



**COMPETITION IN HONG KONG'S BANKING SECTOR:  
A PANZAR-ROSSE ASSESSMENT**

**Key Points:**

- *A re-examination of the competitive conditions of the banking industry in Hong Kong, based on the Panzar-Rosse approach and using a panel dataset with longer time-series data, reconfirms previous findings in our [RM 04/2004](#) that the degree of competition was fairly high during the period 1992-2002. The empirical analysis also suggests that competitive pressures have been maintained in subsequent years, notwithstanding significant changes in the operating environment.*
- *The estimation results showed that competitive pressures were higher among larger banks and lower among smaller banks. This may suggest that while larger banks compete with smaller banks keenly in local retail markets on products such as mortgages and credit cards, they may be subject to even stronger pressures from other competitors at the regional or international levels in the corporate banking market, wealth management and other off-balance sheet activities, where they are more heavily involved.*
- *While relaxation of regulations and advances in technology tend to increase competition in the banking system, the effect of consolidation may depend on the prevailing market settings. To the extent that bank consolidation in recent years may have hampered competition, regulatory liberalisation and technological progress appear to have largely offset the adverse effect. The emergence of a number of larger banks through mergers and acquisitions which should be more capable of competing with existing large banks may have also contributed. Nonetheless, with bank consolidation expected to continue, how market concentration may impact on competition in the years to come needs to be closely monitored.*

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## I. INTRODUCTION

The operating environment of the banking sector in Hong Kong has undergone major changes in recent years, including regulatory liberalisation, technological progress and industry consolidation<sup>1</sup>. These structural developments could have implications for competitive conditions in the sector. Competition could lower financial intermediation costs and contribute to improvements in economic efficiency. However, since it may also reduce market power and profitability of banks, it could weaken their ability to withstand adverse developments. It is important for policymakers to know the extent of competition in the sector and how it has evolved over time.

Jiang et al. (2004)<sup>2</sup> examined the evolution of the market structure of Hong Kong's banking sector during the period 1992 to 2002 by using the Panzar-Rosse assessment.<sup>3</sup> The study suggested that while there was evidence that competitive pressures in the sector may have eased somewhat in the latter years, the sector remained highly competitive. However, the analysis, which is based on aggregate data of the banking sector, was significantly restrained by data limitations, in particular the relatively small number of observations.

To address this drawback, this paper re-visits the issue of the competitive structure of the banking industry in Hong Kong, also adopting the Panzar-Rosse approach as in the previous study, but based on a panel dataset which covers all retail banks in Hong Kong for the period of 1991 Q1 to 2005 Q4. The use of a panel dataset not only enhances the efficiency of the estimates<sup>4</sup>, thus allowing the drawing of a more precise inference on the population characteristics of the market structure, but also facilitates the construction and testing of more complicated models, such as the relationship between competitive pressures and bank size in Hong Kong, which was difficult to achieve in the past study due to the data constraint.

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<sup>1</sup> Following the banking sector consultancy study in 1998, the Hong Kong Monetary Authority (HKMA) has gradually removed several barriers to competition, including regulated interest rates, branching restrictions for foreign banks, limited access of restricted licence banks (RLBs) to the Real Time Gross Settlement (RTGS) system, and certain market entry criteria to the banking sector. Technological advancement also enhanced competition by eliminating geographical barriers and facilitating product innovations. Meanwhile, bank consolidation has resulted in increased market concentration. The effects of the Asian financial crisis, an ongoing process of consolidation of international banks and weak credit demand have created ongoing pressures for mergers and acquisitions in the Hong Kong banking sector.

<sup>2</sup> The paper was published as an HKMA Research Memorandum, [RM 04/2004](#).

<sup>3</sup> See Panzar and Rosses (1987)

<sup>4</sup> Panel data, by combining inter-individual differences with intra-individual dynamics, offer many advantages over cross-sectional or time series data. Panel data enlarge the number of observations for estimation, increasing the degree of freedom and reducing the collinearity among explanatory variables, hence improving the efficiency of estimates. A more detailed discussion on the advantages of panel data estimation can be found in Hsiao (1986).

