



TESTING FOR COLLUSION IN THE HONG KONG BANKING SECTOR

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Abstract

This working paper examines the degree of collusion in the banking sector of Hong Kong based on the conjectural variation approach. The results suggest that banks in Hong Kong operated in a competitive fashion in the loan market during the period 1991-2002 with no significant sign of collusion on pricing. The market conduct was largely maintained in subsequent years, despite significant changes in the operating conditions. While major bank consolidations in 2001-2002 have resulted in fewer banks and thus a market more conducive to develop and maintain collusions, interest rate deregulations implemented around the same time has promoted a more competitive environment. The estimation results show that while banks do not appear to have exercised any collusive pricing in either the retail market or the corporate loan market, it is relatively less likely to develop oligopolistic collusions in the corporate loan market than in the local retail market.

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Executive Summary:

- *An examination of collusion in the banking sector of Hong Kong based on the conjectural variation approach suggests that banks operated in a competitive fashion in the loan market during the period 1991-2002 with no significant sign of collusion on pricing. The market conduct was largely maintained in subsequent years, despite significant changes in the operating conditions. While major bank consolidations in 2001-2002 have resulted in fewer banks, interest rate deregulation implemented around the same time has promoted a more competitive environment.*
- *The estimation results show that banks do not exercise any collusive pricing in either the retail market or the corporate loan market. Comparing the two markets, oligopolistic collusion is relatively less likely to develop in the corporate loan market than in the local retail market. Highly differentiated products, wider product scope, and more potential competitors at the regional and international level may make it more difficult for effective collusion to develop among banks involved in the corporate loan market than in the local retail market.*

I. INTRODUCTION

The banking industry in Hong Kong is characterised by the existence of a few major banking groups and a relatively high degree of market concentration. Reflecting this, the Herfindahl-Hirschman Index (HHI)² of the banking sector in Hong Kong is around 0.14 in 2005, which is higher than some other developed banking centres, such as the US (0.02), UK (0.06), and Japan (0.06).³ The 3-bank concentration ratio⁴ of Hong Kong is also high at around 0.56 in 2005, compared with 0.15 in the US, 0.34 in UK, and 0.39 in Japan.⁵ Such a structure could be conducive to the forming of oligopolistic coordination, as large banks may gain strong market power and could exercise leadership in pricing. Indeed, the existence of the interest rate rules (IRRs) prior to 2001 had long been a competition concern. When the IRRs were in place, deposit rates offered by banks under an administered rate structure were to an extent dictated by the large banks. At the same time, the best lending rate (BLR), the reference rate for most bank loans, was set by the large banks, which was followed by other banks. There also appeared to be similar fee-setting trends among banks.⁶ Even after the full deregulation of the IRRs, for a long period of time banks still adopted the same BLR set by the large banks, although the effective interest rates could be different due to different mark-ups. It was not until April 2005 that smaller banks began to adjust their BLRs differently from large banks.⁷ However, the gap between different BLRs has so far never exceeded 25 basis points.

² The HHI is the sum of the squared market shares of assets of all retail banks, ranging from zero to one. A large number of banks, each with a small share, produce an HHI close to zero. A monopolist bank with a 100 percent share produces an HHI of one.

³ Biker and Haff (2002) estimated the HHI for the banking industries of 20 countries. The HHI are found to range from 0.02 (US) to 0.26 (Switzerland). The average HHI for the 20 selected countries is found to be 0.11, which is lower than the HHI in Hong Kong in 2005 (i.e. 0.14).

⁴ The 3-bank concentration ratio is defined as the ratio of the sum of assets of the first three largest banks to the sum of assets of all banks.

⁵ Besides the HHI, Biker and Haff (2002) also estimated the 3-bank concentration ratio of the banking industries for 20 countries. The values ranged from 0.15 (US) to 0.78 (Netherlands), and the average value is 0.47, which is lower than that of Hong Kong in 2005 (0.56).

⁶ One of the notable examples was the service charge/maintenance fees imposed on small depositors, which were first introduced by one of the larger banks during 2001 amid the removal of the remaining interest rate rules. This was followed by most of the smaller banks later.

⁷ All banks have the same BLRs from July 2001 to March 2005. Since April 2005, they started to have different BLRs in response to the recent tightening of US interest rates. Concerns over the impact of fewer and larger banks in a market on competition resulting from bank consolidations stem from the structure-conduct-performance paradigm, which asserts that the degree of competition is positively related to the number of banks in the market. Fewer banks and a more concentrated market are said to be conducive to oligopolistic coordination, as it reduces the coordination problem among the incumbents, and favours the development or maintenance of collusion agreement among banks.

