Scale and Scope Economies of Futures Commission Merchants in Taiwan

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Abstract

Based on the survey data of Taiwan's futures commission merchants (FCMs) in 2004, this paper applies Zellner's seemingly unrelated regression technique to a simultaneous system of a translog multi-product cost function and its corresponding factor share equations to investigate the extents of scale and scope economies of Taiwan's FCMs. The empirical results show that product-specific scale economies exist for brokerage service, as well as proprietary and other services. Ray scale economies are significantly present. The degrees of ray scale economies and the scale economies specific to the brokerage service rise as firm sizes increase for relatively larger FCMs. Economies of scope exist especially for small-sized FCMs.

Keywords: Scale economies、Scope economies、Seemingly unrelated regression

1. Introduction

Taiwan Futures Exchange (TAIFEX) was established and the first futures contract, Taiwan Stock Exchange Capitalization Weighted Stock Index (TAIEX) futures, was introduced in 1998. With the introduction of new products, easier access via electronic trading system, and deregulation in financial markets, Taiwan futures markets has attracted increasing numbers of individuals and institutions looking for ways to manage their financial risk. The authorities opened the futures market to Qualified Foreign Institutional Investors (QFIIs), overseas Chinese, and foreign nationals to engage in futures trade for hedging purpose in 2000. Furthermore, the restrictions on foreign investments in the securities market were relaxed and the QFII system was cancelled in 2003. As a result, foreign institutions that intend to invest in Taiwan securities market only need to register with Taiwan Stock Exchange (TSEC) instead of applying to the authorities for approval.

By the end of 2004, products traded at TAIFEX include electronic and finance sector indices futures, TAIEX futures and options, mini TAIEX futures, equity options, Taiwan 50 futures, 10-year government bonds, and 30-day commercial papers. Taiwan's futures market has been experiencing rapid growth and moving in world ranking. Global futures and options exchange statistics show that TAIEX options at TAIFEX increased 22.10 percent to 43.82 million contracts traded in 2004, and ranked seventh on the top ten largest increases in trading

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volume, which was the only one not in Europe or the Americas on that ranking. In addition, trading volume (including futures and options exchanges) in TAIFEX increased from 31.87 million contracts, ranking twenty-seventh, in 2003 to 59.15 million contracts, ranking twentieth, in 2004.

In Taiwan, futures commission merchants (FCMs) conduct brokerage and proprietary business for all contracts at TAIFEX and designated foreign contracts according to the Article 5 of the Futures Trading Law. Practically, most of FCMs have their own extensive research departments and can provide current information and analysis concerning market development as well as specific trading suggestions to futures traders. According to Taiwan's futures markets statistics, although trading volume and trading accounts for the past five years grew substantially, the number of brokerage firms, including FCMs, securities firms with concurrent operations in futures trading business (SFs), and introducing brokers (IBs), had been decreasing gradually (See Table 1).[1] It could be reasonably inferred that some firms might exit the market due to fierce price competition, or some firms might be acquired or merged. In face of continuing pressure from falling commission rates, one of the primary challenges for FCMs is how to exploit cost advantages in the process of different services providing to survive or even to be profitable. This motivates our interest in the issues concerning the magnitude of cost advantages that FCMs in Taiwan can realize as a result of both their greater sizes and their ability to engage in the joint production of a broad as opposed to a more narrow line of services.

Table 1 Taiwan's futures markets statistics

	Number of brokers			Number of accounts and contracts		
Year	FCMs	SFs	IBs	Individual accounts	Institutional accounts	Contracts
1998	26	41	79	139,378	608	NA
1999	25	42	104	225,111	921	1,077,672
2000	25	25	100	303,438	1,604	1,926,789
2001	26	24	99	368,792	2,134	4,351,390
2002	24	20	87	566,311	2,691	7,944,254
2003	24	17	82	816,083	4,296	31,874,934
2004	23	16	77	1,016,348	5,351	59,146,376

Sources: TAIFEX Review, TAIFEX, Taiwan, 1998~2004.