Moreover, in this paper, the data available for analysing the impact of the recent developments on the competitive structure in the banking sector are extended from 2002 Q4 to 2005 Q4. As the interest rate deregulation was only completed in July 2001 and a number of other significant market liberalisation moves and substantial bank consolidation only took place around 2001 and 2002, the overall impact on the competitive conditions in the banking sector of these structural developments may not have been fully visualised in Jiang et al. (2004), the study period of which only covered up to 2002. It is important to assess properly how the extent of competition in the sector has changed in the subsequent years, with the effects of both market liberalisation and consolidation being more fully realized. With longer time series of data, this paper should provide a more accurate assessment.

The rest of the paper is organised as follows. The Panzar-Rosse 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 PANZAR-ROSSE APPROACH

The Panzar-Rosse approach estimates the sum of elasticities ( $H$  statistic) of a firm's revenue with respect to input prices in a reduced form revenue equation. The measure is grounded in the idea that competitive firms are price takers and must pass through cost changes to customers, while a monopoly can vary output to maximise profits in the face of higher input prices.

Let  $R$  be the revenue function of a vector of  $k$  input prices,  $\mathbf{w} = (w^1, w^2, \dots, w^k)$  and a vector exogenous variables  $\mathbf{x}$  that shift the revenue function:

$$R = R(\mathbf{w}, \mathbf{x})$$

$$H = \sum_k \frac{\partial R}{\partial w^k} \frac{w^k}{R}$$

Panzar and Rosse showed that the  $H$  statistic indicates the nature of market structure under certain assumptions<sup>5</sup> (Table 1). In a monopoly market,  $H$  is negative, as an increase in input prices will increase marginal costs and reduce equilibrium output, and subsequently a decline in total revenue given the profit maximisation hypothesis. In contrast, in a perfectly competitive market,  $H$  is equal to one, as any increase in input prices raises both marginal and average costs and in turn leads to a one-to-one increase in total revenue, without changing the optimal output of banks. This is true since those institutions that cannot cover the increase in input prices through increased revenue will be forced to exit the market. If the market structure is characterized by monopolistic competition,  $H$  will be between zero and one, with the total revenue rising less than proportionally to the changes in input prices.

**Table 1: Competitive Structures and the  $H$  Statistic**

Competitive Structure	Values of $H$
Monopoly	$H \leq 0$
Monopolistic Competition	$0 < H < 1$
Perfect Competition	$H = 1$

The Panzar-Rosse approach has been widely applied to assess competitive conditions in the banking systems of the United States, Canada and Japan since early 1980s, with later work focusing on European countries. Most of these banking systems exhibited characteristics of monopolistic competition (Bikker and Haaf, 2002).

### III. THE EMPIRICAL SPECIFICATIONS

In our application of the Panzar-Rosse approach, the following equation is estimated to derive the  $H$  statistic from a panel dataset of banks in Hong Kong:

$$\log\left(\frac{R_{it}}{TA_{it}}\right) = \alpha_0 + \sum_{k=1}^K \alpha_k \log w_{it}^k + \mathbf{x}_{it}\boldsymbol{\beta} + \varepsilon_{it}, \quad (1)$$

<sup>5</sup> The assumptions include (1) banks are profit maximising, single product firms facing normally distributed revenue and cost functions; (2) banks produce revenue using labor, capital and intermediated funds (mainly deposits) as inputs; (3) higher input prices are not associated with higher quality services that generate higher revenue; and (4) banks are in long run equilibrium. The single product firm assumption is consistent with the “intermediation” approach, where banks are viewed mainly as financial intermediaries, transforming inputs of labor, capital and deposits into outputs including loans and investments (De Bandt and Davis, 2000). Nonetheless, product differentiation is allowed in the monopolistic competition model (Gelos and Roldos, 2002).

where  $R$  is the revenue;  $TA$  is the total assets;  $w^k$  is the unit price of factor  $k$ ;  $\mathbf{x}$  is a vector of control variables;  $\varepsilon$  is the disturbance term;  $i$  and  $t$  denote bank and time respectively. The  $H$  statistic is the sum of  $\alpha_1$  to  $\alpha_K$  in this specification.

