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Firm Interdependency in a Mixed Oligopolistic Market

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Abstract

This paper uses data from Taiwan's banking sector to investigate whether state-owned banks can serve as an internal regulation mechanism to sustain market competition. In contrast to the traditional second-best literature, the evidence shows that a certain degree of market coordination exists in the industry, even though the government owns most of the dominant banks in Taiwan.

Keywords: state-owned banks, market coordination, conjectural variation

JEL Classification: L13

I. Introduction

Many studies focusing on the issue of banking market competition in the empirical literature are based on data from the United States, United Kingdom, and Canada. As opposed to the Anglo-Saxon financial system founded on private ownership of banks, in most developing countries the state owns the majority of the banks and controls a significant portion of the financial system's assets. According to Beck et al. (1999), state-owned bank assets constitute over 70 % of commercial bank assets in low-income countries, and their share is around 40 % in middle-income countries.[1] However, not too much attention has been given to the effect of such ownership settings on market competition in both the public economics and industrial organization literature. This article aims to provide an empirical study to detect the differences in competitive behaviors between state-owned banks and private banks.

Aspects of ownership are frequently explored in the literature, often concluding that professionally-managed banks are more profit-oriented than state-owned

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[1] A bank is categorized as state-owned if at least 50% of the equity is held by the government.

banks, in which profit maximization is not the main goal.[2] This line of reasoning builds on the second-best literature [Beato and Mas-Collel (1984), Cremer et al. (1989), De Fraja and Delbono (1990), and Barros and Modesto (1999)]. For instance, Barros and Modesto (1999) provide an empirical study of the Portuguese banking sector and find that state-owned banks tend to provide loans at lower interest rates. In particular they propose that state-owned banks could be instructed to maximize social welfare and could serve as a policy instrument for the government to regulate an imperfect competitive market. This kind of policy might help to prevent the rent-seeking behavior of a private bank cartel.

Although public banks' objective may be aligned by large with social welfare maximization, a criticism often made of public ownership is that the monitoring system is too poor, leaving managers with considerable discretion to pursue their personal agendas. The personal agenda could consist of a variety of elements. One of them is to avoid the stiff competition from their competitors so as to make the management easier and enterprise performances superior. Vickers and Yarrow (1991) indicate that managers of state-owned enterprises are typically responsible to political decision makers, who might not be very concerned about the social welfare objective of public firms and lack strong incentives to monitor enterprise management. However, some enterprise performances (like plant closures) tend to be very sensitive politically, and may become a priority item on political agendas. In order to avoid outlet closures or even bankruptcy public enterprises' managers may want to avoid stiff market competition. Hence, collusive outcome may also prevail in mixed oligopolies. For instance, Connor (2004) indicates that some cartels are organized by state agencies or government-owned corporations. Azzam and Anderson (2002) use data from the Swedish beef industry and find that the hypothesis of price-taking behavior is rejected for public firms, but not for private firms.

Based on this line of argument, the central point of this paper is to propose a kind of test to determine whether state-owned firms have conjectures which support collusive like outcomes. The empirical study is conducted under the structure of a conjectural variation model based on the pioneering work of Spiller and Favaro (1984). The data are from Taiwan's commercial banking sector. The main advantage of this dataset is that it includes all the banks in the sector.[3] This is of great importance especially when analyzing the type of ownership and its effect on market competition. Based on the conjectural approach, this dataset is used to test whether state-owned banks behave less aggressively (i.e. a smaller output and a higher price) and reach a more collusive equilibrium behavior. The empirical evi-

[2] If the state-owned banks are instructed to maximize an objective function that is different from profit maximization, then public banks' strategy might affect their rival private banks' behaviors and, consequently, the market outcome.

[3] The data are similar to the FDIC data file in the United States, but our advantage is that Taiwan's banking sector is far more homogeneous.

dence is employed to interpret firm interdependency in a mixed oligopoly. If the evidence shows that a certain degree of market coordination exists among state-owned banks and private banks, then state-owned banks might not be used as a regulatory intervention in the banking market to maximize social welfare.

The empirical result shows that Taiwan's state-owned banks neither serve as a policy tool to correct market failures nor provide a socially optimum quantity of loans. In fact, a certain degree of collusiveness exists in the industry even if the government owns most of the dominant banks. This evidence is contrary to the presumption that public firms can be used as an internal regulation mechanism to enhance market competition. It is nevertheless consistent with the findings of Ma and Hung (2001), who choose 109 Taiwanese cartel cases and use probit analysis to investigate what structural factors – such as firm size, industry concentration, ownership, etc. – can account for the guilty or not guilty decision made by Taiwan's Fair Trade Commission. They find that the ownership of firms cannot be used to explain if the cartel is sustained or not. In other words, the probability of state-owned firms to be guilty of collusion is as much as that for private firms.