Previous studies regarding Taiwan futures market are primarily concentrated on the issues of investigating the impacts of foreign investment liberalization on the price discovery

[1] The introducing brokers are securities firms contracted with FCMs so that the clients can place orders of futures via associated staff of securities firms. In addition, FCMs have to pay commission fees to the introducing brokers for each transaction.

function and volatility of markets, the behavior and performance of different trader types, as well as the price discovery of the index futures contracts (Chiang and Kuo, 2004; Lin et al., 2005; Chan et al., 2004). Though there have been many empirical researches studying economies of scale and scope in the banking and securities industries (e.g., Gilligan et al., 1984; Goldberg et al., 1991; Wang and Yu, 1995), empirical work concentrating on FCMs' economies of scale and scope is so far absent. This paper attempts to provide the first empirical analysis to investigate if FCMs in Taiwan are subject to economies of scale, which are evident when the firm's average cost declines as its output expands, and/or economies of scope, which appear when cost savings can be realized by a single firm providing several services jointly, as compared to many firms each specializing in a single service.[2] Hopefully, the results will be expected to provide a useful basis to discuss: (1) the magnitude of cost advantages associated with increasing firm sizes; (2) the range of the services FCMs can efficiently provide to customers; and (3) the economic rationales underlying FCMs' mergers and acquisitions.

The rest of this paper is organized as follows. Section 2 builds an empirical model composed of a translog multi-product cost function (TMCF) and its associated factor share equations. Data description, estimation procedures and empirical results are presented in Section 3. Section 4 concludes the paper.

2. The empirical model

According to the duality theory, cost and production functions which are dual to each other contain the same information regarding production possibilities given certain regularity conditions (Shephard, 1953). The structure of production can be studied empirically using either a production function or a cost function. Since functional forms developed for cost functions imply derived demand equations that are linear in the parameters, and at the same time represent very general production structures, estimation of the cost function is more attractive than direct estimation of the production function for studying the issues of economies of scale and scope.

Although there are a variety of flexible functional forms (e.g., generalized Leontief, translog, quadratic and CES) for empirical estimation of the production technology, the translog form proposed by Christensen et al. (1973) will be used in this paper due to its empirical practicality. The TMCF for futures commission merchants with *m* inputs and *n* outputs can be written as:

[2] Baumol et al. (1982) have shown that, in an unregulated market, the presence of multi-product firms is evidence of at least weak economies of scope over the set of products that they produce. In addition, Maurice et al. (1992, pp.624-636) also claim that many firms in the United States produce multiple products mainly because these products are complements in production or consumption.

$$\begin{aligned}\ln TC = \alpha_0 + \sum_i \alpha_i \ln w_i + \sum_k \beta_k \ln Q_k \\ + \tfrac{1}{2}\sum_i\sum_j \gamma_{ij} \ln w_i \ln w_j + \tfrac{1}{2}\sum_k\sum_l \theta_{kl} \ln Q_k \ln Q_l \\ + \sum_i\sum_k \delta_{ik} \ln w_i \ln Q_k, \quad i, j = 1,\dots,m, \quad k,l = 1,\dots,n,\end{aligned} \tag{1}$$

where $\gamma_{ij} = \gamma_{ji}$, $\theta_{kl} = \theta_{lk}$, TC is the total cost, Q_k is the level of the k^{th} output, and w_i is the price of the i^{th} input. Corresponding to a well-behaved production function, the TMCF must be linearly homogeneous in input prices. This requires the following parameter restrictions:

$$\sum_i \alpha_i = 1, \quad \sum_i \gamma_{ij} = \sum_j \gamma_{ij} = 0, \quad i, j = 1,\dots,m, \quad \sum_i \delta_{ik} = 0, \quad k = 1,\dots,n. \tag{2}$$

Though equation (1) contains all necessary information on the futures commission merchants' technology, additional equations summarizing the futures commission merchants' input choice need to be included in order to obtain accurate parameter estimates. Applying the Shephard's lemma directly to equation (1) yields *m* factor share equations as follows:

$$S_i = \frac{w_i X_i}{TC} = \frac{w_i(\partial TC/\partial w_i)}{TC} = \frac{\partial \ln TC}{\partial \ln w_i} = \alpha_i + \sum_j \gamma_{ij} \ln w_j + \sum_k \delta_{ik} \ln Q_k, \quad i = 1,\dots,m, \tag{3}$$

where S_i and X_i indicate, respectively, the cost share and the level of input usage of the i^{th} input. The set of factor share equations adds structural information but no additional unknown parameters. Equations (1)-(3) form a system to be estimated to explore the production properties of FCMs.

