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# DEREGULATION, COMPETITION AND CONSUMER WELFARE IN BANKING MARKET: EVIDENCE FROM HONG KONG

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# Deregulation, Competition and Consumer Welfare in Banking Market: Evidence from Hong Kong*

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## Abstract

This paper examines competition among commercial banks following deregulation in a small open economy. I jointly estimate a system of differentiated product demand and pricing equations, and use conduct parameters to identify market structure. The empirical results show that the banking sector is characterized by the Nash-Bertrand equilibrium in which bank size is important for product differentiation. Following deregulation, bank competition intensifies and cost efficiency improves.

*Keywords*: Banking, Conduct Parameters, Consumer Welfare, Demand, Deregulation, Hong Kong, Product Differentiation.

*JEL classifications*: G21, L13

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# 1. Introduction

Governments of many industrialized economies deregulated banking industries in recent decades in an attempt to improve the productivity and efficiency of banks, and promote consumer welfare. Berger and Humphrey (1997) argue quite convincingly that the effects of deregulation should depend greatly on the condition of the industry prior to deregulation, yet a preponderance of the research on policy effects has focused on large industrialized economies;[1] the policy implications in other environments are not well-understood. I examine the effects of banking deregulation in a small open economy in order to better understand the effects of policy changes in which difficulty in reaching a minimum efficient scale presents a natural barrier to entry and in which firms are subject to volatile strongly exogenous shocks. Empirical results show an intensification of competition following deregulation and an improvement in consumer welfare, suggesting that the benefits of deregulation understood in large industrialized economies indeed apply to small open economies.

This paper attempts to enrich the existing literature by examining banking deregulation in a small open economy, Hong Kong, where the market size is limited. In particular, I focus on consumer welfare and the dynamics of market structure in the post-deregulation period. My empirical strategy makes inference about market power based on observations on bank-level data from 23 commercial banks in the loan market during 1997–2004. I propose an oligopolistic framework in which banks, offering differentiated products and facing asymmetric costs, maximize profit by setting prices. Product differentiation is an important determinant of market power in that banks develop a wide range of products to create their market niches. I jointly estimate: (i) a differentiated product demand system based on utility maximization and (ii) first-order conditions derived from bank profit-maximizing behavior. Furthermore, the market structure is identified by the conduct parameters, which capture the interaction of price setting behaviors among banks. Finally, I utilize the structural model to analyze the impacts of banking deregulation on consumer welfare, profit margin and the dynamics of the market structure.

The reasons for considering Hong Kong as an example of a small open economy are three fold. First, the financial integration between Mainland China and Hong Kong reflects the important role of Hong Kong in providing funding to investment in China. Therefore, the banking industry in Hong Kong is crucial for sustaining economic growth in China, which in turn contributes a significant share of the world economic growth. Second, Hong Kong is a global banking center in which 70 of the world's largest 100 banks operate.[2] Thus, the industry is heterogeneous and segmented which provides an ideal setting to analyze the impacts of product differentiation on banking market structure. Third, the collapse of the property market and the Asian financial crisis provide exogenous variations in demand. Exploiting these natural experiments, I can analyze the heterogeneous responses of banks to a new competitive environment.

[1] For example: Berger and Mester (2003) argue that U.S. banks raised their profits and market powers by upgrading product quality during the 1990s in the post-deregulation era. On the other hand, after the 1993 regulatory reform, Angelini and Cetorelli (2003) show that the banking competition in Italy intensified. For a case of developing countries, Kumbhakar and Sarkar (2003) examine the 1992 deregulation of Indian banks and suggest that productivities did not improve.

[2] Sources: http://www.info.gov.hk/info/hkbrief/eng/index.htm

My results indicate that the banking sector is characterized by the Nash-Bertrand equilibrium. There is significant product differentiation among commercial banks and thus the loan market is segmented. The results also suggest that the industry becomes more competitive and the consumers are better-off after the deregulation. Furthermore, I show that the degree of market power and its dynamics are robust to alternative demand specifications with different substitution patterns among banks.

The remainder of the paper is organized as follows. Section 2 discusses the related literature. Section 3 introduces the structural model. Section 4 describes the industry background, data and descriptive statistics. Section 5 presents the estimation procedures. Section 6 reports the empirical results. Section 7 discusses the conclusions.

## 2. Related Literature

Recent empirical literature on banking market structure employs the econometric models developed in the industrial organization literature to analyze the market power of banks through demand estimation. Examples include: Dick (2005), Adam et al. (2007) and Knittel and Stango (2007) for the U.S., Nankane et al. (2006) for Brazil, Ho (2007) for China, and Molnar et al. (2007) for Hungary. In the same vein, another literature adopts the conjectural variation models of Bresnahan (1982,1989) and Lau (1982) to measure market competition.[3] In contrast to previous works, my paper has two novel features. First, I provide a framework to synthesize these two literatures. Second, I perform a joint estimation of a discrete choice model of demand and a profit-maximizing pricing condition. Consequently, I can control for both demand and cost factors and use conduct parameters to measure the market power of banks.

This paper also adds to the new empirical industrial organization literature which examines the properties of conduct parameters in differentiated products models. Nevo (1998) argues that it is difficult to estimate conduct parameters in a differentiated product model due to the large number of conduct parameters. I overcome this problem by formulating conduct parameters as a function of product characteristics, which are time varying and heterogeneous across banks. Furthermore, I look into the dynamics of conduct parameters and show that they are robust to alternative demand specifications.

Finally, the paper contributes to the literature on banking deregulation in Hong Kong. Drake et al. (2006) and Kwan (2006) find that the efficiency of the banking industry improved from 1992 to 1999 using the data envelopment analysis and stochastic frontier approach, respectively. Following Berger and Hannan (1997), Wong et al. (2007a) use a structure-performance model[4] to show that there is no reduced form relationship between market structure and banks' profitability. Using the Panzar and Rosse (1987)

3 For example in homogenous good: Berg and Kim (1994) for Norway, Gruben and McComb (2003) for Mexico, Neven and Roller (1999) for Europe, Shaffer (1989) for the United States, Shaffer (1993) for Canada, Spiller and Favero (1984) for Uruguay and Toolsema (2002) for Netherlands. For the papers using differentiated products framework, see Canhoto (2004) for Portugal, Coccorose (2005) for Italy and Wong et al. (2007) for Hong Kong.