The paper is organized in the following manner. Section II describes Taiwan's banking sector. The model is described in Section III. Section IV describes data construction and sources. Section V presents the empirical results and analyzes the pattern of conjectures in the industry in general and within and across given groups. Section VI concludes the paper.

II. The Taiwanese Banking Sector: An Overview

Taiwan is a small island, roughly the size of Maine or West Virginia in the U.S., in which all banks compete directly in the national market. The industry consists of state-owned and private banks. The two groups have different legal status, but banking products tend to be homogeneous within the network of each bank. These banks can thus be considered to be operating in the same deposit and loan market.

Although Taiwan's banking sector contains 51 commercial banks, the leading eight firms account for 51 % of the industry's outstanding loans. The sizes of state-owned banks are much larger than private banks. The former group consists of 11 banks with average assets of 700 billion NTD (21 billion USD). The latter contains 40 banks with average assets of 150 billion NTD (4.5 billion USD). Table 1 shows that all state-owned banks fall into the cluster of the twenty largest banks. The largest private bank is merely ranked 8th among these dominant banks. Hence, the average size of banks differs markedly across the two different groups.

Table 1

Market Share of the Twenty Largest Banks

(Ranked by Outstanding Loans)

1st	Bank of Taiwan	9.07 %	*	11th	Transportation Bank	2.97 %	*
2nd	Cooperative Bank	8.22 %	*	12th	Taipei-Fubon Bank	2.72 %	*
3rd	Land Bank	7.98 %	*	13th	Chinese Farmer's Bank	2.48 %	*
4th	First Bank	5.92 %	*	14h	Taishin Bank	2.18 %	
5th	Huanan Bank	5.67 %	*	15th	Bank of Taipei	1.61 %	
6th	Chung-Hwa Bank	5.44 %	*	16th	Hsinchu Bank	1.53 %	
7th	Taiwan Business Bank	4.60 %	*	17th	E. Sun Bank	1.38 %	
8th	Chinatrust bank	3.95 %		18th	Bank Sinopac	1.36 %	
9th	ICBC	3.62 %	*	19th	Shanghai Bank	1.35 %	
10th	Cathay United Bank	3.22 %		20th	Da-An Bank	1.20 %	

Notes: * denotes state-owned banks. For each banks, the market share is calculated by averaging the outstanding loans in the period of 1999:7 through 2004:12.

Source: Data Bank of Taiwan Economic Journal.

III. The Model

This model is essentially the same as Spiller and Favaro (1984). However, in their model, a firm's conjecture about rivals' reactions depends only on the sizes of the firms under consideration. In this model, the conjecture or expected retaliation may depend as well on the ownership of the firms.

Firstly, assume that banks compete in market share by changing the quantity of loans supplied and deposits solicited. Consequently, in the model to follow I specify conjectures to be formed in terms of quantities. Consider a banking sector with n banks producing a homogeneous output and facing a demand function given by

$$P_t = P(Q_t) = P\left(\sum_{i=1}^{n} q_{it}\right) ,$$

where P_t is the price, Q_t is the total quantity, and q_{it} is the ith bank's output at time t. Each bank attempts to maximize profits $\pi_{it} = P_t q_{it} - C(q_{it})$, where $C(q_{it})$ is the total cost for bank i.

Given these assumptions, the first-order condition for the ith bank can be expressed as:

$$P_t + q_{it}\frac{\partial P_t}{\partial Q_t}\left(1 + \sum_{j \neq i}^{n} \frac{\partial q_{jt}}{\partial q_{it}}\right) - MC_{it} = 0 , \tag{1}$$

where MC_{it} is the marginal cost. Most oligopoly models stress that, in an industry characterized by a homogeneous product market, a firm's conjecture about rivals'

reactions depends on the relative size of the firm under consideration.[4] This requires the transformation of the conjecture to the following elasticity form:

$$\frac{\partial q_{jt}}{\partial q_{it}}\frac{q_{it}}{q_{jt}} = \lambda_{ji} + \delta_{ji}\, m_{it} \ , \tag{2}$$

where λ_{ji} and δ_{ji} are constant across time, and $m_{it} = \dfrac{q_{it}}{Q_t}$ is bank i's market share.