Ray scale economies (*RSCE*) are a straightforward extension of the concept of single-product scale economies and measure the proportional change in cost resulting from an equal proportional change in the levels of all outputs, holding the product mix unchanged. Therefore, the degree of ray scale economies is defined as:

$$\begin{aligned} RSCE &\equiv \sum_k SCE_k \\ &\equiv \sum_k \frac{\partial \ln TC}{\partial \ln Q_k}, \end{aligned} \tag{4}$$

where

$$\frac{\partial \ln TC}{\partial \ln Q_k} = \beta_k + \sum_l \theta_{kl} \ln Q_l + \sum_i \delta_{ik} \ln w_i, \quad k = 1,\dots,n. \tag{5}$$

SCE_k , the measure of the product-specific scale economies as described in Panzar and Willig (1977), indicates how costs change as the level of one output changes, holding the levels of all other outputs constant. SCE_k is greater than, equal to, or less than one as there are decreasing, constant, or increasing returns to scale with respect to the output *k*. Similarly, a value of *RSCE* greater than one indicates that total cost increases more than proportionately with scale, implying that firms are operating in the region of decreasing returns to scale; firms are operating in the region of increasing returns to scale for a value of *RSCE* less than one; returns to scale are said to be constant as *RSCE* is equal to one.

Economies of scope measure the cost advantages for firms' providing diversified outputs against specializing in the production of a single output (Panzar and Willig, 1981). That is, economies of scope exist when it is more economical or efficient to produce two or more outputs jointly in a single firm than to produce the outputs in separate specializing firms. Theoretically, interproduct cost complementarities are a sufficient, not a necessary, condition for economies of scope (Baumol et al., 1982). Interproduct cost complementarities can be examined by measuring the impact of a change in the level of one output on the marginal cost of the other output. Thus, the degree of interproduct cost complementarities is measured as:

$$C_{kl} \equiv \frac{\partial^2 TC}{\partial Q_k \partial Q_l} = \frac{TC}{Q_k Q_l}[\frac{\partial^2 \ln TC}{\partial \ln Q_k \partial \ln Q_l} + \frac{\partial \ln TC}{\partial \ln Q_k} \cdot \frac{\partial \ln TC}{\partial \ln Q_l}], \quad k,l = 1,\ldots n, \quad k \neq l. \quad (6)$$

where C_{kl} will have the same sign as the expression in the brackets. A negative derivative indicates that economies of scope exist.[3]

3. Data description, estimation procedure and empirical results

3.1 Data description

The data used in this paper are from the 2004 survey of FCMs in Taiwan, which was investigated by TAIFEX. The outputs of FCMs measured in terms of revenues are divided into two broad categories: brokerage service (including clearing and settlement service) (Q_A), as well as proprietary and other services (including management and consulting service) (Q_B). The inputs are categorized as labor, capital, and material, which were generally adopted in the theoretical and empirical frameworks in the existing literatures. Consequently, the price of labor (w_L) is measured by dividing annual labor expenditures (including salaries, pensions and fringe benefits) by the total number of employees, which is namely the average annual wage per employee. By referring to Muldur and Sassenou (1993), the price of capital (w_K) is approximately constructured by dividing capital expenditures (including rent, interest expenditures, depreciation and various amortizations and depletions) by the net fixed assets. The price of material (w_M) is approximately measured by dividing material expenditures (including expenditures on brokerage and proprietary services, and other operating expenditures) by the total operating revenues (Weng and Wang, 2006). Total cost (*TC*) is the sum of labor, capital and material expenditures. The labor cost share (S_L), the capital cost share (S_K) and the material cost share (S_M) are then defined, respectively, as labor expenditures, capital expenditures and material expenditures per dollar of total cost. After

[3] Baumol et al. (1982) have shown that interproduct cost complementarities are a sufficient, not a necessary, condition for economies of scope.

deleting unqualified and incomplete observations, the actual sample size for this paper is 22. The basic statistics of all relevant variables are listed in Table 2. The data are standardized by dividing each output and price variable by its mean to make the calculations of the measures of economies of scale and scope more tractable (Caves et al., 1980).

