statistic and subsequently increases the monopolistic power. Thus, the size and economic scale of a bank have given rise to greater power in the market since the more variety in its banking products, the more monopolistic power it has. Furthermore, the variety in products (deposits and credits) has decreased the H-statistic in the market. Although, variety in products brings economies and favorable monopolistic power for the bank as well as power to select for customers, banks should continue their intermediacy role in the economy as well. This paper has three more advantage than Barbosa *et al.* (2015). The first advantage is the calculated economies of scope of diversification is proportional to the type of activity and ownership of the banks, the second advantage is the ability to estimate the multi-level paradigm, and the final advantage is that we use a new dataset on the Iranian banking industry. However, our results are inadequate in the initial review with the results of Khodad Kashi *et al.* (2015), Nevertheless, we haven taken into consideration the effect of economies of scope on market power in the Iranian banking sector. Our study allows us to review the effect of economies of scope in the Iranian banking. and the second advantage estimates the multi-level paradigm which presented types of ownership and type of activity in the banking industry.

To summarize, our empirical models show that empirical studies that do not consider the economies of scope underestimate the multi-product firms' competition in the banking markets. Moreover, an individual banking-level measure of economies of scope is created and included in Panzar and Rosse (1987). The initial view of product diversity is supported by banks and their customers, so banks by gaining customer satisfaction, also gain market power through a variety of products. However, moving into an exclusive atmosphere can consequently reduce social welfare. Therefore, our results indicate that the economies of scope increase the monopoly power of banks.

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