In addition to equation (1), an equation for unscaled total revenue will also be estimated by:

$$\log(R_{it}) = \alpha_0 + \sum_{k=1}^K \alpha_k \log w_{it}^k + \mathbf{x}_{it}\boldsymbol{\beta} + \beta_{TA} \log TA_{it} + \varepsilon_{it}, \quad (2)$$

with the variable  $TA$  controlled as an explanatory variable. Equation (1) is a special case of equation (2) if  $\beta_{TA}$  equals to one. In this regard, equation (1) is a restricted model of equation (2). The consideration of equation (2) follows the idea in Gelos and Roldos (2002). With the specification in equation (2), the value of the coefficient of  $TA$  can identify the presence or absence of scale economies.

We measure the revenue as total revenue<sup>6</sup> rather than gross interest revenue to account for also the growing off-balance sheet business in the banking sector which mainly generates fees and commission-based incomes. Taking total revenue as the dependent variable is consistent with other studies such as Shaffer (1982), Nathan and Neave (1989), Hempell (2002) and Claessens and Laeven (2004).

In this study, banks are considered as employing three factor inputs: labour, funds, and capital. The unit price of labour is computed as the ratio of staff expense to total assets<sup>7</sup>. The unit price of funds 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). Finally, the unit price of capital is derived as the ratio of expense other than staff and interest expenses to fixed assets.

Bank-specific factors which reflect differences in risk and funding structures are incorporated to control for other heterogeneities in the samples. Capital adequacy ratio ( $CAR$ ) is considered as a proxy for bank risk. The coefficient estimate is expected to be negative, as a lower level of bank risk (i.e. a higher value in  $CAR$ ) should lead to lower bank revenue. To capture differences in the funding structure, bank's deposit mix ( $DM$ ) as measured by the ratio of deposits from customers to bank's total funding (the sum of deposits from customers, due to banks, amount payable under repos and negotiable debt instruments issued and outstanding) is included in the estimation. Regarding the sign of the coefficient of  $DM$ , literatures do not have a priori expectation.

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<sup>6</sup> Total revenue includes gross interest revenue and non-interest revenue.

<sup>7</sup> This follows Bikker and Groeneveld (1998) 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 Claessens and Laeven (2004)).

In addition to the bank characteristics, certain macroeconomic variables are included. We incorporate the real GDP growth rate in Hong Kong into equations (1) and (2) to control for the influence of economic cycles. Generally, banks should generate larger revenue with the same quantities of inputs under good economic conditions. Inflation rate is incorporated to avoid obtaining a spurious relationship between revenue and factor prices, as their movements are to some extent driven by inflation.

### The models

A total of six models are specified for estimation:

- (1) To provide insights on the overall competitive condition during 1991-2005, Models A and B are specified as equations (1) and (2) respectively – specifically, scaled  $R$  and unscaled  $R$  are regressed on the explanatory variables with a constant  $H$  statistic for the entire sample period.
- (2) To study how the degree of competition has evolved over time, two models (Models C and D) will be estimated for scaled  $R$  and unscaled  $R$  with time-varying  $H$  statistic. Models C and D are modified from Models A and B, respectively, to include the interactions between the input-price variables and a dummy variable,  $DUM$ .  $DUM$  is defined as one after 2001 Q2, and zero otherwise.  $DUM$  is so specified as to examine the effect of the structural changes in the banking sector in Hong Kong on the competitive condition in the sector. The time point 2001 Q2 is so chosen to distinguish the two periods as major structural changes either completed or took place around this time:
  - (a) The interest rate deregulation was fully completed by July 2001, with interest rate restrictions on current and savings accounts also removed<sup>8</sup>;
  - (b) the restriction on the number of branches and offices for foreign banks was completely removed in 2001,
  - (c) the market entry criteria have been relaxed since 2002, and