Table 2 The basic statistics of relevant variables

Variable	Mean	Std.
Revenues from Brokerage Service	484,021,075	370,578,545
Revenues from Proprietary and Other Services	73,282,575	184,187,968
Total Operating Revenues	557,303,650	511,818,607
Herfindahl Index (H)	0.8846	0.1634
Labor Cost	87,272,254	61,917,737
Capital Cost	18,619,900	13,404,252
Material Cost	74,526,110	62,873,427
Total Cost	180,418,265	134,116,183
Wage	950,599	185,432
Capital Price	1.6243	2.5720
Material Price	0.1662	0.0782
Share of Labor Cost	0.4876	0.0781
Share of Capital Cost	0.1070	0.0338
Share of Material Cost	0.4054	0.0861

Note: Revenues and expenditures are measured in terms of NT dollars.

To show the extent of FCMs' variability in regard to composition of two services, a scattered diagram where the values of H are plotted against FCMs' sizes measured by their total operating revenues is constructed in Figure 1, in which the value of the Herfindahl Index (H) is defined as the sum of the squared ratios of revenues from each service to total operating revenues. The concept of Herfindahl Index is used here to measure the degree of service concentration due to that it takes into account both the number of services and the inequality of services' revenue shares. Theoretically, the value of H lies between 0 and 1. Since FCMs in the sample provide all these two services, H actually has a range of 0.5 to 1. If a FCM's total operating revenue is spread equally across its two services, the value of H would be 0.5. Higher is the value of H, higher is the degree of service concentration. In fact, it is observed from Table 2 that the mean value of H is 0.8846, with the range being from 0.5067 to 0.9999, indicating considerable inequality in revenues across services. It seems to indicate that smaller and medium-sized FCMs are highly concentrated on a specific service; larger FCMs provide more diverse services.