Our previous tests for market structure using a Panzar-Rosse approach in Wong et al. (2006) have shown that the banking sector in Hong Kong was highly competitive during the period 1992-2005. Nevertheless, evidence of the co-movement of BLRs and fee setting among banks, even after the removal of the IRRs, has caused some concerns about the existence of oligopolistic coordination among banks. Whether such a phenomenon reflects oligopolistic coordination or is simply the result of price competition thus needs to be examined. This is particularly important in view of recent market consolidations that have resulted in fewer banks and an even more concentrated market. Oligopolistic coordination may lead to higher profit for the colluding banks at the expense of customers and other competitors, and would adversely affect economic efficiency. The issue is therefore of interest to policy makers.

This paper, based on the conjectural variation approach derived from the oligopoly theory, focuses on evaluating the degree of oligopolistic coordination of the banking industry in Hong Kong. It forms part of our series of projects examining the market structure and competitive environment of the banking sector.

The rest of the paper is organised as follows. The conjectural variation approach will be discussed in the next section. Sections III and IV describe the empirical specifications, and data and estimation methods respectively. Section V presents the estimation results. Finally, Section VI concludes.

II. THE CONJECTURAL VARIATION APPROACH

The conjectural variation approach involves identification⁸ and estimation of a conjectural variation parameter of the market being examined. In our context, the parameter is defined as the bank's belief about its rivals' pricing responses to changes in its own interest rates charged on loans (hereafter referred to as λ).⁹

⁸ The conjectural variation parameter may be difficult to estimate econometrically due to the identification problem. For detailed discussions, see Bresnahan (1982), Lau (1982) and Nevo (1998).

⁹ The concept of conjectural variation was introduced and defined by Bowley (1924) and Frisch (1951) as the firm's belief about the rivals' response to changes of its decision variables. Regarding the decision variables, most past studies formulate the model with only one decision variable by assuming firms choosing either the output level (i.e. the Cournot model) or the price level (i.e. the Bertrand model). While the Cournot model is extensively applied on banking studies such as Spiller and Favaro (1984), Shaffer (1989, 1993), Berg and Kim (1998), Angelini and Cetorelli (2000) and Bikker (2003), the Bertrand model that assumes banks compete with their rivals by using prices is also very common. See Coccores (2002, 2005) and Haan and Sterken (2006), for example.

The theoretical model employed in this study to estimate λ is based on Coccoresse (2002, 2005)¹⁰ which specifies a price-setting game in a duopolistic market with heterogeneous products, where each bank faces a demand function for its loans,

$$q_i = q(p_i, p_{-i}, Z_i), \quad i=1, \dots, N \quad (1)$$

where N is the number of banks in the market, q_i is the quantity demanded. p_i and p_{-i} are the interest rates charged (i.e. prices) on loans by bank i and by all other competitors respectively. Z_i is a vector of exogenous factors affecting demand. This demand function assumes that each bank faces a single competitor which is formed by all other banks, and hence the demand for loans for each bank depends on the interest rate charged by itself as well as the average interest rate charged by all other banks.

The cost function of banks in the model is specified by

$$C_i = C(q_i, w_i, Y_i), \quad i=1, \dots, N \quad (2)$$

where costs depend on quantity and a vector of k factor prices, $w_i = (w_1, w_2, \dots, w_k)$, as well as a vector of exogenous cost factors affecting bank costs, Y_i . Based on equations (1) and (2), the profit function of banks can be written as

$$\pi_i = q(p_i, p_{-i}, Z_i)p_i - C(q_i, w_i, Y_i), \quad i=1, \dots, N \quad (3)$$

where π_i is the profit earned by bank i . To maximise profit subject to the exogenous factors, p_{-i} , Z_i , w_i and Y_i , banks must satisfy the following condition¹¹:

$$p_i = MC_i - \frac{1}{\frac{\eta_i}{p_i} + \lambda \frac{\eta_{-i}}{p_{-i}}}, \quad i=1, \dots, N \quad (4)$$

where $MC_i = \frac{\partial C_i}{\partial q_i}$ is the marginal cost, $\eta_i = \frac{\partial \ln q_i}{\partial \ln p_i} = \frac{\partial q_i}{\partial p_i} \frac{p_i}{q_i} < 0$ is the own-price

¹⁰ For a more complete explanation of the model, see Roller and Sickles (1995) and Neven and Roller (1996) which develop the model originally to examine the market structure of European airline industry.