By substituting (2) into (1), the first-order condition can be written as:

$$\frac{MC_{it}}{P_t} = 1 + \frac{1}{\varepsilon}\left[m_{it} + \sum_{j\neq i}^{n}\left(\lambda_{ji}\, m_{jt} + \delta_{ji}\, m_{it}\, m_{jt}\right)\right] \ , \tag{3}$$

where $\varepsilon = \dfrac{\partial Q}{\partial P}\dfrac{P}{Q}$ is the demand elasticity. If there are homogeneous expectations across banks, then $\lambda_{ji} = \lambda_{ij} = \lambda$ and $\delta_{ji} = \delta_{ij} = \delta$.[5] The individual supply equations in (3) can be weighted by market share (m_{it}), and after added up, the industry supply relationship becomes:

$$\sum_{i=1}^{n} m_{it}\left(\frac{P_t - MC_{it}}{P_t}\right) = -\frac{1}{\varepsilon}\left[\lambda + (1+\delta-\lambda)H_t - \delta\sum_{i=1}^{n} m_{it}^3\right] \ , \tag{4}$$

where $H_t = \sum_{i=1}^{n} m_{it}^2$ is the Herfindahl index of industry concentration. The left-hand side of the equation is the weighted average price-cost margins at the industry level.

If I were interested only in estimating a conjectural variation model of the industry structure based on and in the spirit of oligopolistic interdependence, then it would be sufficient to test if the conjecture of a bank varies across its size. The relevant conjecture for firm i could become $\lambda + \delta\, m_{it}$. However, since I am interested not only in the existence but in the pattern of interdependence, it is necessary to distinguish the differences in conjecture between state-owned banks and private banks. Thus, one can divide the banks into two groups – called S (for state-owned banks) and P (for private banks).

A bank's conjecture regarding its rival's reaction depends on its size as well as the groups to which it and its rivals belong. Thus, I have:

$$\lambda_{ss} + \delta_{ss} m_{it}, \quad \lambda_{ps} + \delta_{ps} m_{it}, \quad \lambda_{pp} + \delta_{pp} m_{it}, \quad \lambda_{sp} + \delta_{sp} m_{it} \ , \tag{5}$$

where subscripts s (state-owned) and p (private) represent the group to which the bank belongs. For instance, $\lambda_{ss} + \delta_{ss}\, m_{it}$ is the conjecture of a state-owned bank i

[4] See Gollop and Roberts (1979), Spiller and Favaro (1984), and Berg and Kim (1994).

[5] Under such a situation, (3) could be written as $\dfrac{MC_{it}}{P_t} = 1 + \dfrac{1}{\varepsilon}\left[m_{it} + \lambda(1 - m_{it}) + \delta m_{it}(1 - m_{it})\right]$.

concerning about another state-owned bank's reaction, and $\lambda_{ps} + \delta_{ps} m_{it}$ is its conjecture about a private bank's reaction. Note that in the models of Gollop and Roberts (1979), Spiller and Favaro (1984), and Berg and Kim (1994), a firm's conjecture about rivals' reactions depends only on the sizes of the firms under consideration. In our model this conjecture or expected retaliation may depend as well on the ownership of the firms. Thus, each firm has a distinct conjecture depending on both its size and the groups to which it and its rivals belong.

As in Spiller and Favaro (1984), the first-order condition of a state-owned bank can be obtained by rewriting (3) as:

$$\frac{MC_{it}}{P_t} = 1 + \frac{1}{\varepsilon}\left[m_{it} + \lambda_{ss}(M_{st} - m_{it}) + \delta_{ss} m_{it}(M_{st} - m_{it}) + \lambda_{ps}(1 - M_{st}) + \delta_{ps} m_{it}(1 - M_{st})\right] \quad \text{for} \quad i \in S\ , \tag{6}$$

where $M_{st} = \sum_{i \in S} m_{it}$. By weighted averaging (6) for $i \in S$, the supply relationship for the group of state-owned banks becomes:

$$\sum_{i \in S} \frac{MC_{it}}{P_t} \frac{m_{it}}{M_{st}} = 1 + \frac{1}{\varepsilon}\left[M_{st} H_{st} + \lambda_{ss} M_{st} - \lambda_{ss} M_{st} H_{st} + \delta_{ss} M_{st}^2 H_{st} + \lambda_{ps}(1 - M_{st}) - \delta_{ss} \sum_{i \in S} \frac{m_{it}^3}{M_{st}} + \delta_{ps} H_{st} M_{st}(1 - M_{st})\right] \quad \text{for} \quad i \in S\ , \tag{7}$$

where $H_{st} = \sum_{i \in S} \left(\frac{m_{it}}{M_{st}}\right)^2$. In the similar way, one can get the supply relation for the group of private banks:

$$\sum_{i \in P} \frac{MC_{it}}{P_t} \frac{m_{it}}{M_{pt}} = 1 + \frac{1}{\varepsilon}\left[M_{pt} H_{pt} + \lambda_{pp} M_{pt} - \lambda_{pp} M_{pt} H_{pt} + \delta_{pp} M_{pt}^2 H_{pt} + \lambda_{sp}(1 - M_{pt}) - \delta_{pp} \sum_{i \in P} \frac{m_{it}^3}{M_{pt}} + \delta_{sp} H_{pt} M_{pt}(1 - M_{pt})\right] \quad \text{for} \quad i \in P\ , \tag{8}$$