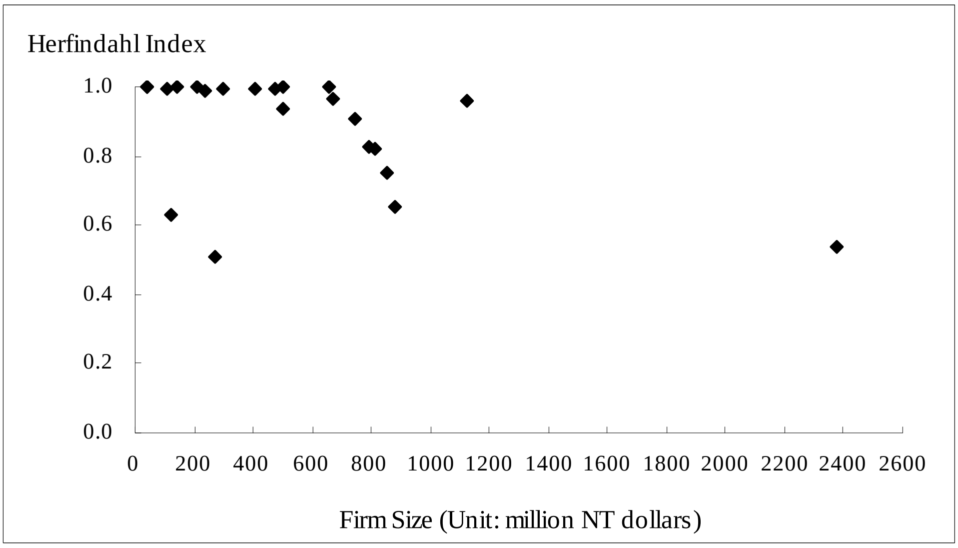

Figure 1 Service Concentration (measured as Herfindahl Index) vs. Firm Size

3.2 Estimation procedure

The TMCF and each of the factor share equations are specified with additive disturbances that are jointly normally distributed with a zero mean and constant variance. The disturbances are assumed to be contemporaneously correlated across equations. Accordingly, Zellner's seemingly unrelated regression (SUR) technique is used to estimate the system of equations (Zellner, 1962). Since the factor shares sum to unity, the variance-covariance matrix of disturbances across equations is singular. One of the factor share equations must be deleted from the system prior to estimation. Then, the Zellner's procedure is iterated until convergence to yield maximum-likelihood estimates (Kmenta and Gilbert, 1968), and to guarantee that the estimates are invariant to which equation is dropped (Barten, 1969, pp.24-25).[4] Since the results of the Zellner's procedure are maximum-likelihood estimates, the hypotheses based on various restrictions imposed on the production technology can be tested by using the likelihood ratio test.[5]

3.3 Empirical results

The parameter estimates, of which 15 are estimated directly and the remaining 6 are derived from the linear homogeneity restrictions, are presented in Table 3. The first-order parameters are all significant at the 0.01 level. The parameters that measure the interactions between input prices are significant at least at the 0.05 level except the parameter that

[4] In this paper, the cost of material equation is excluded from estimation.

[5] The likelihood ratio is $\lambda = (|\hat{\Omega}_R| / |\hat{\Omega}_U|)^{-T/2}$, where $|\hat{\Omega}_R|$ and $|\hat{\Omega}_U|$ represent the determinants of the restricted and unrestricted estimates of the disturbance covariance matrix, respectively; T is the number of observations. Theil (1971) has shown that the test statistic, $-2\ln\lambda$, is distributed asymptotically as Chi-squared with degrees of freedom equal to the number of independent restrictions being imposed.

measures the interaction between labor and capital prices. The parameters that measure the interactions between the output levels are all significant at the 0.01 level. The parameters that measure the interactions between outputs and input prices are insignificant except that two parameters measuring the interactions between the brokerage service output and labor price, as well as between the brokerage service output and material price are significant at the 0.01 level. Since all output and price variables are mean-scaled, the measures of *RSCE* and interproduct cost complementarities calculated at the mean levels of outputs and input prices are degenerated into $\sum_k \beta_k$ and $(\beta_k \cdot \beta_l + \theta_{kl})$, $k,l = A,B,\ \ k \neq l$, respectively. The computed measures of product-specific scale economies, *RSCE* and interproduct cost complementarities from the parameter estimates are given in Table 4.

Table 3 Parameter estimates of the TMCF model

Parameter	Estimate	Standard Errors
α_0	19.1831[aa]	0.0930
α_L	0.4504[aa]	0.0185
α_K	0.1047[aa]	0.0108
α_M	0.4449[aa]	0.0159
β_A	0.5518[aa]	0.1004
β_B	0.1016[aa]	0.0280
γ_{LL}	0.1510[aa]	0.0215
γ_{LK}	0.0104	0.0077
γ_{LM}	-0.1614[aa]	0.0182
γ_{KK}	0.0115[bb]	0.0052
γ_{KM}	-0.0219[aa]	0.0045
γ_{MM}	0.1833[aa]	0.0174
θ_{AA}	0.3802[aa]	0.1011
θ_{AB}	-0.0878[aa]	0.0157
θ_{BB}	0.0296[aa]	0.0048
δ_{LA}	-0.0621[aa]	0.0190
δ_{LB}	-0.0038	0.0045
δ_{KA}	-0.0150	0.0097
δ_{KB}	-0.0010	0.0025
δ_{MA}	0.0771[aa]	0.0174
δ_{MB}	0.0048	0.0040

Note: Significance levels are aa=1%, and bb=5% for two-tail tests.

Table 4 Economies of scale and scope estimates (calculated at the mean levels of input prices and outputs)

	Estimate	Standard Errors
SCE_A	0.5518[aa]	0.1004
SCE_B	0.1016[aa]	0.0280
$RSCE$	0.6534[aa]	0.0856
$\beta_A \cdot \beta_B + \theta_{AB}$	-0.0318[c]	0.0237

Note: Significance levels are aa=1% for two-tail tests; c=10% for one-tail tests.