¹¹ This is derived from the first-order condition of the bank profit maximisation problem. Mathematically, the problem can be expressed as $\underset{p_i}{Max} \pi_i = q(p_i, p_{-i}, Z_i)p_i - C(q_i, w_i, Y_i)$.

elasticity, $\eta_{-i} = \frac{\partial \ln q_i}{\partial \ln p_{-i}} = \frac{\partial q_i}{\partial p_{-i}} \frac{p_{-i}}{q_i} > 0$ is the cross-price elasticity, and $\lambda = \frac{\partial p_{-i}}{\partial p_i}$ is the conjectural variation parameter of bank i .

The derivative $\lambda = \frac{\partial p_{-i}}{\partial p_i}$, if identified, can be interpreted as the degree

of oligopolistic coordination between banks on pricing loans. By estimating λ , the existence of collusive behavior on loan pricing can be detected. Specifically, a positive λ implies that collusive pricing behaviour exists in the loan market (See Chart 1 below). Such a pricing behaviour can be revealed by changes in the market equilibrium price and quantity as a consequence of an initial increase in price by one of the banks. For illustration, suppose a bank raises its loan price and thereby reduces its loans made. If its rivals are expected to increase their prices ($\lambda > 0$) too, then their output levels are expected to move in the same direction as that of the bank which initiates the price increase. On the whole, the equilibrium quantity is reduced, the equilibrium price is raised and the joint profit of banks is increased. In other words, such evidence suggests that the bank expects its rivals to match its prices, and to co-operate with each others to hold revenues at a profitable level. In the limit, the joint profit of the banks is maximised by perfect coordination in prices where the bank expects its changes in price to be followed exactly by all other banks (i.e. $\lambda = 1$).

In contrast, non-positive values of λ imply that banks react in a competitive fashion to any increase in price by their counterparts. A zero value for the conjectural variation parameter (i.e. $\lambda = 0$) indicates that each bank does not (or fails to) consider rivals' choices when setting prices. In other words, banks are expected to keep their prices fixed despite an increase in prices of their counterparts. For the banks to maintain their prices unchanged, they must increase their loans to fill the loan supply gap arising from the upward price adjustments by the bank which initiates the price change. On balance, the total amount of loans made by the banking sector as well as prices should be little affected or even unchanged. A negative conjectural derivative indicates that a bank raising its prices expects its rivals to react in a competitive fashion by reducing their prices. In the extreme, $\lambda = -\infty$ implying perfect competition.

While the formulation of the theoretical model varies somewhat in literature, the conjectural variation approach has been widely applied to assess the degree of oligopolistic coordination between banks in the banking systems of the US (Shaffer, 1989) and Canada (Shaffer, 1993) since 1980s, with later work focusing on European countries (Berg and Kim, 1998; Angelini and Cetorelli, 2003; Coccoresse, 2002 and 2005). Most of these studies found no evidence of significant oligopolistic coordination in the banking systems.

III. THE EMPIRICAL SPECIFICATIONS

The System of Equations

In our application of the conjectural variation approach, a system formed by equations (1), (2) and (4) is estimated simultaneously to infer the λ statistic from a panel dataset of banks in Hong Kong. The demand function corresponding to equation (1) is specified by the following log-linear equation:

$$\ln q_i = \phi_{0,i} + \phi_1 \ln p_i + \phi_2 \ln p_{-i} + \phi_3 \ln Y + \phi_4 \ln B_i + \varepsilon_D, \quad (5)$$

where the quantity demanded q_i and the price p_i are measured by total loans produced by individual banks (the sum of loans and advances to customers and amount due from banks) and the ratio of total gross interest incomes to total loans respectively. The competitor's price p_{-i} is calculated as the ratio of the sum of gross interest incomes to the sum of total loans of all other banks. The estimated coefficient of $\ln p_i$ (i.e., ϕ_1) is interpreted as the own price elasticity and that of $\ln p_{-i}$ (i.e., ϕ_2) is interpreted as the cross-price elasticity, and they are expected to be negative and positive respectively. The demand for loans is assumed to be affected by two exogenous factors: Y and B_i , the quarterly real GDP growth rate in Hong Kong and the number of bank branches respectively. Generally, demand for loans should be higher under good economic conditions and for banks with a large branch network. Therefore, the estimated coefficients of ϕ_3 and ϕ_4 are expected to be positive.

As for the cost equation (4), a multi-product translog cost function, which is adopted by many related banking studies¹², is specified. Two regularity conditions are imposed on the cost equation to ensure that the estimated cost function is well behaved.¹³ The cost equation can be written as

¹² See Gilligan et al. (1984), Mester (1987) and Berger et al. (1987), for example.