The following demand relationship is estimated using time series data for the same period:

$$\log Q_t = \alpha + \varepsilon \log P_t + \gamma \log(GNP_t)\ , \tag{9}$$

where *GNP* is gross national product in fixed prices. The model includes two supply equations ((7) and (8)) and one demand equation (9), with only ε being a common parameter. This means that one has to restrict ε to be the same across equations in the estimation of the model. Each supply relation contains five parameters and five linearly independent regressors. To avoid simultaneity bias caused by the endogeneity, I estimate the model using the Generalized Method of Moments

(GMM). Eight instruments are selected to serve as exogenous variables: industrial production, M2 money supply, amount of direct balance, foreign exchange reserves, exchange rates, stock price index, rediscount rate, and construction permits. Most of these variables are financially related indicators. Although the instruments do not have to be free of errors, they have two advantages. Firstly, they are uncorrelated with the disturbance term. Secondly, they are highly correlated with the variable they are instrumenting for.

The second-best literature worries that private firms might behave non-competitively, leading to a market failure. Hence, these studies suggest that the first best allocation can be achieved if public firms can compute the competitive price in the industry and make up any difference between the corresponding output and private firms' output [see, e.g. Harris and Wiens (1980), Rees (1984), and Cremer et al. (1989)]. Hence, state-owned banks should behave aggressively and choose a larger output as well as lower price.

However, if our empirical evidence shows that state-owned banks behave less aggressively and choose a smaller output as well as higher price, then one can claim that the second-best solution is not acceptable in Taiwan's banking sector.

IV. Data

The data required to estimate equations (7), (8), and (9) must provide time series for each bank. For each period, I need information on the output, price, and marginal cost of each bank. Although a bank is a multi-product firm, this article defines banking as one that produces domestic currency loans and ignores other operations for the sake of data limitation. Thus, this article is dealing with a subset of the multiple activities that Taiwanese banks perform.[6]

For each bank, I collect the information on outstanding loans at the end of each month (measure of output, Q_t), which are used to calculate market share (m_{it}) for each bank and the Herfindahl index (H_t) for the industry. I also collect the ratio of the interest income to total loans (measure of price, P_t) and ratio of interest expenses to total deposits (measure of marginal cost, MC_{it}).[7] All data are obtained from the data bank of Taiwan Economic Journal (TEJ, hereafter).

As to the limitation of the data, this paper assumes that loans in Taiwan are a homogeneous product, i.e. that prices across all banks are identical. However, besides that there is evidence that banks compete on prices rather than quantities (Barros and Modesto, 1999), our price and *MC* are also likely to be measured with

[6] It is also likely that banks of different scales specialize in different clients as the market segmentation hypothesis claims.

[7] Due to the lack of data on the wage rate and rental rate of capital, etc., this article uses funding cost as the marginal cost of a bank by following Spiller and Favaro (1984) and Ruthenberg and Elias (1996).

errors.[8] Auspiciously, Spiller and Favaro (1984) argue that there does not exist strong evidences that this might cause a serious bias in estimates.

The sample used to estimate the regression models covers the monthly data of 51 domestic commercial banks in Taiwan for the period 1999:7 through 2004:12.[9] Foreign banks are excluded from the sample, because they have product mixes distinctly different from domestic banks; in particular, their share of home loans is very low. Altogether the panel data are made up of 3,271 observations starting with 51 banks in 1999 and declining somewhat to 45 banks in 2005 as a reflection of the significant consolidation. The dataset is not adjusted for bank mergers, i.e. two merging banks are treated as separated banks up to the date they merge from where on only the "takeover" bank is accounted for.[10]

V. Empirical Results

Table 2 presents the results of estimating equations (7), (8), and (9). In all cases the standard errors are corrected for conditional heteroscedasticity and serial correlation.[11] The estimated price elasticity of –0.6 indicates that the increases in interest rate for loans (P) result in lower sales (Q).[12] The income-elasticity of 0.49 is less than one such that demand is income-inelastic. This estimate somewhat contrasts with the expectation that the loan demand should exhibit income-elastic property. The reason why demand increases less than proportionately to income might be that this article is only dealing with a subset of a bank's multiple activities (indirect finance services). However, banks in Taiwan provide numerous direct finance services not included in our analysis. Since direct finance (investment banking) is becoming more important than indirect finance (commercial banking) as a source of business finance, one can expect that the demand for loan is substi-

8 See footnote 7.

9 The bank data of TEJ begin from July 1999. Since, in 2005, the Taiwanese government began the second financial reform to privatize the state-owned banks and reduced the number of the state-owned banks from 11 to 6 within 2 years, the sample period ends in 2004.