4 In the structural-performance approach, profitability is regressed on concentration and efficiency indices to examine the market power hypothesis and the efficient structure hypothesis, respectively. However, Bresnahan (1989) argues that the price, profit and concentration are jointly determined in equilibrium, thus the regression in the structural-performance approach is endogenous.

approach,[5] Claessens and Laeven (2004), Jiang et al. (2004) and Wong et al. (2006) show that the banking industry belongs to monopolistic competition. Furthermore, Wong et al. (2007b) employ the model of Coccorose (2005) and confirm that the banking sector belongs to monopolistic competition. However, the literature does not discuss the welfare implication of the banking deregulation. Using a structural model of demand and pricing, this paper provides a unified framework to study the market structure, product differentiation and consumer welfare which is relevant to the formulation of banking regulation (Carse, 2001) and competition policy.[6]

# 3. Model

The specification and estimation of the demand system follows Berry (1994), which is based on the aggregation of heterogeneous consumers' discrete choices. The advantage of employing demand models based on product characteristics is to avoid estimating a large number of free parameters due to cross-price elasticities. In the pricing specification, I employ the intermediation model proposed by Klein (1971) and Sealey and Lindley (1977) in which banks use labor, capital and deposits to produce loans as output. To identify market structure, I employ the conduct parameters, which measure the interaction of price setting behaviors among banks.

## 3.1 Demand

The market is defined as the market for loans in Hong Kong. I index banks by $j$ = 1, .., $J$. Consumers borrow from a bank (inside good) or choose the outside good, $j$ = 0. The outside good includes not using any service or employing other financial institutions. For corporate clients, the main competitors in outside alternatives are debt and stock issuance. For retail clients, the competition comes from financial companies which require less collateral but demand higher interest rates than commercial banks. The mean utility of the outside good is normalized to zero but is allowed to vary over time.

Consumers maximize indirect utility by deciding whether to borrow or not and which bank to use. In addition to the lending services, they use other services provided by the bank. Therefore, I use the observed product characteristics to capture the service quality of a bank (i.e., the variety of banking services available or the number of branches). The indirect utility function of a consumer $i$ who borrows from bank $j$ is:

$$\begin{aligned} u_{ij} &= x_j\beta - \alpha p_j + \xi_j + \zeta_{ig} + (1-\sigma)\varepsilon_{ij} \\ &= \delta_j + \zeta_{ig} + (1-\sigma)\varepsilon_{ij} \end{aligned} \quad (1)$$

where $\delta_j$ is the mean utility. The mean utility depends on $p_j$ , the loan interest rate of bank $j$; and $x_j$ , a *K*-dimensional row vector of observed product characteristics of bank $j$. The *K* + 2 dimensional vector $\theta_d = (\beta, \alpha, \sigma)$ represents the demand parameters. The consumer-specific preference is captured by a common deviation for all banks in group $g$, $\zeta_{ig}$ , and a deviation specific to bank $j$, $\varepsilon_{ij}$.

5 It involves a regression of total revenue of a bank on interest expense, staff expense, capital expense and bank assets to quantify the impact of input prices on equilibrium revenue. The sum of the coefficients of the input prices from the revenue regression is known as the *H* statistic which is the sum of elasticity of total revenue with respect to input prices.

6 Currently, the Competition Policy Review Committee is drafting a new competition law in Hong Kong. See Cheng and Wu (1998) for a detailed discussion on competition policy in Hong Kong.

To allow for flexible substitution patterns among products, I use the nested logit framework which allows consumer preferences to be correlated within each of the pre-defined product groups.[7] Following Cardell (1997), I specify $\zeta_{ig} + (1-\sigma)\varepsilon_{ij}$ to be a mean zero stochastic term with iid extreme value type 1 distribution.[8] It captures consumer heterogeneity in preferences for different banks in various groups. The distribution function depends on parameter $\sigma \in [0, 1]$, which measures the relative importance of between-group horizontal product differentiation. If $\sigma$ is close to one, the utility from products within the group becomes more correlated, and hence more substitutable with each other. If $\sigma$ is close to zero, then the grouping of banks is less relevant for consumer' choices, and the model approaches a logit model.

Following Berry (1994), it can be shown that the market share of bank $j$ can be written as

$$s_j = \frac{\exp\left(\frac{\delta_j}{1-\sigma}\right)}{\sum_{k\in G_g} \exp\left(\frac{\delta_k}{1-\sigma}\right)} \frac{\left(\sum_{k\in G_g} \exp\left(\frac{\delta_k}{1-\sigma}\right)\right)^{1-\sigma}}{1+\sum_{g=1}^{G}\left(\sum_{k\in G_g} \exp\left(\frac{\delta_k}{1-\sigma}\right)\right)^{1-\sigma}} \tag{2}$$

The own-price elasticities are given as

$$\frac{\partial s_j(\delta;\theta,\sigma)}{\partial p_j} = \alpha\, s_j \left(s_j - \frac{1}{1-\sigma} + \frac{\sigma}{1-\sigma} s_{j|g}\right) \tag{3}$$

where $s_{j|g}$ is the market share of bank $j$ within its group. The cross-price elasticities are

$$\begin{aligned} \frac{\partial s_j(\delta;\theta,\sigma)}{\partial p_k} &= \alpha s_j \left(s_k + \frac{\sigma}{1-\sigma} s_{k|g}\right) \quad for \quad k \neq j \ and \ k \in G_g \\ &= \alpha s_j s_k \quad for \quad k \neq j \ and \ k \notin G_g \end{aligned} \tag{4}$$

The within-group share and correlation parameters are important to determine the own- and cross-price elasticities within group $g$ and introduce a flexible substitution pattern among banks.