¹³ Homogeneity of degree one in factor prices and symmetry are imposed.

$$\begin{aligned}
\ln C_i = & \alpha_{0,i} + \alpha_1 \ln q_i + \alpha_2 \ln oq_i + \beta_1 \ln w_{1,i} + \beta_2 \ln w_{2,i} + (1 - \beta_1 - \beta_2) \ln w_{3,i} \\
& + 0.5\sigma_{11} \ln q_i \ln q_i + 0.5\sigma_{22} \ln oq_i \ln oq_i + \sigma_{12} \ln q_i \ln oq_i \\
& - 0.5(\gamma_{12} + \gamma_{13}) \ln w_{1,i} \ln w_{1,i} - 0.5(\gamma_{12} + \gamma_{23}) \ln w_{2,i} \ln w_{2,i} \\
& - 0.5(\gamma_{13} + \gamma_{23}) \ln w_{3,i} \ln w_{3,i} + \gamma_{12} \ln w_{1,i} \ln w_{2,i} \\
& + \gamma_{13} \ln w_{1,i} \ln w_{3,i} + \gamma_{23} \ln w_{2,i} \ln w_{3,i} \\
& - (\delta_{12} + \delta_{13}) \ln q_i \ln w_{1,i} + \delta_{12} \ln q_i \ln w_{2,i} \\
& + \delta_{13} \ln q_i \ln w_{3,i} - (\delta_{22} + \delta_{23}) \ln oq_i \ln w_{1,i} \\
& + \delta_{22} \ln oq_i \ln w_{2,i} + \delta_{23} \ln oq_i \ln w_{3,i} + \varepsilon_C
\end{aligned} \tag{6}$$

where C_i is total costs of bank i . While this study mainly assesses the existence of collusive behaviour in the loan market, off-balance sheet (OBS) outputs generated by banks, oq_i , are incorporated into the cost function estimation to serve as a control variable to avoid understating bank outputs.¹⁴

In this study, banks are considered as employing three factor inputs: funds, labour and capital. The unit price of funds, $w_{1,i}$, is proxied by the ratio of interest expense to total funding (the sum of deposits from customers, due to banks, amount payable under repos and negotiable debt instruments issued and outstanding). The unit price of labour, $w_{2,i}$, is computed as the ratio of staff expense to total assets.¹⁵ Finally, the unit price of capital, $w_{3,i}$, is derived as the ratio of expense other than staff and interest expenses to total assets.

Based on the specification of equation (6), the marginal cost function of bank i for producing q_i can be derived as

$$\begin{aligned}
MC_i &= \frac{\partial C_i}{\partial q_i} \\
&= \frac{C_i}{q_i} \frac{\partial \ln C_i}{\partial \ln q_i} \\
&= \frac{C_i}{q_i} [\alpha_1 + \sigma_{11} \ln q_i + \sigma_{12} \ln oq_i \\
&\quad - (\delta_{12} + \delta_{13}) \ln w_{1,i} + \delta_{12} \ln w_{2,i} + \delta_{13} \ln w_{3,i}].
\end{aligned} \tag{7}$$

¹⁴ Past studies on the cost structure of banking industry generally suggest that omitting OBS activities in the cost estimation could seriously understate actual bank outputs. For example, in cost-efficiency studies, Rogers (1998) and Clark and Siems (2002), by comparing the results which included proxies for the OBS outputs in the estimation, such as non-interest incomes, with those without incorporating OBS outputs in the estimation, showed that omitting OBS activities in the cost efficiency estimation could seriously understate actual bank outputs and efficiency levels.

¹⁵ This follows Bikker and Groeneveld (2000) and Gelos and Roldos (2002). Note that other measures of unit price of labour as the ratio of staff expense to the number of employees are also frequently used (see, for example, Molyneux et al. (1994) and Classens and Laeven (2004)).

With the specification of equations (5) and (7), equation (4) can be specified as

$$p_i = \frac{C_i}{q_i} [\alpha_1 + \sigma_{11} \ln q_i + \sigma_{12} \ln oq_i - (\delta_{12} + \delta_{13}) \ln w_{1,i} + \delta_{12} \ln w_{2,i} + \delta_{13} \ln w_{3,i}] - \frac{1}{\frac{\phi_1}{p_i} + \lambda \frac{\phi_2}{p_{-i}}} + \varepsilon_p \quad (8)$$

The conjectural variation parameter λ can be inferred by estimating the system of equations formed by equations (5), (6) and (8).