10 This article does not adjust the sample for mergers. Thus, there might exist a correlation between banks' exit (e.g. merging) and their ability to sustain more or less explicit collusive agreements. A further possible robustness check would be to estimate the model on a sub-sample basis, in which one considers only those banks that were always present in the market and checks if the estimates of the parameters change or not. However, the Taiwanese government did not allow new entry in the banking market until the 1990s such that most of the private banks opened their business in the 2000s. Besides, mergers mainly occur between private banks. If one estimates the model on a sub-sample basis in which one considers only those banks that were always present in the market, then the sub-sample would be composed mainly by public banks. There are only 3 private banks still remaining in the sample. Thus, it is infeasible to conduct such kind of robust test.

11 See White (1980).

12 The value of 0.6 is lower than 1.9 of European banking market (Shaffer, 2001), but higher than 0.3 of the US market (Berg and Kim, 1994).

tuted by the demand for direct financing. Thus, one observes that banks face a low income elasticity of their loan products.

Cournot Conjectures. Given the results of Table 2, I now evaluate the pattern of interdependence among banks, and begin with a Cournot model, in which all conjectures are zero. A bank may make a production decision without taking account of its rivals' potential reactions or, more formally:

$$\lambda_{ss} = \lambda_{pp} = \lambda_{ps} = \lambda_{sp} = \delta_{ss} = \delta_{pp} = \delta_{ps} = \delta_{sp} = 0 \ .$$

The test is performed using the likelihood ratio test, and the null hypothesis is rejected at the 99 % level. The calculated χ^2 statistic is 261.25. One can conclude, at a minimum, that at least some banks do incorporate into their decision process their rivals' expected reactions.

Table 2

Estimated Coefficients of the Conjectural Elasticity Model

Coefficient	Estimate	Asymptotic Standard Error
State-owned Banks $\left(\text{Dependent Variable: } \sum_{i \in S} \frac{MC_{it}}{P_t} \frac{m_{it}}{M_{st}}\right)$		
λ_{ss}	1.10*	0.36
δ_{ss}	–7.97*	4.03
λ_{ps}	0.47	0.29
δ_{ss}	–19.75*	6.86
Private Banks $\left(\text{Dependent Variable: } \sum_{i \in P} \frac{MC_{it}}{P_t} \frac{m_{it}}{M_{pt}}\right)$		
λ_{pp}	1.74	1.52
δ_{pp}	–95.40	128.33
λ_{sp}	–1.24	1.36
δ_{sp}	68.67*	20.23
Demand Equation		
ε	–0.60*	0.14
γ	0.49*	0.08

Notes: * Denotes that the estimate is significant at the level of 1 %.

Homogeneous Expectations. I next test the restriction that the conjectures are the same across two groups (the homogeneous model presented in (4)). The joint hypothesis becomes $\lambda_{ss} = \lambda_{pp}$, $\lambda_{ps} = \lambda_{sp}$, $\delta_{ss} = \delta_{pp}$, and $\delta_{ps} = \delta_{sp}$. The analogue of the likelihood ratio test is 37.98 and, relative to the critical χ^2 value of 13.28, is significant at the 99 % level. The hypothesis that all the parameters are the same

across two groups is rejected. This result indicates that differences exist in conjecture patterns between state-owned banks and private banks.

For the measurement of the conjectures, one has to consider the market shares of both those banks initiating the market change as well as the responding ones.[13] For instance, the fact that $\hat{\lambda}_{ss} < \hat{\lambda}_{pp}$ does not necessarily mean that banks in the state-owned group behave less cooperatively than private banks, because state-owned banks are generally larger than private banks.

Theoretical Predictions and Hypotheses to be Tested. Before I further my presentation, I first elucidate the proposition of New Empirical Industrial Organization (NEIO) School on a firm's conjecture in a homogeneous good oligopoly model. In this class of models a firm's conjectures about its rivals' reactions are modeled in terms of the firm's position in the size distribution. For instance, Spiller and Favaro (1984) divide an industry into the dominant group and a fringe. They find that a dominant firm expects strong retaliations from other dominant firms if it expands output. On the other hand, a dominant firm expects fringe firms to reduce their output when it expands its output. Similar findings are also reported in Gollop and Roberts (1979) and Berg and Kim (1994). In order to test whether state-owned firms have conjectures which support collusive like outcomes, the hypothesis can be stated as follows.