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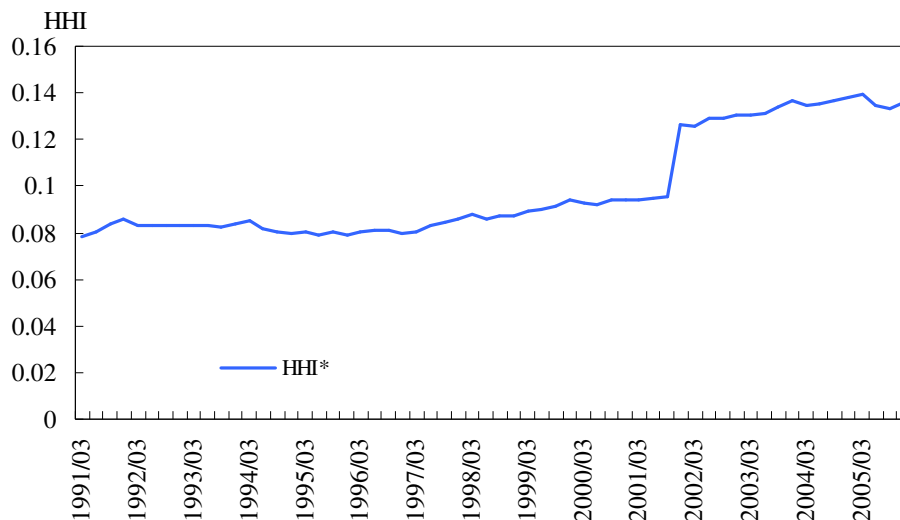
<sup>8</sup> The deregulation of interest rates in Hong Kong was undertaken in two phases. Phase 1 of the deregulation took place in July 2000 which removed the interest rate cap on time deposits with a maturity less than 7 days and the prohibition on benefits for all deposits with the exception of Hong Kong dollar current and savings accounts. Phase 2 of the deregulation took place in July 2001 which removed all interest rate rules over current and savings accounts.

- (d) 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.<sup>9</sup>

The impact of industry consolidation on market concentration is apparent. As can be seen in Chart 1, the market concentration measured by the Herfindahl-Hirschman index (HHI)<sup>10</sup> increased sharply around the second half of 2001, largely due to the merger and acquisition activities.

In addition to Models C and D, time series of rolling estimates of the *H* statistic from 1999 to 2005, which are generated by a series of rolling regressions of Models A and B, are also employed to assess the change of *H* statistic from 1999 to 2005.

**Chart 1: Major Changes in Market Concentration around 2001**



Note:

\* The HHI is the sum of the squared market shares of assets of all the retail banks in the market, ranging from zero to one.

Source: HKMA

<sup>9</sup> A detailed summary of other regulatory liberalisation measures can be found in Box 1 of Jiang et al. (2003). The forming of the Bank of China Group involved the consolidation of the ten member banks of the Bank of China Group into the Bank of China (Hong Kong); the forming of the DSB Bank (Hong Kong) involved the merger of DBS Kwong On Bank, Dao Heng Bank and Overseas Trust Bank. Details of the consolidations can be found at Table 1 of Jiang et al. (2004).

<sup>10</sup> 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) To study how competitive pressures vary with bank size, Models E and F will be estimated to facilitate the analysis. Models E and F differ from Models A and B in that the formers include the interactions between the input-price variables and bank-scale dummies, *Size*, to examine whether the competitive condition among large banks is different from that of smaller banks. In a given period, a bank is considered as large (i.e. *Size* =1) if its asset size is one of the seven largest. These model specifications can deliver a more in-depth analysis on how the competitive condition relates to bank size.

#### 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 the 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 the Authorized Institutions in Hong Kong must file with the HKMA. Since our purpose is to examine the banking competition in Hong Kong, the sample is restricted to incorporate only the data on the Hong Kong offices of retail banks. Table 2 presents summary statistics on the sample.

**Table 2: Summary Statistics on the Sample (1991 Q1 – 2005 Q4)**

	Median	Mean
<i>Total Revenue (HK\$ million)</i>	584	1,169
<i>Unit price of labour</i>	0.0015	0.0019
<i>Unit price of funds</i>	0.0122	0.0115
<i>Unit price of capital</i>	0.6995	3.6293
<i>Total assets (HK\$ million)</i>	32,352	76,628
<i>Capital adequacy ratio (%)</i>	19.7	25.9
<i>Deposit mix (%)</i>	83.1	78.6
<i>Growth (%)</i>	1.200	1.123
<i>Inflation (%)</i>	0.250	0.232

Notes:

1. *Deposit mix* is defined as the ratio of deposits from customers of a bank to its total funding.
2. The *Growth* series is the seasonally adjusted quarterly real GDP growth rate series published by the Census and Statistics Department.
3. The *Inflation* series is constructed by quarter-end figures from the seasonally adjusted monthly CPI(A) inflation series published by the Census and Statistics Department.