The Models

A total of three models are specified for estimation:

- (1) To provide insights on the overall degree of oligopolistic coordination between banks during 1991-2005, Model A is specified to estimate a constant λ statistic for the entire sample period based on equations (5), (6) and (8).
- (2) To study how the degree of oligopolistic coordination in the banking sector has evolved over time, Model B, a modification of Model A, will be estimated. By including the interaction between λ and two dummy variables which separate the whole sample period into two sub-periods – one from 1991 Q1 to 2001 Q2 and the other from after 2001 Q2 to 2005 – Model B attempts to examine the effect of the structural changes on the degree of oligopolistic coordination in the banking sector. The time point 2001 Q2 is so chosen to distinguish the two periods as structural changes including major bank consolidations and bank deregulations either completed or took place around the time.^{16,17} Theoretically, while bank consolidations, which lead to a more concentrated market, may favour the

¹⁶ (1) The interest rate deregulation was fully completed by July 2001, with interest rate restrictions on current and savings accounts also removed; (2) the restriction on the number of branches and offices for foreign banks was completely removed in 2001; (3) the market entry criteria have been relaxed since 2002, and (4) most major bank consolidations took place in 2001 and 2002, including the forming of the Bank of China Group and DBS Bank (Hong Kong) through mergers and acquisitions.

¹⁷ An alternative way to analyse the evolution of the degree of oligopolistic coordination is by including a time trend variable. However, such specification implicitly assumes that the evolution of the degree of oligopolistic coordination is either increasing or decreasing continuously and linearly over time, which is unlikely to be true in reality. Given that major bank consolidations and deregulations were concentrated around 2001-2002, the evolution of the degree of oligopolistic coordination may be more appropriate to be specified by a structural break around the period.

development of collusion^{18,19}, bank deregulations can constrain market power of individual banks, and hence lower the likelihood of establishing and maintaining collusive behaviour among banks²⁰. The results of Model B would shed light on the net impact of these structural changes on the industry conduct.

- (3) To study how the degree of oligopolistic coordination varies in different bank markets, such as the local retail market versus the corporate loan market, Model C is estimated with the interaction between λ and bank-scale dummies, *Size*, included. As large banks in general are more active in the corporate loan market than smaller banks, the difference in the degree of pricing coordination between the group of larger banks and the group of smaller banks can facilitate our analysis of price co-ordination in different markets. In the model, a bank is considered as large if its asset size is one of the seven largest at the specific point of time.²¹

IV. DATA AND ESTIMATION METHODS

The dataset used in the estimation is a panel dataset of all retail banks in Hong Kong covering the period from 1991 Q1 to 2005 Q4. Retail banks are the locally incorporated banks plus a number of larger foreign banks whose operations are similar to those of the locally incorporated banks in that they operate a branch network and are active in retail banking. The banking data are obtained from the regulatory returns that Authorized Institutions in Hong Kong must file with the HKMA. Since our purpose is to examine the degree of oligopolistic coordination among banks in Hong Kong, the sample is restricted to incorporate only data of their

¹⁸ This argument is based on the structure-conduct-performance paradigm (Bain, 1951) which asserts that the degree of competition is positively related to the number of banks in the market and negatively related to the market concentration. Theoretically, joint profit of banks is maximized if all banks tacitly collude to behave as a single monopolist in the loan market. To form such a collusion or cartel, it would be more possible with fewer banks in the market.

¹⁹ Early studies based on the conjectural variation approach (Spiller and Favaro, 1984; Shaffer, 1993; Angelini and Cetorelli, 2003; Toolsema, 2002; Coccoresse, 2005; Uchida and Tsutsui, 2005) generally suggested that the degree of strategic interactions across banks is lower after bank deregulations, while the impact of bank consolidations is inconclusive empirically.

²⁰ This argument is based on the implication from the contestability theory which follows the lead of Baumol et al. (1982) in stressing that potential competitors, like currently active competitors, can effectively constrain market power of incumbents, so that in a market with only few competitors, sufficiently low barriers to entry which make potential competition highly possible can serve to discipline the established firms to act in a competitive fashion.

²¹ Regarding the classification of large and small banks, another way of classification is based on the ranking of average asset size of banks in the whole sample period. Under such classification method, each bank will be classified into only one specific group for the whole sample period regardless of changes in the asset size of the bank during the period. This classification method should be appropriate in a case that only a few mergers and acquisitions happen in the sample period and the asset size of banks has not changed substantially over time. Since there were major bank consolidations taking place during 2000-2001, which changed the asset size of some banks dramatically, we choose to adopt the classification of banks according to the asset size of each bank at each point of time.