### 3.2 Pricing

Assume banks set their prices in a Bertrand competition. Each bank sets the interest rate to maximize profit

$$\pi_j = [p_j - mc_j(q_j, W_j;\theta_s)]\, s_j(p,x,\xi;\theta_d)M - F_j \tag{5}$$

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7 It avoids the independent of irrelevant alternatives (IIA) property in logit demand which restricts the cross-price elasticities of product $j$ with respect to product $k$ to be equal for all $j$. Thus, cross-price elasticities with respect to a particular product are all equal.

8 It seems iid is a questionable assumption for $\varepsilon_{ij}$ since many households borrow more than once in a year. Rysman (2004) argues that it can be justified by a less restrictive assumption. In the case of loan demand, I can allow $\varepsilon_{ij}$ to be correlated within a household, but require that it is uncorrelated with the amount of loan a household needs to borrow.

where $mc_j$ is the marginal cost, $q_j$ is the total loan produced, $W_j$ is a vector of exogenous input prices, $F_j$ is the fixed cost of bank $j$ and M is the market size. The marginal cost parameter is $\theta_s$. Note that marginal cost depends on output and thus allows for economies of scale. The first order condition for profit maximization of bank $j$, which equalizes marginal revenue and marginal cost, is derived as follows

$$p_j + \left( \frac{\partial s_j(p,x,\xi;\theta)}{\partial p_j} + \sum_{k \neq j} \frac{\partial s_j(p,x,\xi;\theta)}{\partial p_k} \lambda_{jk} \right)^{-1} s_j(p,x,\xi;\theta) \quad = \quad mc_j \tag{6}$$

### 3.3 Conduct Parameter

The conduct parameter $\lambda_{kj} \equiv \frac{\partial p_k}{\partial p_j} \in [-\infty, 1]$ is a $J^2$ vector value. It measures market power by the deviation of the perceived marginal revenue curve from the demand schedule.[9] If banks collude with each other to act as a joint monopoly, they match prices and internalize the substitution effect. The loan interest rate is set by equalizing marginal cost and marginal revenue of the joint monopoly, i.e. $\lambda_{kj}$ = 1 for all ($k$, $j$) pairs. If banks act as price takers, they do not perceive any difference between their marginal revenue and demand functions. When a bank raises its interest rate to borrowers, it perceives there are some banks that will reduce the rate to $-\infty$ to acquire all its borrowers. Therefore, for each bank $j$, $\lambda_{kj}$ = $-\infty$ for some $k$ corresponds to the competitive equilibrium. Intermediate values of $\lambda_{kj}$ corresponds to oligopolistic competition. In particular, $\lambda_{kj}$ = 0 for all ($k$, $j$) pairs, where $k \neq j$, corresponds to the Nash-Bertrand equilibrium in which banks expect competitors to not respond to changes in their loan interest rates and the pricing equations coincide with the pricing equations of a monopoly.

In practice, I estimate the model with time varying and heterogeneous conducts across banks. To understand the identification of conduct parameters, it is useful to focus on a restricted version of the model.[10] Suppose $\lambda_{kj} \equiv \lambda_j$ , then the conduct parameters can be expressed as:

$$\lambda_j \quad = \quad -\frac{1}{\sum_{k \neq j} \frac{e_k}{p_k}} \left( \frac{1}{p_j - mc_j} + \frac{e_j}{p_j} \right) \tag{7}$$

where $e_j = \frac{\partial s_j(p,x,\zeta;\theta)}{\partial p_j} \frac{p_j}{s_j(p,x,\zeta;\theta)}$ and $e_{jk} = \frac{\partial s_j(p,x,\zeta;\theta)}{\partial p_k} \frac{p_k}{s_j(p,x,\zeta;\theta)}$

As shown in equation (7), the sign of the conduct parameter is determined by the observed price-cost margin and own-price elasticity. If the observed price-cost margin is larger than that obtained from the Nash-Bertrand equilibrium, i.e. $\frac{p_j - mc_j}{p_j} > \frac{1}{|e_j|}$ , the model implies that the industry is less competitive than that in the Nash-Bertrand equilibrium. In a collusive regime, high cross-price elasticities foster coordination among banks. Thus, the model relies less on market power to match the observed price-cost margin, and hence the conduct parameters move closer to zero from the positive side. On the other hand, in a competitive regime with high cross-price elasticities, banks need more market power to achieve the observed price-cost margin. As a result, the conduct parameters move towards zero from the negative side.

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9 Corts (1999) argues that, in some cases, the conduct parameter may not be able to infer market power. In my case, I use annual data which is less problematic according to his simulations.

10 For the identification result for the unrestricted model, see Nevo (1998).

The identification shows that product substitutability affects the conduct parameters through own- and cross-price elasticities. To obtain reliable estimates of conduct parameters, it is important to employ a demand specification with flexible substitution patterns. Therefore, in the empirical section, I will utilize three alternative nested logit demand models and a log-linear demand model to check the robustness of parameter estimates.