The six models, Models A to F, are estimated by the panel dataset, and the first difference forms of equations (1) and (2) are estimated instead of the original series. This is for several reasons. First, differencing the equation 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 equation, we follow a feasible generalised least-squares (FGLS) procedure instead of applying the method of ordinary least squares (OLS) because estimators of the former are more efficient with a large sample<sup>11</sup>. In the FGLS procedure, we use the seemingly unrelated regression (SUR) weights to correct for both cross-section heteroskedasticity and contemporaneous correlation.<sup>12</sup>

## V. ESTIMATION RESULTS

Empirical results of the six models are presented in Tables 3 and 4. The adjusted *R*-squared statistics of the six models, which measure the goodness of fit, range from 0.613 to 0.792. This is considered as satisfactory, given that the dependent variables are in first difference form. The coefficients of all input-price variables are positive and significant at the 1% level, except that of the unit price of capital in Models C and D which are significant at the 10% level. The estimated coefficients of all input-price variables are in line with the theory and empirical findings of other developed banking systems. As for the estimated coefficients of other bank-specific factors, *CAR* and *DM* are significant at the 1% level in all the six models. The variable *CAR* has the expected negative sign, indicating that the level of risk positively affects the level of revenue. The variable *DM* has a positive sign, suggesting that banks with a larger portion of their funding from customer deposits may generate larger revenue. As for the macroeconomic variables, all estimated coefficients are statistically significant at the 1% level, except for the variable *Growth* which are only significant at the 10% level in Models A and B and at the 5% level in Model F. Overall, the estimation results appear robust and stable, as the signs, values and statistical significance of coefficient estimates are not sensitive to the model specifications across Models A to F.

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<sup>11</sup> With a panel dataset, the number of observations is sufficiently large, and FGLS is considered more appropriate. Note that OLS may be more efficient than FGLS with a small sample, if the departure from classical assumptions is not too severe.

<sup>12</sup> Alternatively, we have also made use of the fixed effect model by adding individual effects into the differenced equation, which requires us to follow the least-squares dummy variable (LSDV) estimation. Estimates obtained from our FGLS procedure and the fixed effect model suggest the same competitive structure of the banking industry. The random effect model is not attempted because the residuals are expected to follow an autoregressive process.

The empirical results from Models A and B (Table 3), which mainly attempt to provide insights on the overall competitive condition during 1991-2005, suggest that the market can be characterised as monopolistic competition during the period 1991-2005<sup>13</sup>. The estimated  $H$  statistics are around 0.64 in the two models, broadly in line with results obtained in other studies<sup>14</sup>. Both the hypothesis of  $H = 0$  and  $H = 1$  are rejected statistically at the 1% level, indicating that the market can neither be classified as perfect competition nor monopoly. Nevertheless, while the market structure cannot be described as perfect competition, the degree of competition was fairly high.

The estimation results in Models C and D (Table 3), which facilitate the study of evolution of the degree of competition during the sample period, show that the  $H$  statistic for the period 1991 Q1 – 2001 Q2<sup>15</sup> is slightly higher than the  $H$  statistic for the period 2001 Q3 – 2005 Q4<sup>16</sup>. To evaluate the statistical significance of the change in  $H$  statistic over the two periods, the hypothesis of  $H_1 = H_2$  is tested. The hypothesis is not rejected at the 10% level in both Models C and D. This suggests that the competitive condition was not statistically different between the two periods. Time series of rolling estimates of the  $H$  statistic from 1999 to 2005, which are generated by a series of rolling regressions of Models A and B, show similar results -- as shown in Charts 2 and 3, the  $H$  statistic estimates move around 0.6 to 0.8 between 2001 and 2005 and do not have a persistent upward or downward trend.