Hong Kong offices.²² All nominal values of the variables are deflated by the composite consumer price index.

The three models, Models A to C, are estimated with equations (5) and (6) specified in the first difference form. This is for several reasons. First, differencing the equations removes the individual effects (which are time invariant and cross-section specific), reducing the number of parameters to be estimated. Second, removing the individual effects also avoids complications arising from the possibility that they may be correlated with the explanatory variables. Third, differencing the equation avoids the omitted-variable bias stemming from the cross sectional unobserved heterogeneities that are constant over time.

In estimating the system of equations (5), (6) and (8), we follow a non-linear three-stage least squares method instead of applying the single-equation method such as ordinary least squares, limited information maximum likelihood or two-stage least squares because estimators from the former are statistically consistent and asymptotically more efficient than the other estimators.²³

V. ESTIMATION RESULTS

Empirical results of the three models are presented in Table 1. The adjusted R -squared statistics of the three models, which measure the goodness of fit, are all over 0.9, indicating that the specification of equations is appropriate. The estimated own-price elasticity (ϕ_1) and cross-price elasticity (ϕ_2) are negative and positive respectively, with a statistical significance at the 1% level. The former implies a downward sloping demand curve for loans for individual banks and the latter implies that loans offered by a bank are substitutes of loans offered by other banks; both results are in line with standard economic theories. The estimated

²² Regarding the data for estimation, another common source is from banks' annual reports. Such data source is subject to various limitations. First, the relatively small number of observations constrains the construction and testing of more complicated models and the estimation results may be subject to large statistical variances, given the large number of parameters estimated under the conjectural variation approach. Second, most of the data disclosed in annual reports are on a consolidated basis that contain the operation of banks' overseas branches and their subsidiaries, which may not be appropriate for analysing the local banking market structure. This is in particular the case for some large banks which have substantial operations overseas. Using such data to examine the banking market structure in Hong Kong may also generate results that are affected unduly by large banks' data as their market shares and assets are exaggerated.

²³ The three-stage least square estimator takes account of the fact that the system of equations be disturbance-related and makes use of the covariance matrix of disturbances among the equations within the framework of the seeming unrelated regression method. So, the estimator is asymptotically more efficient than other single equation estimators. With a panel data, the number of observations is sufficiently large and the three-stage least square method is considered more appropriate. Note that the single equation estimator may be more appropriate if the number of observations is small.

own-price elasticity in absolute value is larger than the cross-price elasticity, suggesting that the demand for loans of customers are more sensitive to the variation of prices offered by the bank which they currently bank with than to price changes of other banks. The estimated coefficients of the income variable (ϕ_3) have the expected positive sign, and are statistically significant at the 10% level.²⁴ The number of bank branches is also estimated to be positively related to the demand for loans (i.e. $\phi_4 > 0$ and statistically significant at the 1% level).

As for the estimation result of the cost function, since the specification involves cross-product terms and quadratic terms, it is difficult to visualise the reasonableness of the estimated coefficients based on themselves alone. Nevertheless, a check on the marginal cost values for all observations, derived based on equation (6) with the estimated coefficients, found that they are all positive as expected.

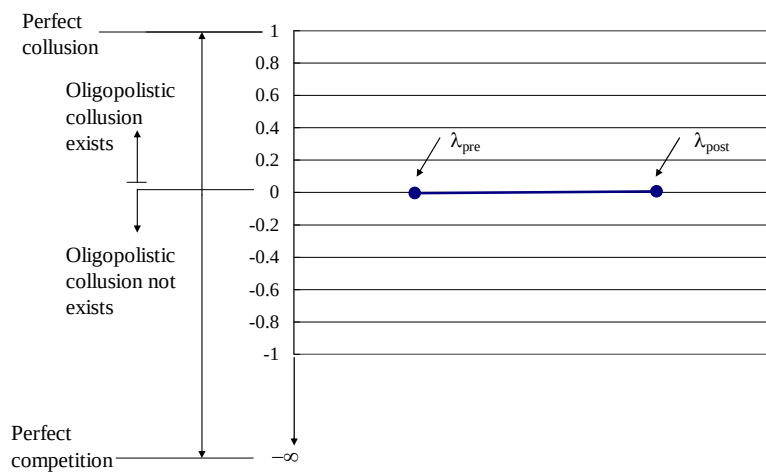
Overall, the estimation results appear robust and stable, as the signs, values and statistical significance of the estimated coefficients do not vary significantly with different specifications across Models A to C.