# 4. Banking Industry in Hong Kong

In the last two decades, the Hong Kong banking industry experienced dramatic transformations.[11] First, interest rate deregulation, initiated in 1994 and completed the last phase in 2001, abolished interest rate rules in the deposits market.[12] Kwan (2003) finds that deregulation reduces the market value of banks due to the negative impact on profit in the deposit market. Second, there were new entrants from abroad through merger and acquisition following the removal of branching restrictions for foreign banks in 2001 and the relaxation of market entry criteria in 2003. Among these events, the largest one was the partial privatization of the Bank of China (Hong Kong) in 2001.[13] The 10 members[14] of the Bank of China Group merged into the Bank of China (Hong Kong) and later on listed in the Hong Kong Stock Exchange in July 2002. Chen et al. (2005) show that there were adverse effects on the returns of financial institutions in Hong Kong after the announcement regarding the privatization of the Bank of China (Hong Kong). Furthermore, the Development Bank of Singapore (DBS) acquired Dao Heng Bank in 2001 and then merged with DBS Kwong On Bank and the Overseas Trust Bank into DBS Bank (Hong Kong) in 2003. Consequently, the industry has become more concentrated since the year 2001 (Wong et al., 2006).[15]

## 4.1 The Data

The data are extracted from BANKSCOPE for the years from 1997 to 2004.[16] The sample consists of balance sheet information of 23 commercial banks with 169 observations.[17] The sample of banks is listed in Appendix 1. The data contains bank assets, customer loans, interest income, interest expenses, personnel expenses and total operating expenses. Due to data limitations, the analysis cannot differentiate between loan types (i.e., consumer and corporate loans). If banks compete with each other in the consumer and corporate loan markets, the conduct parameters capture the average competitive conduct in these two markets. However, the behavior of banks in each submarket can be different from the one implied by the conduct parameters.

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[11] For detailed history of banking industry in Hong Kong, see Jao (1997).

[12] The interest rate rules apply to: (a) current accounts, (b) savings accounts, (c) 24-hours call deposits, (d) 7-day call deposits, (e) deposits with maturity up to 15 months.

[13] A detailed list of consolidations can be found in Jiang et al. (2004).

[14] They include the Bank of China, China and South Sea Bank, China State Bank, Hua Chiao Commercial Bank, Kincheng Banking Corporation, Kwangtung Provincial Bank, National Commercial Bank, Po Sang Bank, Sin Hua Bank, and Yien Yieh Commercial Bank.

[15] They use HHI, the sum of the squared market shares of all retail banks in the market, as a measure of industry concentration.

[16] The database only provides the data for 8 consecutive years.

[17] I use the data from the category “Commercial Banks”. Although the sample has a wide coverage as shown in Bhattacharya (2003) and Cunningham (2001), it may not cover all foreign banks. In the sample of Hong Kong, the data on Citibank and Standard Chartered Bank are not complete. Therefore, I do not include them in the analysis. It is expected that my sample contains commercial banks focusing more on retail market which tend to be less competitive.

The nested structure captures the fact that consumers have different borrowing needs, thus they choose a type of bank first, and then choose a bank. I use three specifications of nested logit demands. The first specification *Nlogit1* has two groups of banks, namely *Listed* and *Non-listed*. Large banks in Hong Kong are usually listed on the Hong Kong Stock Exchange and therefore the grouping can also be interpreted as a classification by bank size. Large banks typically have stronger financial strength and better risk management than small banks and also tend to focus more on corporate clients.[18] Therefore, the grouping captures the diversity of consumer preferences. In the second specification *Nlogit2*, I divide the group *Listed* into two groups according to their asset sizes. The group *Listed-1* contains banks that have more than 100 billion HKD assets and the remaining listed banks belong to *Listed-2*. Finally, the third specification *Nlogit3* assigns HSBC and the Bank of China in *Listed-1* and the remaining listed banks in *Listed-2*. Utilizing a more detailed nesting structure, these two specifications aim to capture the consumers' choices more closely. Hence, the model can produce more realistic substitution patterns among banks. The groupings of banks in those three nested logit demands are shown in Appendix 1.

In the empirical analysis, I supplement the bank-level data with a set of aggregate variables, including CPI, GDP, the wage index and the property price index. The CPI, GDP and wage index are obtained from CEIC whereas the property price index is obtained from the overall residential series in Chau et al. (2005). Appendix 2 shows the time series of these aggregate variables. The nominal variables, namely GDP and bank-level variables, are deflated to price level at year 2000.

### 4.2 Stylized Facts

The descriptive statistics of bank characteristics are reported in Table 1 and 2. Following the model *Nlogit1*, I classify banks into two groups: *Listed* and *Non-listed*. Then, I further categorize the *Listed* into two groups, namely *Listed-1* and *Listed-2*, according to the model *Nlogit2*.

Two empirical patterns emerge from Table 1. First, the industry involves a wide range of banks with different levels of financial resources, human resources and physical capacities. The listed banks are more than eight times larger than the non-listed counterparts in terms of assets, customer loans, interest income, interest expenses, personnel expenses and total operating expenses. The large listed banks are about ten times larger than the small listed banks in terms of those characteristics. The standard deviations of bank characteristics in *Listed-1* are large because HSBC and the Bank of China (Hong Kong) are much larger than the other banks in that group. For this reason I use model *Nlogit3* to address the differences within this group in the estimation. Second, the factor shares are similar across banks. For all types of banks, the interest expenses are twice as much as total operating expenses which turns out to be twice as much as personnel expenses.

[18] Although banks usually cover all kinds of loans, they do specialize in a segment of lending markets, such as mortgage, consumer finance (such as credit card), small and medium enterprise loans, and corporate lending. In Hong Kong, small banks place more emphasis on mortgage and credit card businesses whereas large banks cover a wider range of lending services. However, due to data limitations, I cannot analyze nested logit demand models with domestic and foreign banks, or retail and wholesale banks.

Figure 1 displays the median values of the ratio between interest margin to total asset size (solid line) and the ratio between total operating expenses to asset size (dash line).[19] Both series were decreasing over the sample period. Jiang et al. (2003) report that mortgages account for about 30% of lending. The drop in interest income results from the 300 basis points drop in the mortgage rate over the period 1997–2003. In response to the change, banks maintain their interest margins by reducing interest expenses.[20] However, total operating expenses decreased at a slower rate than the interest margin throughout this period,[21] which put further pressure on banks' profits. Lower profits can be explained by more competitive markets or weaker demand. In the empirical section, I will employ a structural model to disentangle the competitive effects from demand and cost factors.

# 5. Estimation

In this section, I specify the parametric forms for demand and cost functions. Then, I outline the estimation procedures.