If the empirical evidence shows that the pattern of conjectures is in the form of:

$$(10) \qquad \lambda_{ss} + \delta_{ss}\, m_{it} > 0, \quad \text{and} \quad \lambda_{ps} + \delta_{ps}\, m_{it} < 0 \quad \text{for} \quad i \in S\ ,$$

then one can claim that a certain degree of collusiveness exists in Taiwan's banking sector, even if most of the dominant banks are owned by the government. This can be illustrated as follows.

Since in Taiwan, the sizes of state-owned banks are much larger than private banks,[14] all state-owned banks fall into the dominant group, and most private banks are in the fringe group. In an oligopolistic industry with a certain degree of collusiveness, a firm in the dominant group (state-owned bank) expects retaliations from other dominant firms (state-owned banks) if it expands output. Thus, a positive value of $\lambda_{ss} + \delta_{ss}\, m_{it}$ captures a state-owned bank's belief that other state-owned banks will respond aggressively to any attempt by it to increase its output. Such belief leads it to less aggressively behavior, i.e. a smaller output and a higher price. This, in turn, leads to a more collusive equilibrium.

On the other hand, a negative value of $\lambda_{ps} + \delta_{ps}\, m_{it}$ means that a dominant firm (state-owned bank) expects fringe firms (private banks) to reduce their output when it expands its output. This belief is based on the grounds that output expan-

[13] If $\hat{\delta}_{ij} \neq 0$, then banks of different sizes have different expectations regarding the responses of their rivals.

[14] See Section II.

sion by a state-owned bank might lower prices, all else being equal, and this should lead to an output reduction by private banks. State-owned banks in the dominant group do not worry about retaliations from private banks, since their capacities are relatively small.

Firm Interdependency. I now insert estimated coefficients into (5) and compute the conjectural elasticity for the mean, 90th, and 10th percentile firms, which are listed in Table 3. Note that the effect of the market share on conjectures is put into consideration in creating such evidence.

On average, a state-owned bank expects the other state-owned banks to increase their output by 0.68 % for every 1 % expansion of their own. The evidence shows that state-owned banks are expected to behave as an implicit or explicit cartel vis-à-vis the other banks in their own groups no less than the way an ordinary private cartel behaves. In essence, state-owned banks fail to act as an internal regulation mechanism to protect and uphold market competition. Secondly, the larger state-owned banks anticipate a lower retaliatory output expansion than the smaller ones. For instance, a 90th percentile state-owned (large) bank with 9 % share of the overall market would expect the other state-owned banks to increase their output by 0.43 % for each 1 % expansion of its own. However, a 10th percentile bank with a market share of 2.33 % would expect the other banks to increase their output by 0.90 %. This constitutes a strong deterrent for the output expansion of small state-owned banks.

As to the conjectures of state-owned banks with respect to the reactions of private banks, one can find that the larger state-owned banks behave like von Stackelberg leaders *vis-à-vis* the private banks. For instance, a 90th percentile state-owned bank expects the private banks to contract by 1.18 % for each 1 % expansion of its own.[15] However, for a 10th percentile bank, its conjecture is quite low and statistically insignificant from 0. Smaller state-owned banks expect little if any reaction from private banks. The evidence indicates that Taiwan's state-owned banks behave exactly the way NEIO predicts in a dominant cartel model.[16]

Among the private banks, banks' conjectures' about other banks' retaliatory output expansions are not significantly different form zero. Hence, private banks expect little reaction from other banks in their own group. As to the conjectures of private banks with respect to the reactions of state-owned banks, a 90th percentile private bank expects state-owned banks to increase their output by 0.08 % for each 1 % expansion of its own. However, the conjecture of a 10th percentile private bank is not significantly different from 0. In our sample, most of the private banks are small with respect to market share by comparison and would not expect reactions from state-owned banks, except that some large private banks might hold the con-

[15] The state-owned bank conjecture of small private banks is negative, provided that the bank has a market share higher than 2.3 %.