The empirical result from Model A, which attempts to provide insights on the overall degree of oligopolistic coordination between banks during 1991-2005, suggests no evidence of oligopolistic coordination between banks during the period. The estimated conjectural variation λ is -0.0023 and is not significantly different from zero at the 10% level, indicating that banks react in a competitive fashion in response to any increase in price by their counterparts in the market. As the estimated value of λ is far smaller than the perfect collusive value of 1 and is significantly larger than the perfect competition value of negative infinity, the market can neither be classified as a monopoly (formed by all of the banks) nor be considered as perfect competition. These findings are in line with Wong et al. (2006), which concludes that the degree of competition in Hong Kong's banking industry was fairly high, although the market structure cannot be described as perfect competition.

²⁴ This is in line with Coccoresse (2005) in which the income variable has a positive sign but is statistically significant in only some of the cases.

The estimation result in Model B, which studies the evolution of the degree of oligopolistic coordination during the sample period, shows that the estimated values of the conjectural variation parameter for the period 1991 Q1 – 2001 Q2²⁵ is slightly lower than that for the period 2001 Q3 – 2005 Q4²⁶. However, they are both statistically indistinguishable from zero at the 10% significance level. The result suggests that despite major mergers and acquisitions of banks taking place around 2001, which have resulted in higher market concentration in recent years, no significant evidence is found of collusive behaviour of banks in either the period before or after the bank consolidations.

Chart 1: Degree of oligopolistic coordination before and after structural changes



λ_{pre} = The estimated value of the conjectural variation parameter for the period 1991 Q1 – 2001 Q2.

λ_{post} = The estimated value of the conjectural variation parameter for the period 2001 Q3 – 2005 Q4.

Source: HKMA

²⁵ $\lambda_{pre} = -0.0048$

²⁶ $\lambda_{post} = 0.0054$

As for the analysis of oligopolistic coordination by different markets, the empirical results of Model C show that the estimated conjectural variation parameter among larger banks has a negative value²⁷ while that of smaller banks has a positive value²⁸, although both values are close to zero. The null hypothesis of a zero value conjectural variation of large banks can be rejected at the 5% significant level.²⁹ On the other hand, the null hypothesis of zero value conjectural variation of smaller banks cannot be rejected at the 10% significant level.³⁰ As large banks are more heavily involved in corporate banking than smaller banks, these findings suggest that while banks in general do not have sufficient market power to exercise any collusive pricing in the markets, it is relatively less likely to have oligopolistic collusion in the corporate loan market than in the retail market. This is in line with findings in the literature on collusion that it appears in general more feasible to develop and maintain effective oligopolistic collusions among firms in markets with more standardised products, less asymmetry on sellers, particularly on their cost structures, and more small buyers.^{31, 32} To the extent that these characteristics play an important role in developing collusive pricing behaviour, the corporate loan market, especially for large and multinational corporations, in which regional and international banks also actively participate, is less prone to developing and maintaining oligopolistic coordination than the local retail market.

²⁷ $\lambda_L = -0.0156$

²⁸ $\lambda_{NL} = 0.0003$

²⁹ The null hypothesis is tested against the alternative hypothesis of a negative value conjectural variation of larger banks.

³⁰ The null hypothesis is tested against the alternative hypothesis of positive value conjectural variation of smaller banks.

³¹ See Stigler (1964), Eckbo (1976), Baker and Faulkner (1993), Symeonidis (2003), and Suslow (2005).

³² In essence, markets with such characteristics are more able to facilitate colluding firms to reach some mutually agreed prices in a single market and easier for colluding firms to monitor each other's behaviour in order to deter or prevent cheating, which are fundamental for successful collusions. For instance, loan arrangements for large multinational corporations usually involve more customised terms to fit for the unique needs of individual corporations. These loans are also very common to tie-in with other related products provided by the bank or its affiliates such as legal and financial consultancy services, leading to the loan arrangements being more differentiated and involving wider product scopes. The complexity of such loans prevents banks from reaching a mutually agreed collusive price in this market. Moreover, potential colluding banks in this market could be banks operated in the domestic, regional, or international levels, leading to higher monitoring costs for detecting if each colluding bank follows the collusive agreement. These may contribute to the less likelihood of oligopolistic coordination observed among larger banks than among smaller banks.