### 5.1 Demand Function

Integrating the individual utilities to obtain the estimating equation, Berry (1994) shows that the demand equation has the following form

$$\ln(s_{jt}) - \ln(s_{0t}) = x_{jt}\,\beta - \alpha\, p_{jt} + \sigma\, \ln\left(s_{j|gt}\right) + \xi_{jt} \quad (8)$$

I use total customer loans to measure the output for each bank, $q_{jt}$. The market size $M_t$ is the total loan output in the market multiplied by a scaling factor, $r$ = 0.3.[22] The scaling factor captures the potential market size in addition to the existing consumers. The market share of bank $j$ is $s_{jt} = \frac{q_{jt}}{(1+r)*\sum_{k=1}^{J} q_{kt}}$ and the share of the outside good is $s_{0t} = 1 - \sum_{k=1}^{J} s_{kt}$. The price of output for bank $j$, $p_{jt}$, is measured by the interest rate earned on loans, which is calculated as the ratio of interest income to total customer loans.

The vector of variables included in the mean utility is

$$x_{jt} = \{\, d\ln Y_t,\ d\ln Ph_t,\ \ln Asset_{jt},\ Year,\ 1\} \quad (9)$$

[19] Interest margin is defined as interest income minus interest expenses. Asset size is a denominator for normalization.

[20] During the period between 1997–2004, the median interest income decrease from 2.50 to 1.94 billion HKD, whereas the median interest expenses decreased from 1.54 to 0.57 billion HKD.

[21] The ratio between interest margin to total operating expenses is reduced from 1.86 in 1997 to 1.50 in 2004.

[22] Ivaldi and Verboven (2005) show that demand estimation is robust to the scaling factor on potential market size.

The product characteristics are represented by $Asset_{jt}$, which is total assets minus total customer loans. It captures vertical differentiation since large banks have a wider range of lending services and better personnel and physical resources to provide to consumers.[23] Moreover, I use the real GDP growth, the growth of property price and time trend to allow the mean utility of using inside good to be time varying and affected by the aggregate economy.

### 5.2 Cost Function

Utilizing the literature on estimating bank cost functions,[24] I employ the translog cost function in this study. In the case of Hong Kong, this cost function is already used by Kwan and Lui (1999) and Kwan (2006) to examine the effect of deregulation on the cost efficiency of the banking industry. In this paper, I use a three factor translog cost function as suggested in the intermediation model

$$\begin{aligned}\ln tc_{jt} &= \gamma_0 + \gamma_1 \ln q_{jt} + \tfrac{\gamma_2}{2}(\ln q_{jt})^2 + \sum_{k=1}^{3} \gamma_{2+k} \ln q_{jt} \ln Wk_{jt} + \sum_{k=1}^{3} \gamma_{5+k} \ln Wk_{jt} \\ &+ \sum_{k=1}^{3} \gamma_{8+k} (\ln Wk_{jt})^2 + \gamma_{12} \ln W1_{jt} \ln W2_{jt} + \gamma_{13} \ln W1_{jt} \ln W3_{jt} + \gamma_{14} \ln W2_{jt} \ln W3_{jt}\end{aligned} \quad (10)$$

where $tc_{jt}$ is total cost and $q_{jt}$ is loan output. $W1_{jt}$ ,$W2_{jt}$ and $W3_{jt}$ are exogenous input prices on labor, capital and deposits, respectively. The marginal cost can be written as

$$\begin{aligned}mc_{jt} &= AC_{jt}(\gamma_1 + \gamma_2 \ln q_{jt} + \gamma_3 \ln W1_{jt} + \gamma_4 \ln W2_{jt} + \gamma_5 \ln W3_{jt}) + \gamma_y year + \gamma_a Asset_{jt} \\ &= c_{jt}\theta_s\end{aligned} \quad (11)$$

where $AC_{jt} \equiv \dfrac{tc_{jt}}{q_{jt}}$ is the average cost, $c_{jt}$ is the vector of variables related to marginal cost and $\theta_s$ contains the marginal cost parameters. The cost of labor, $W1_{jt}$, is measured as the ratio of personnel expenses to total assets.[25] The cost of capital, $W2_{jt}$, is measured as the ratio of total operating costs net of personnel expenses to total assets. The cost of deposit, $W3_{jt}$, is measured as the ratio of interest expenses to total asset. In order to control for aggregate and bank-specific factors in the marginal cost function, I include time trend and asset size in the set of cost variables. As suggested in Bresnahan (1989, p. 1034), I impose linear homogeneity in input prices, i.e. $\beta_3 + \beta_4 + \beta_5 = 0$, to identify the conduct parameters. For the nested logit demand and translog cost function, the pricing equation is derived as

$$p_{jt} = c_{jt}\theta_s + \frac{1}{\alpha}\left(\left(s_{jt} - \frac{1}{1-\sigma} + \frac{\sigma}{1-\sigma} s_{j|gt}\right) - \lambda_{jt}\left(\sum_{k \neq j,0} s_{kt} + \frac{\sigma}{1-\sigma} \sum_{k \neq j,0 \ \& \ k \in G_g} s_{k|gt}\right)\right)^{-1} + \omega_{jt} \quad (12)$$

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23 Bower et al. (2003) argue that, first, large banks have better opportunities to attract talented employees to provide high quality and diversified services. For example, affluent consumers require more sophisticated financial services, such as financial planning, to fulfill their needs. Second, large banks have financial and human resources to upgrade consumer services by employing information technology and expanding distribution network. Third, large banks have a lower cost of funding and better risk management to handle high lending risks. Moreover, Fung and Cheng (2004) show that large banks are more likely to adopt financial innovations such as option and swap contracts to increase non-interest income and diversify the income sources.

24 See Berger and Humphrey (1997) and the references therein.

25 Due to the lack of data on number of employees, this approximation is also used in Claessens and Laeven (2004) and Jiang et al. (2004) for wage rate in the Panzar-Rosse Regression.

where $\omega_{jt}$ is the random cost shock to bank $j$ in year $t$.