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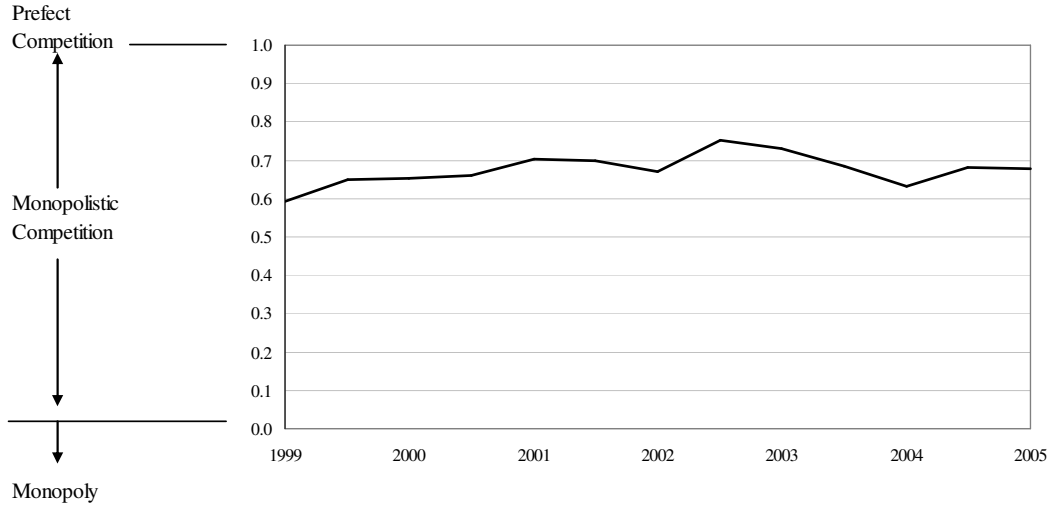
<sup>13</sup> For the  $H$  statistic to be valid and interpretable, the market under study needs to be in long-run equilibrium for the sample period (Panzar and Roose (1987)). In long-run equilibrium, the rate of returns should not be correlated with inputs prices (De Bandt and Davis (2000)). To conduct the equilibrium test, equation (1) is estimated by replacing the endogenous variable with the rate of return and the hypothesis of  $H = 0$  is tested. The results found that  $H = 0$  cannot be rejected at the 10% level, indicating that the rate of return is not correlated with input-price variables, satisfying the long-run equilibrium condition.

<sup>14</sup> The  $H$  statistics obtained by Clasessens and Laeven (2004) for the different banking sectors of 50 economies range from 0.41 (USA) to 0.92 (Costa Rica). The paper estimated the  $H$  statistic for Hong Kong to be 0.7, which was quite similar to our estimate of 0.64. The study also showed that a number of other developed countries have similar  $H$  statistics as Hong Kong, such as Austria (0.66), Belgium (0.73), Canada (0.67), Denmark (0.50), France (0.69), Germany (0.58), Italy (0.60), Luxemborug (0.82), Norway (0.57), Spain (0.53), Switzerland (0.67), and UK (0.74). The  $H$  statistic for Japan was estimated at 0.47.

<sup>15</sup>  $H_1 = 0.683$  and  $0.690$  in Models C and D respectively.

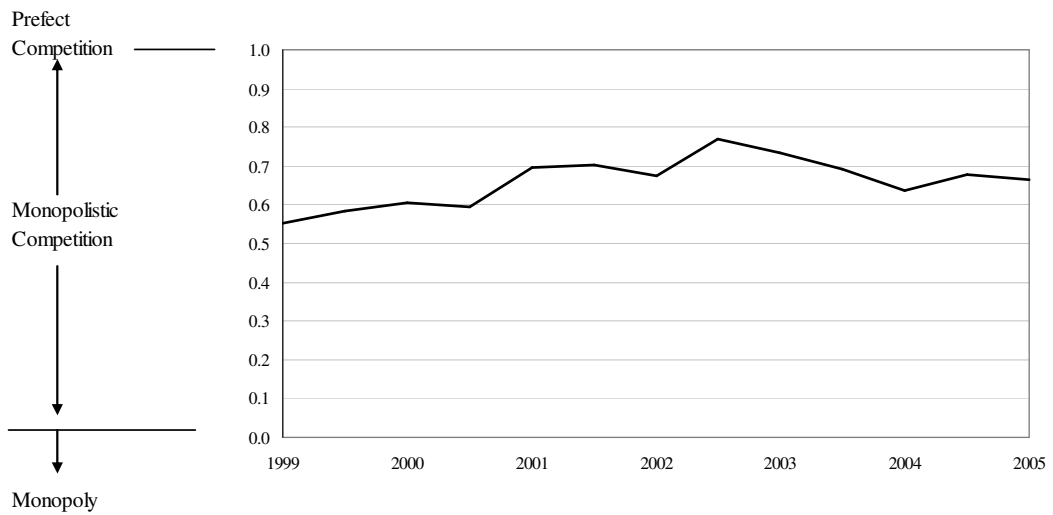
<sup>16</sup>  $H_2 = 0.659$  and  $0.656$  in Models C and D respectively.