Table 1: Empirical Results of the conjectural variation parameter for the Hong Kong Banking Sector

Independent Variables	Regression Results		
	Sample Period: 1991 Q1 to 2005 Q4		
	Models		
	A	B	C
Dependent Variables			
Equation (5): demand equation	$\ln q_i$		
ϕ_1	-1.0350 *** (0.0064)	-1.0344 *** (0.0063)	-1.0476 *** (0.0070)
ϕ_2	0.5430 *** (0.0488)	0.5422 *** (0.0489)	0.5508 *** (0.0488)
ϕ_3	0.8294 * (0.4373)	0.8448 * (0.4379)	0.8202 * (0.4367)
ϕ_4	2.4701 *** (0.0786)	2.4668 *** (0.0787)	2.4858 *** (0.0786)
R-squared	0.9837	0.9837	0.9834
Equation (6): cost equation	$\ln C_i$		
α_1	-0.0096 (0.0420)	-0.0130 (0.0414)	-0.0803 * (0.0459)
α_2	-0.1546 ** (0.0786)	-0.1671 ** (0.0792)	-0.1297 * (0.0751)
β_1	0.0002 (0.0004)	0.0001 (0.0004)	0.0002 (0.0004)
β_2	0.4716 *** (0.0765)	0.4232 *** (0.0766)	0.5129 *** (0.0770)
σ_{11}	0.0148 *** (0.0056)	0.0159 *** (0.0055)	0.0207 *** (0.0057)
σ_{22}	0.0339 *** (0.0080)	0.0379 *** (0.0081)	0.0279 *** (0.0081)
σ_{12}	-0.0104 * (0.0053)	-0.0122 ** (0.0053)	-0.0081 (0.0057)
γ_{12}	-0.1027 *** (0.0013)	-0.1027 *** (0.0013)	-0.1026 *** (0.0013)
γ_{13}	-0.1043 *** (0.0012)	-0.1040 *** (0.0012)	-0.1044 *** (0.0012)
γ_{23}	-0.0361 *** (0.0010)	-0.0361 *** (0.0010)	-0.0362 *** (0.0010)
δ_{12}	-0.0120 ** (0.0047)	-0.0092 * (0.0047)	-0.0145 *** (0.0047)
δ_{13}	-0.0084 * (0.0046)	-0.0116 ** (0.0047)	-0.0058 (0.0047)
δ_{22}	0.0032 *** (0.0008)	0.0031 *** (0.0008)	0.0033 *** (0.0008)
δ_{23}	-0.0041 *** (0.0011)	-0.0035 *** (0.0011)	-0.0043 *** (0.0011)
R-squared	0.9958	0.9958	0.9964
Number of Observations	1,887	1,887	1,887

Source: HKMA.

Notes: 1. Numbers in brackets are standard errors unless specified.
2. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively.

Table 1: Empirical Results of the conjectural variation parameter for the Hong Kong Banking Sector (con't)

Independent Variables	Regression Results		
	Sample Period: 1991 Q1 to 2005 Q4		
	Models		
	A	B	C
	Dependent Variables		
Equation (8): first-order condition	P_i		
λ	-0.0023 (0.0067)		
λ_{pre}		-0.0048 (0.0066)	
λ_{post}		0.0054 (0.0068)	
λ_L			-0.0156 * (0.0082)
λ_{NL}			0.0003 (0.0070)
R-squared	0.9998	0.9999	0.9996
Number of Observations	1,887	1,887	1,887

Source: HKMA.

Notes: 1. Numbers in brackets are standard errors unless specified.
2. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively.

VI. CONCLUSION

The empirical analysis, based on the conjectural variation approach and a panel dataset which covers all retail banks in Hong Kong for the period of 1991 Q1 to 2005 Q4, suggests that banks in Hong Kong operated in a competitive fashion in the loan market without any significant sign of collusion on pricing during the period 1991-2002, and the market conduct was largely maintained in the subsequent years, notwithstanding significant changes in the operating conditions. While major bank consolidations taking place in 2001-2002 have resulted in fewer banks, and thus a market more conducive to developing and maintaining collusions, interest rate deregulations implemented around the same time have promoted a more competitive environment.

Empirically, evidence indicates that banks do not exercise any collusive pricing in either the retail market or the corporate loan market. The estimation results also suggest that oligopolistic collusions is less likely to develop in the corporate loan market than in the local retail market. This is probably due to the fact that in the corporate loan market, where the products are usually highly customised and wider product scopes exist, effective collusions are more difficult to be developed. Moreover, there are more participating banks in the corporate loan market, which is not limited to local larger banks, but also larger banks at the regional and international level.

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