[16] See Spiller and Favaro (p. 251, 1984).

sensus to coordinate the market behaviors and indeed be concerned about the reactions of state-owned banks. The consensus of coordination is not industry-wide and exists among state-owned and large private banks. However, small private banks are excluded from the market coordination. This makes up a typical incomplete cartel, in which large firms cooperate, while the small fringe firms are ignored by dominant firms.[17]

Table 3

Estimated Conjectures (Unit: %)

	Mean bank	90th percentile (large) bank	10th percentile (small) bank
State-owned banks			
$\lambda_{ss} + \delta_{ss}m$	0.68*	0.43*	0.90*
	(0.09)	(0.20)	(0.19)
$\lambda_{ps} + \delta_{ps}m$	–0.56*	–1.18*	0.004
	(0.21)	(0.37)	(0.005)
Private banks			
$\lambda_{pp} + \delta_{pp}m$	0.74	0.13	1.51
	(0.83)	(0.16)	(1.46)
$\lambda_{sp} + \delta_{sp}m$	0.03	0.08*	–1.07
	(0.03)	(0.03)	(1.31)

Notes: The figures in brackets are asymptotic standard errors, which are estimated by the delta method. [See Green 2003, pp. 172 – 173]. * denotes that the estimates are significant at the 1% level.

The empirical evidence reveals that a certain degree of market coordination exists in Taiwan's banking industry and rejects the hypotheses of the second-best literature, even if some banks are owned by the government. Here, this paper does not attempt to draw a borderline between the legal market coordination (conscious parallel behavior) and illegal cartel behavior.[18] I simply let data speak out and estimate a positive conjecture among the group of state-owned banks. The significantly positive conjecture illustrates a state-owned bank's belief that other state-owned banks will respond aggressively to any attempt by it to increase its output.[19] Such a belief leads state-owned banks to less aggressive behaviors, i.e. a smaller output and a higher price. The expectation of an aggressive rival response actually leads to more collusive equilibrium behavior.

[17] Several textbooks contain such an incomplete cartel model and elucidate the reasons why it is advantageous to leave out the fringe firms. See, for example, Blair and Kaserman (1985).

[18] A cartel is illegal in Taiwan, but the banking industry has not been involved in any cartel case since the Taiwanese Fair Trade Act was enacted in 1992.

[19] This mechanism worked through the channel whereby if output expansions were observed by other banks, then they might produce at full capacity and the intensity of market competition might increase. Subsequently, prices might fall down and banks end up with lower profits or even losses.

VI. Conclusion

This article conclusively obtains the following evidence: 1) one can reject a model with homogeneous conjectures across two groups of banks; 2) however, one cannot reject the hypothesis that state-owned banks behave as an implicit or explicit cartel *vis-à-vis* the other state-owned banks and large private banks; 3) one also cannot reject a von Stackelberg type model in which state-owned banks behave as dominant ones *vis-à-vis* the private banks and in which small private banks do not expect a large retaliation from either state-owned banks and / or other private banks. This pattern of conjecture is similar to the oligopolistic interdependency predicted by NEIO even though most dominant banks are owned by the government.

The second-best literature concerns that private firm's non-competitive conducts might lead to a market failure and suggests that the first best allocation can be achieved if public firms can compute the competitive price in the industry and make up any difference between the corresponding output and private firms' output. Hence, this line of argument emphasizes that state-owned banks should behave aggressively and choose a larger output as well as lower price. However, this paper shows that state-owned banks behave less aggressively and choose a smaller output as well as higher price than under Cournot competition. The evidence indicates that the second-best solution is not acceptable in Taiwan's banking sector.

Where to go from here? I believe that two next steps will extend the study on firm interdependency in a oligopolistic market. The first step should go in the direction of investigating the role of conjectural variation in analysis of collusion in repeated games. However, the repeated game with trigger strategies is dynamic, while the conjectural variation model is clearly static. Hence, there might be a potential bias when the dynamic payoff is calculated based on estimates from a static model. For instance, Corts (1999) examines this conjectural variation method and argues that the static parameter does not accurately measure market power in a dynamic oligopoly model. However, Pfaffermayr (1999) indicates that conjectural variation model can indeed be interpreted as a reduced form of an infinitely repeated game such that there exists a relation between conjecture and firm's discounting factor. This relation in turn determines the likelihood of collusion. It not only gives a theoretical basis for empirical research, but also provides an enhanced menu of testable hypotheses.

The second direction concerns the counterfactual case when no state-owned bank exists in the sector. Would this kind specification still give rise to the same industry outcome? If so, then could it be possible that the presence of public banks leads to a better market outcomes? I am not sure what the final conclusion is. But, I firmly believe that, other than market monopolization, the real problem here is that these public banks have slowed down the deregulation and the related structural changes in Taiwan's banking market, since they not only operate at low efficiency, but have also made reforms difficult for the sake of the powerful interest

groups backing state industry. *The most serious consequence may be a weakening of the banking system, which is burdened by large quantities of bad loans (particularly to those firms with political connections that are able to take advantage of regulations), and which may eventually cause problems of the kind seen in the rest of East Asia during the late 1990s* (Ma, 2008).