In order to study market competition, I postulate the heterogeneous conduct parameters as follows

$$\lambda_{jt} = v_{jt}\varphi \quad (13)$$

where $v_{jt}$ = {1, $year$, $Asset_{jt}$ - $rAsset_{jt}$} and $\varphi$ is a vector of parameters to be estimated. The first two terms capture the time varying average competitive conduct in the industry. Additionally, the term $Asset_{jt} - rAsset_{jt}$ represents the size effect on market power, where $rAsset_{jt}$ is the average asset size of rival banks in the same group. Note that the product characteristics, $Asset_{jt}$, enters into both demand and pricing equations. The effects of product characteristics on demand and interest rate are separately identified by these two equations from the structural model.

### 5.3 Empirical Implementation

The unobserved product characteristics are captured by the error term in the equation (8). Equilibrium prices and market shares depend on the observed and unobserved product characteristics, and therefore the regressor $p_{jt}$ and ln ($s_{j|gt}$) are correlated with the unobservable $\xi_{jt}$. The correlations are positive and therefore the OLS estimator of $\alpha$ is biased toward zero (i.e. it under-estimates the own-price elasticity). The parameter $\sigma$ is also biased upwards, which overestimates product differentiation among different types of banks. I handle these endogeneity problems using the instrumental variables approach. To estimate the demand equation, I use the following set of instruments[26]

$$z_{jt} = \{\ AC_{jt}, W1_{jt}, W2_{jt}, W3_{jt}, HIBOR_t, Wage_t, listed_{it}\ \} \quad (14)$$

It includes average cost, input prices, the Hong Kong Interbank Offered Rate (HIBOR), the wage index and the dummy variable for listed banks.[27] HIBOR is the rate at which Hong Kong dollar-denominated instruments are traded between banks in Hong Kong and reflects the cost of funding of banks. A lower rate in the HIBOR reduces the cost of funding and allows banks to price loans more aggressively. Similarly, I use the same set of variables to instrument for output in the pricing equation.

The estimation procedure is as follows: Let $z$ = ($z_d, z_s$) be the set of instruments to be used, where $z_d$ and $z_s$ are the instruments for demand and pricing equations, respectively. I assume $z$ is exogenous and independent of the error terms in the demand and pricing equations and therefore $z_d$ and $z_s$ are correspondingly orthogonal to $\xi$ and $\omega$. Utilizing the conditions $E(z_d\xi)$ = 0 and $E(z_s\omega)$ = 0, I construct the following set of moment equations

$$m = \begin{bmatrix} z_d'\xi \\ z_s'\omega \end{bmatrix} \quad (15)$$

Define $\theta$ = {$\theta_d, \theta_s$}, the general method of moment (GMM) estimator given my moment conditions, as

$$\min_{\theta} \ m'(z'\Omega z)m \quad (16)$$

[26] Berry (1994) suggests that the average product characteristics of competitors in the same group is another set of valid instruments. However, it does not further control the endogeneity problem for my sample, thus I do not include them in the analysis.

[27] For the model with two types of listed banks, there is a dummy variable for each type of banks.

where $\Omega$ is the optimal weighting matrix. The joint estimation of demand and pricing equations have two advantages. First, it imposes a cross-equation restriction on the interest rate coefficient, thereby improving the identification of that coefficient. Second, there is a gain in efficiency from exploiting the correlation in the error structure induced by the interest rate.

# 6. Empirical Results

In this section, I present the estimates from the joint estimation of demand equation (8), pricing equations (12) and conduct parameters (13).

## 6.1 Demand and Marginal Cost

Table 3 shows the estimated demand and marginal cost parameters.[28] All specifications show similar results on many of the variables. The coefficient on ln($s_{j|g}$) of *Nlogit1* is positive and significant at 0.04. It suggests that the loan markets for listed and non-listed banks are segmented. The nests in the other two specifications also show their significance in explaining consumers' choices. Moreover, as shown in model *Nlogit2* and *Nlogit3*, horizontal product differentiation between the large and small listed banks is another important determinant of loan demand.

Looking into the bank characteristics, the coefficient on ln($Asset$) is positive and significant. Borrowers prefer large banks to small banks and thus asset size plays a role in vertical product differentiation in addition to horizontal product differentiation. The parameter estimates on aggregate variables suggest that the mean utility of using the inside good is time varying. The negative time trend shows that mean utility is diminishing over time, or equivalently that demand for loans from commercial banks is shrinking. Moreover, the cyclical components of mean utility are significant. Positive real GDP growth brings up loan demand, whereas growth in property prices reduces loan demand as consumers are less interested in borrowing for mortgages.[29]

On the supply side, the coefficient on time trend is negative, which implies banks becoming more cost-efficient. Although the demand is shrinking over the sample period, the marginal cost is also decreasing which allows banks to approximately maintain their profit margins over the sample. Moreover, banks have lower marginal cost if the ratio of personnel expenses to total assets is higher or if the ratio of interest expenses to total assets is lower. As banks recruit more talented high-wage employees, they are more efficient in handling the expansion of lending. On the other hand, high interest payments increase marginal cost. Furthermore, the coefficient on the interaction terms of *AC* and log *q* is negative in model *Nlogit1*. It provides evidence that banks have economies of scale where marginal cost is decreasing with output.[30]

[28] The over-identification test in my model is a joint specification test of the demand model, pricing model, and validity of the instruments. Therefore, the J-statistics are less useful to justify the validity of the instruments.

[29] The interpretation of the coefficient on price is conditional on GDP growth, which is related to the expectation of the future property price. Therefore, the coefficient on price captures the price effect of rising property on loan demand rather than the income effect due to the expectation of future property price.

[30] The marginal cost can increase in output if an additional client imposes high auditing and monitoring costs on the banks. Nonetheless, economies of scale dominate the net effect.