**Chart 2: Rolling Estimates of  $H$  statistic of Model A**



Source: HKMA

**Chart 3: Rolling Estimates of  $H$  statistic of Model B**



Source: HKMA

The results of Models C and D suggest that despite significant changes in the operating environment of the banking sector in recent years, competitive pressures have been maintained.

As for the relationship between competitive conditions and bank size, estimation results of Models E and F show that the  $H$  statistic among larger banks<sup>17</sup> has a slightly higher value than that of smaller banks<sup>18,19</sup>. Interestingly, the hypothesis that the  $H$  statistic among larger banks ( $H_L$ ) equals to the  $H$  statistic of smaller banks ( $H_{NL}$ ) is rejected at the 1% level in both Models E and F, suggesting that competitive pressures among larger banks are higher than that among smaller banks. The result is consistent with other studies. For example, Bikker and Haaf (2002), based on a panel dataset of 23 industrialised countries, concluded that competitive pressures were statistically higher among larger banks and lower among smaller banks. A plausible explanation is that while larger banks compete keenly with smaller banks in local retail markets such as mortgages and credit cards, they compete even more fiercely with other competitors at regional or international dimensions in the corporate banking market, wealth management or other off-balance sheet activities where larger banks usually are relatively more heavily involved than smaller banks. This may lead to higher competitive pressures observed among larger banks.

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<sup>17</sup>  $H_L = 0.673$  and  $0.675$  in Models E and F respectively.

<sup>18</sup>  $H_{NL} = 0.648$  and  $0.651$  in Models E and F respectively.

<sup>19</sup> The estimation results are robust to moderate changes on the assumed thresholds for classifying the large banks.

**Table 3: Empirical Results of the Panzar-Rosse Model for the Hong Kong Banking Sector**

Independent Variables	Regression Results			
	Sample Period: 1991 Q1 to 2005 Q4			
	Models			
	A	B	C	D
	Dependent Variables			
	Total revenue/ total assets	Total revenue	Total revenue/ total assets	Total revenue
Constant	-0.007 *** (0.001)	-0.008 *** (0.001)	-0.009 *** (0.001)	-0.010 *** (0.001)
Unit price of labour	0.156 *** (0.008)	0.157 *** (0.009)	0.186 *** (0.011)	0.185 *** (0.011)
Unit price of fund	0.462 *** (0.008)	0.464 *** (0.008)	0.490 *** (0.014)	0.497 *** (0.014)
Unit price of capital	0.022 *** (0.004)	0.020 *** (0.004)	0.007 * (0.004)	0.007 * (0.004)
Unit price of labour*DUM			-0.043 *** (0.016)	-0.046 *** (0.016)
Unit price of fund*DUM			-0.051 *** (0.017)	-0.054 *** (0.017)
Unit price of capital*DUM			0.070 *** (0.010)	0.067 *** (0.010)
CAR	-0.031 *** (0.007)	-0.026 *** (0.007)	-0.025 *** (0.006)	-0.021 *** (0.006)
DM	0.238 *** (0.027)	0.267 *** (0.027)	0.215 *** (0.026)	0.237 *** (0.027)
TA		1.051 *** (0.011)		1.049 *** (0.011)
Growth	0.002 * (0.001)	0.002 * (0.001)	0.002 *** (0.001)	0.002 *** (0.001)
Inflation	0.012 *** (0.003)	0.010 *** (0.003)	0.014 *** (0.002)	0.011 *** (0.002)
<i>H</i> Statistic (1991 Q1 to 2005 Q4)	0.640	0.641		
<i>H</i> Statistic (1991 Q1 to 2001 Q2) ( <i>H</i> <sub>1</sub> )			0.683	0.690
<i>H</i> Statistic (2001 Q3 to 2005 Q4) ( <i>H</i> <sub>2</sub> )			0.659	0.656
No. of banks	30	30	30	30
<i>F</i> -statistic	205.437	417.879	169.722	353.726
Adjusted <i>R</i> -squared	0.617	0.782	0.629	0.792
DW Statistics	1.972	1.967	1.978	1.974
Number of Observations	1,394	1,394	1,394	1,394

Source: HKMA.