Appendix: Data Description

Variables	Number of Observations	Mean	Std. Error	Minimum	Maximum
q_{it} (million NT$)	3269	267222.70	300267.70	2908.00	1358847.00
MC_{it}	3262	0.03	0.01	0.01	0.07
m_{it}	3269	0.02	0.02	0.0003	0.10
q_{it}	66	0.06	0.01	0.04	0.11
M_{pt}	66	0.42	0.01	0.40	0.45
H_{pt}	66	404.66	28.51	360.83	451.01
$\sum_{i \in P} \frac{MC_{it}}{P_t} \frac{m_{it}}{M_{pt}}$	66	0.44	0.14	0.27	0.66
M_{st}	66	0.57	0.02	0.50	0.60
H_{st}	66	1115.31	12.09	1093.59	1134.25
$\sum_{i \in S} \frac{MC_{it}}{P_t} \frac{m_{it}}{M_{st}}$	66	0.54	0.12	0.41	0.73

* All the data are taken from the data bank of the Taiwan Economic Journal.

References

Azzam, A. / *Anderson,* H. (2002): "Market Power versus Efficiency in Mixed Oligopolies", Working Paper, CAIEP WP002, Department of Agricultural Economics, University of Nebraska.

Barros, F. / *Modesto,* L. (1999): "Portuguese banking sector: a mixed oligopoly?" International Journal of Industrial Organization 17, 869 – 886.

Beato, P. / *Mas-Collel,* A. (1984): "The marginal cost pricing as a regulation mechanism in mixed markets," in The Performance of Public Enterprises, edited by M. Marchand, P. Pestieau, and H. Tulkens, Amsterdam, North-Holland Publishers.

Beck, Thorsten / *Demirgüc-Kunt,* Asli / *Levine,* Ross (1999): "A new database on financial development and structure," Working Paper, World Bank.

Berg, S. / *Kim,* M. (1994): "Oligopolistic interdependence and the structure of production in banking: An empirical approach," Journal of Money, Credit, and Banking 26, 404 – 431.

Blair, R. / *Kaserman,* D.: "Antitrust Economics", Illinois, United States, Richard D. Irwin, Inc.

Connor, J. (2004): "Global cartels redux: The Amino Acid Lysine antitrust litigation," in The Antitrust Revolution, edited by Kwoka and White, 4th ed., United States, Harper Collins Publishers.

Corts, K. (1999): "Conduct parameters and the measurement of market power," Journal of Econometrics 88, 227 – 225.

Cremer, H. / *Marchand,* M. / *Thisse,* J. (1989): "The public firm as an instrument for regulating an oligopolistic market," Oxford Economic Papers 41, 283 – 301.

De Fraja, G. / *Delbono,* F. (1990): "Game theoretic models of mixed oligopoly," Oxford Economic Papers 41, 303 – 311.

Gollop, S. / *Roberts,* M. (1979): "Firm interdependence in oligopolistic markets," Journal of Econometrics 10, 313 – 331.

Green, W. (2003): "Econometric Analysis," 5th edition, New Jersey, Prentice Hall.

Harris, R. / *Wiens,* E. (1980): "Government enterprise: an instrument for the internal regulation of industry," Canadian Journal of Economics 13, 125 – 132.

Ma, T. (2008): "Development strategy and export-led growth: lessons learned from Taiwan's experience," Journal of Development Studies, (in print).

Ma, T. / *Hung,* T. (2001): "An investigation on the cartel cases sanctioned by TFTC," Fair Trade Quarterly 9, 27 – 76.

Pfaffermayr, M. (1999): "Conjectural variation models and supergames with price-competition in a differentiated product oligopoly," Journal of Economics 70, 209 – 326.

Rees, R. (1984): "Public Enterprise Economics," 2nd ed., London, Weinfeld and Nicolson.

Ruthenberg, D. / *Elias,* R. (1996): "Cost economies and interest margins in a unified European banking market," Journal of Economics and Business 48, 231 – 249.

Shaffer, S. (2001), "Banking conduct before the European single banking market license," North American Journal Economics and Finance 12, 79 – 104.

Spiller, P. / *Favaro,* E. (1984): "The effects of entry regulation on oligopolistic interaction: The Uruguayan banking sector," Rand Journal of Economics 15 (2), 244 – 254.

Vickers, J. / *Yarrow,* G. (1991): "Economic perspective on privatization," Journal of Economic Perspective 5, 111 – 132.

White, H. (1980): "A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity," Econometrica 48, 817 – 830.