The estimate of the product-specific scale economies calculated at the mean levels of outputs and input prices for each service is significant and less than one, implying that FCMs in Taiwan on average enjoy product-specific scale economies in providing each of the services. As to the individual FCM's overall economies of scale, the *RSCE* estimate also indicates that FCMs on average experience economies of scale. That is, an equal proportional increase in these two outputs results in a decline in ray average cost (Bailey and Friedlaender, 1982). Furthermore, the hypothesis of constant returns to scale can also be tested by using the likelihood ratio test. The hypothesis implies the following restrictions:

$$\sum_k \beta_k = 1, \quad \sum_k \theta_{kl} = \sum_l \theta_{kl} = 0, \quad k,l = 1,\ldots,n, \quad \sum_k \delta_{ik} = 0, \quad i = 1,\ldots,m. \tag{7}$$

As a result, the test statistics is 27.84, far exceeding the 1% critical Chi-squared value of 15.09 with five degrees of freedom. Hence, the hypothesis that FCMs in Taiwan operate in the region of constant returns to scale is rejected at the 0.01 level of significance. To explore how these scale economies vary with FCMs' sizes, a line diagram where product-specific scale economies and ray scale economies are plotted against FCMs' sizes measured by their total operating revenues is constructed in Figure 2. The degrees of ray scale economies and the scale economies specific to any service seem to be independent of FCMs' sizes. However, the degrees of ray scale economies and the scale economies specific to the brokerage service rise as firm sizes increase for FCMs with total operating revenue above 800 million NT dollars. In other words, the overall cost advantages and cost savings from providing brokerage services decrease with operating scales for relatively larger FCMs.

The estimate of $(\beta_A \cdot \beta_B + \theta_{AB})$ is negative at the 0.1 level of significance.[6] The negative value of $(\beta_A \cdot \beta_B + \theta_{AB})$ indicates that cost savings can be realized while FCMs engage in joint production of brokerage service, as well as proprietary and other services.

6 The null hypothesis of $(\beta_k \cdot \beta_l + \theta_{kl}) = 0$, $k,l = A,B$, $k \neq l$, is also tested by the likelihood ratio test, and the same result is obtained.

That is, the interproduct cost complementarities and economies of scope between these two services do exist. The cost advantages in providing these two services are derived from cost savings when common inputs are shared, or fixed (or quasi-fixed) costs are spread over an expanded product mix due to the presence of excess or idle capacity. The interproduct cost complementarities of these two services for each FCM are also computed and plotted against FCMs' sizes in Figure 3. It also supports the above empirical evidence of cost complementarities. In addition, it is worthnoting that though there is unapparent relationship between interproduct cost complementarities and FCMs' sizes, it seems to indicate that cost savings realized from the joint production of brokerage service, as well as proprietary and other services are substantial for small-sized FCMs. However, the cost advantages from joint production of these two categories of services appear to be exhausted for relatively larger FCMs.