### 6.2 Price Elasticities

The coefficients on price are negative and significant. In order to compare the price coefficient across models, it is informative to compute own- and cross-price elasticities according to equations (3) and (4), respectively. Table 4 presents the elasticities for each model. I report the cross-price elasticities for banks within the same group and that for banks in different groups separately.

The own-price elasticities are about 1.6 and 1.4 for non-listed and listed banks, respectively. It indicates banks set their interest rates on the elastic portion of the demand curve, which is consistent with profit maximizing behavior. Moreover, large banks have stronger pricing power than small banks. The cross-price elasticities indicate consumers substitute among banks. The within-group cross-price elasticities of listed banks and between-group cross-price elasticities of non-listed banks are about 0.36. On the other hand, the between-group cross-price elasticities of listed banks and within-group cross-price elasticities of non-listed banks are about 0.01 and 0.02, respectively. There is evidence that a more detailed nesting structure delivers a more flexible substitution pattern. First, there is larger variation in own-price elasticity across banks according to their size. Second, the cross-price elasticities in model *Nlogit3* is less similar to that which would be obtained from a logit model.

### 6.3 Identifying Market Structure

Turning to the market structure, all specifications with a constant conduct parameter suggest the industry is characterized by Nash-Bertrand equilibrium in which $\lambda$ is about 0.7 but insignificant (shown in Appendix 3).[31] These findings restrict the equilibrium notion of monopolistic competition as shown in Claessens and Laeven (2004), Jiang et al. (2004) and Wong et al. (2006) to be Nash-Bertrand equilibrium, as in Wong et al. (2007b). Comparing to the literature, the banking industry in Hong Kong is less competitive than that documented in Coccorese (2005) for Italy. There are two reasons for the difference. First, Hong Kong has stronger interest rate regulations and entry restrictions. Second, banks cannot fully exercise economies of scale in Hong Kong due to the small market size. As a result, the market can only support a small number of banks and hence the banking industry is more concentrated and less competitive.

Looking into the dynamics of market structure, the aggregate time varying component $\varphi_t$ implies the degree of competition improves over the sample period. It indicates that the banking deregulation successfully introduces more competition to the industry. The results also suggest that tougher market competition is a factor to explain the decline in interest income shown in Table 2.

The coefficient on the bank-specific component $\varphi_a$ in model *Nlogit3* is positive and significant. Thus, large banks have more market power than small banks in the same group. Asset size characterizes competitive behaviors through capacity constraint in two respects: physical capacity and financial strength.[32] If a small bank is capacity constrained, the marginal cost for expanding business is higher and hence less responsive to the expansions of other banks. Therefore, large banks perceive small banks will match their prices more closely than small banks expect large banks to match their prices.

[31] In this section, I focus on the models with heterogeneous conduct. The estimation results for models with constant conduct parameters are shown in Appendix 3. The coefficients on demand and cost parameters are similar to those shown in Table 3.

[32] In a homogenous good framework, Kreps and Scheinkman (1983) show that capacity choice determines the form of competition. As the capacity constraint becomes more stringent, the competition between producers of homogeneous good move from Bertrand to Cournot competition.

On the other hand, the parameter estimate of $\varphi_a$ in model *Nlogit1* is negative. This is because although large banks in each group have stronger market power than small banks, the group of mega-banks (i.e., HSBC and the Bank of China (Hong Kong)) have weaker market power than the group with other listed banks. The strong competitive pressure on mega-banks comes from the fact that their clients have access to foreign banks and additional alternative sources of funding.

Table 6 presents the ratio between markups (i.e., $p_{jt} - mc_{jt}$) in 2004 to that in 1997. Using equation (12), I compute the average of the ratio for listed, non-listed and all banks. The ratio indicates the changes in markup controlling for demand and cost factors, which indicates the competitive effect of the deregulation on banks' profit. If the ratio is lower than one, then the markups of banks are lower in 2004 than those in 1999. It suggests that banks faced stronger pressure on their profits in the post-deregulation period. According to all models shown in Table 6, the average markups do not change significantly over the sample period. However, the average change may mask the underlying dynamics of markups across different groups of banks. Looking into models *Nlogit2* and *Nlogit3*, the estimates show that the markups of large banks are reduced by 2.6% and 6.3%, respectively. It confirms that large banks face more competition after the deregulation. Moreover, the results shed light on competitive behavior of banks of various sizes. Gerlach et al. (2005) argue that, since the source of funding for large banks involves a higher proportion of interbank borrowing,[33] a lower rate in the HIBOR[34] enables large banks to become more competitive in loan pricing, and hence increase interest income. My results suggest that, even though the markups of large banks are shrinking over time, they maintain their interest incomes by acquiring larger market share.

The evidence from Hong Kong is consistent with the competitive effects of liberalizations documented in Drees and Pazarbasioglu (1998) for Finland, Norway and Sweden; Gruben and McComb (2003) for Mexico; and Shaffer (1993) for Canada. They find that banks pursue a strategy to acquire market share in the post-liberalization period and become more competitive. There are additional reasons this phenomenon occurs in Hong Kong. First, while the mass banking market is mature, expanding into the market of affluent consumers requires large fixed cost expenditures to upgrade consumer services and entry into the Chinese market requires a large asset base. Facing these situations, small and medium banks compete more aggressively in the local market. Second, entries of foreign banks such as DBS and Bank of China added to competitive pressures.

### 6.4 Consumer Welfare

In this section, I utilize the structural model of demand to evaluate the welfare effect of the deregulation. In the nested logit model, the consumer surplus to a consumer generated by a set of products can be written as

$$CS_i = \frac{\log\left(1 + \sum_{g=1}^{G}\left(\sum_{k\in G_g}\exp\left(\frac{\delta_k}{1-\sigma}\right)\right)^{1-\sigma}\right)}{\alpha} \quad (17)$$

33 Part of the funding comes from some conservative small banks since they have difficulty in lending to individuals and firms. Moreover, they put more funds into the reserve or lend more money to interbank market to earn interest.