- Notes:
1. The regressions are estimated by the feasible generalised least-squares method with cross-section seemingly unrelated regression weights. Except for the variables *growth* and *inflation*, all variables used in the estimation are expressed in first difference form of the natural logarithm of the series. The residuals are specified as an AR(4) process.
  2. Numbers in brackets are standard errors unless specified.
  3. \*, \*\* and \*\*\* denote statistical significance at the 10%, 5% and 1% levels respectively.

**Table 4: Empirical Results of the Panzar-Rosse Model for the Hong Kong Banking Sector (analysis of bank size)**

Independent Variables	Regression Results	
	Sample Period: 1991 Q1 to 2005 Q4	
	Models	
	E	F
	Dependent Variables	
	Total revenue/ total assets	Total revenue
Constant	-0.032 *** (0.008)	-0.032 *** (0.008)
Unit price of labour	0.163 *** (0.009)	0.165 *** (0.009)
Unit price of fund	0.467 *** (0.008)	0.468 *** (0.008)
Unit price of capital	0.019 *** (0.004)	0.018 *** (0.004)
Unit price of labour*Size	-0.015 *** (0.005)	-0.017 *** (0.005)
Unit price of fund*Size	0.026 *** (0.008)	0.027 *** (0.008)
Unit price of capital*Size	0.014 *** (0.004)	0.015 *** (0.004)
CAR	-0.026 *** (0.007)	-0.021 *** (0.007)
DM	0.223 *** (0.026)	0.256 *** (0.026)
TA		1.058 *** (0.011)
Growth	0.002 *** (0.001)	0.002 ** (0.001)
Inflation	0.013 *** (0.002)	0.010 *** (0.003)
<i>H</i> Statistic (large banks) ( $H_L$ )	0.673	0.675
<i>H</i> Statistic (non-large banks) ( $H_{NL}$ )	0.648	0.651
No. of banks	30	30
<i>F</i> -statistic	158.915	328.815
Adjusted <i>R</i> -squared	0.613	0.779
DW Statistics	1.969	1.964
Number of Observations	1,394	1,394

Source: HKMA.

- Notes:
1. The regressions are estimated by the feasible generalised least-squares method with cross-section seemingly unrelated regression weights. Except for the variables *growth* and *inflation*, all variables used in the estimation are expressed in first difference form of the natural logarithm of the series. The residuals are specified as an AR(4) process.
  2. Numbers in brackets are standard errors unless specified.
  3. \*, \*\* and \*\*\* denote statistical significance at the 10%, 5% and 1% levels respectively.

## VI. CONCLUSION

With both the effects of major market liberalisation and consolidation now being more fully realised<sup>20</sup>, this paper re-visits the issue of competitive conditions of the banking industry in Hong Kong, which were first examined in Jiang et al. (2004), to see how the extent of competition has changed in the years subsequent to the last study. Facilitated by a panel dataset of banks and with longer time series of data up to the end of 2005, the paper also aims to provide a more accurate assessment.

The empirical analysis based on the Panzar-Rosse approach reconfirms the previous findings that the degree of competition was fairly high during the period 1992-2002, and suggests that competitive pressures have been maintained in the subsequent years, notwithstanding significant changes in the operating environment.

The estimation results also showed that competitive pressures were higher among larger banks and lower among smaller banks. This may suggest that while larger banks compete with smaller banks keenly in local retail markets on products such as mortgages and credit cards, they may be subject to even stronger pressures from other competitors at regional or international dimensions in the corporate banking market, wealth management and other off-balance sheet activities, where they are more heavily involved.

While relaxation of regulations and advances in technology tend to enhance competition in the banking system, the effect of consolidation may depend on the prevailing market settings. To the extent that bank consolidation in recent years may have hampered competition, regulatory liberalisation and technological progress appear to have largely offset the adverse effect. The emergence of a number of larger banks through mergers and acquisitions, which should have become more capable of competing with existing large banks, may have also contributed to the maintenance of competitive pressures in the sector. Nonetheless, with bank consolidation expected to continue, how market concentration may impact on competition in the years to come needs to be closely monitored.

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<sup>20</sup> The interest rate deregulation was fully completed in July 2001 and a number of other significant liberalisation moves and substantial bank consolidation took place around 2002.

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