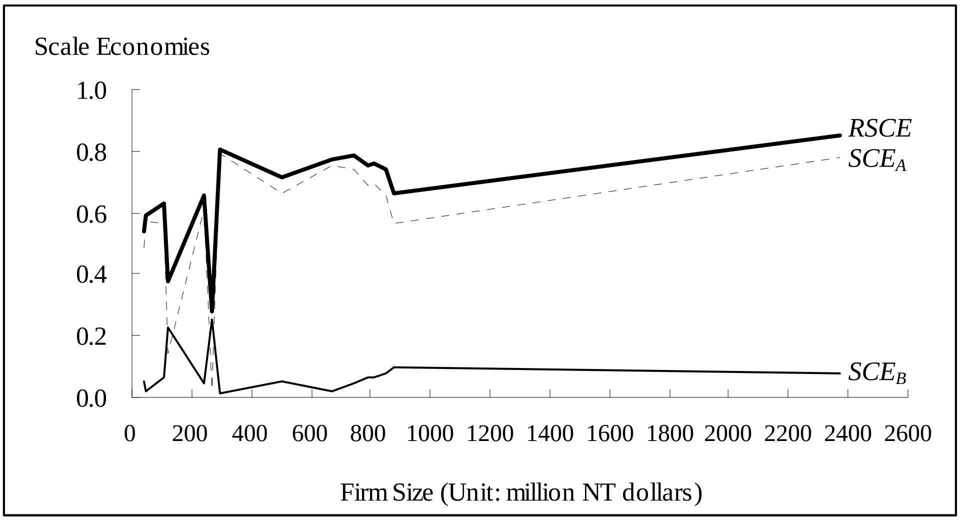

Figure 2 Scale Economies vs. Firm Size

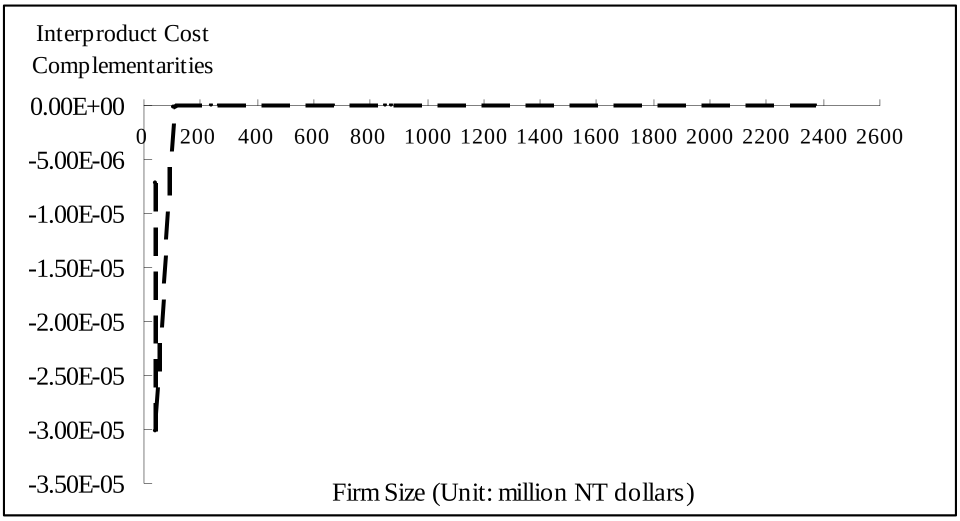

Figure 3 Interproduct Cost Complementarities vs. Firm Size

4. Conclusions

Electronic access, solid performance by managed funds, market volatility, and deregulation in financial markets have all contributed to a spectacular rise in futures trading volume in Taiwan. Though Taiwan futures exchange has enjoyed overall market growth for the past five years, the primary concern for FCMs in Taiwan is how to make their business cost-effective when confronting with the pressure on commission and intense competition. The purposes of this paper try to study the cost properties of FCMs in Taiwan and to investigate if they are operating with efficient scales, offering proper product mixes, and/or moving in the right direction.

Based on the survey data of Taiwan's FCMs in 2004, this paper applies Zellner's SUR technique to a simultaneous system of a TMCF and its corresponding factor share equations to investigate the extents of scale and scope economies of Taiwan's FCMs. The empirical results show that product-specific scale economies exist for brokerage service, as well as proprietary and other services. Ray scale economies are significantly present. However, the overall cost advantages and cost savings from providing brokerage services decrease with operating scales for relatively larger FCMs. Economies of scope exist in providing brokerage service as well as proprietary and other services jointly. Furthermore, the degrees of scope economies are significant for small-sized FCMs while they are not for relatively larger FCMs.

It is known from Figure 1 that smaller and medium-sized FCMs are highly concentrated on a specific service. The empirical evidence of this paper clearly indicates that economies of scale and scope offer substantial incentives for mergers or acquisitions among smaller and medium-sized FCMs. Cost advantages can be realized through mergers or acquisitions by expanding firm sizes and engaging in the joint production of brokerage services as well as proprietary and other services. Just as the financial reform conducted in 2004 in Taiwan that the government encouraged further mergers among financial holding companies to enlarge their scales and competitiveness, the same policy may also be applied to this industry for smaller-sized FCMs to generate scale economies and operational synergies across business. Finally, it is worth noting that the empirical evidence concerning FCMs' scale and scope economies is based on a broader output classification. The interpretations about product-specific scale economies and interproduct cost complementarities may be somewhat restricted.

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