34 As shown in Appendix 2, the HIBOR drops from 7% to 0.4% during the sample period.

Following Nevo (2000), I use the compensating variation to measure the change in consumer welfare. McFadden (1981) and Small and Rosen (1981) show that the compensating variation for a consumer $i$ is given by

$$CV_i = \frac{CS_i^{2004} - CS_i^{1997}}{\alpha} \tag{18}$$

where $CS_i^{1997}$ and $CS_i^{2004}$ are consumer surplus in year 1997 and 2004. Therefore, $CV_i$ represents the compensating variation for each dollar borrowed from banks. Equivalently, it is the percentage change in consumer welfare.

Table 6 displays the compensating variation for two cases: $CV_{i1}$ and $CV_{i2}$. The first specification computes the welfare changes including all components in the mean utility. The results for $CV_{i1}$ suggest that consumer welfare is worsening by 0.01 – 0.11%. However, there is a long-run trend in the mean utility which cannot be altered by the deregulation. To overcome this problem, I calculate the compensating variation excluding the time trend and constant terms in the mean utility. In this case, the consumer welfare is improved by 7% in the post-deregulation regime. From the results, I infer that there is a welfare gain from the deregulation which comes from lower interest rates and better products.[35]

### 6.5 Robustness Test with Alternative Model

Finally, as a robustness check, I estimate the model with a log-linear demand which allows cross-price elasticity to be estimated separately from own-price elasticity. The choice of log-linear demand is because it is often used in banking research (i.e., Canhoto, 2004, Coccorose, 2005 and Wong et al., 2007b). Moreover, this form of demand is simple to estimate and yet Huang et al. (2006) demonstrate that it is robust to misspecification as long as the representative consumer specification is correct (i.e., AIDS and log-log demands).

The log-linear demand for bank $j$ is specified as follows

$$\begin{aligned} \ln q_{jt} &= \alpha_0 + \alpha_1 \ln p_{jt} + \alpha_2 \ln p_{-jt} + \alpha_3 d \ln Y_t \\ &\quad + \alpha_4 d \ln Ph_t + \alpha_5 \ln Asset_{jt} + \alpha_6 Year + \varepsilon_{jt} \end{aligned} \tag{19}$$

where $\varepsilon_{jt}$ is a random error term representing contemporaneous demand shocks and the price index is the total asset weighted average of competitor prices $p_{-jt} \equiv \sum_{k \neq j,0} \frac{q_k}{\sum_{m \neq j,0} q_m} p_k$. The price index of competitors reduces the number of conduct parameters and addresses the identification issues discussed in Nevo (1998). Using the log-linear demand the pricing equation (6) can be rewritten as

$$p_{jt} = c_{jt}\theta_s + \frac{1}{\frac{\alpha_1}{p_{jt}} + \lambda_t \frac{\alpha_2}{p_{-jt}}} + \omega_{jt} \tag{20}$$

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[35] It is also consistent with the stylized facts that, over the sample, assets and loans were increasing, but the interest income was decreasing.

where $\omega_{jt}$ is a random cost shock. I estimate this specification for the cases of constant-conduct and heterogeneous-conduct.

The results from joint estimation of equations (19) and (20) are shown in Table 7. Many of the estimates of the demand and pricing equations have the same signs as the previous models. However, the parameters in the pricing equation are less significant. The conduct parameter is positive and significant at 0.26, which is larger than in the nested logit demand models. This result is driven by high own-price elasticities in the log-linear demand so that the model relies more on market power to generate the observed price-cost margin. Moreover, the result confirms that the industry became progressively more competitive over the sample period and that large banks have more market power than small banks. Therefore, the conclusions from the nested logit models are robust to the choice of demand models.

# 7. Conclusion

In this paper, I examine the competitive and welfare effects of banking deregulation in Hong Kong. Using an empirical framework taken from the industrial organization literature, I estimate the parameters of consumer preferences, marginal costs, and bank conduct. I find that the banking market in Hong Kong is characterized by Nash-Bertrand competition. Both horizontal and vertical product differentiation are important determinants of consumer demand. Moreover, after deregulation the industry becomes more competitive and consumer welfare is higher. Future research might attempt to more closely examine the role of product characteristics in market power acquisition. Finally, the framework and results of this paper might be particularly useful in analysis of the welfare implications of industry consolidation.

# References

Adams, Robert M., Kenneth P. Brevoort and Elizabeth K. Kiser (2007), "Who Competes with Whom? The Case of Depository Institutions," *Journal of Industrial Economics*, LV: 141-67.

Berg, Sigbjorn Atle and Moshe Kim (1994), "Oligopolistic Interdependence and the Structure of Production in Banking: An Empirical Evaluation," *Journal of Money, Credit, and Banking*, 26: 309-22.

Berger, Allen N. and Timothy H. Hannan (1997), "Using Efficiency Measures to distinguish among Alternative Explanations of the Structure-Performance Relationship in Banking," *Managerial Finance*, 23(1): 6-31.

Berger, Allen N. and David B. Humphrey (1997), "Efficiency of Financial Institutions: International Survey and Directions for Future Research," *European Journal of Operations Research*, 98: 175-212.

Berger, Allen N. and Loretta J. Mester (2003), "Explaining the Dramatic Changes in Performance of US Banks: Technological Change, Deregualtion, and Dynamic Changes in Competition," *Journal of Financial Intermediation,* 12: 57-95.

Berry, Steven (1994), "Estimating Discrete Choice Models of Product Differentiation," *Rand Journal of Economics*, 25(2): 242-62.

Bhattacharya, Kaushik (2003), "How Good Is the BankScope Database? A Cross-Validation Exercise with Correction Factors for Market Concentration Measures," BIS Working Paper No. 133, Basle.

Bikker, Jacob A. and Katharina Haaf (2002), "Competition, Concentration and their Relationship: An Empirical Analysis of the Banking Industry," *Journal of Banking and Finance,* 26: 2191-214.

Bower, Tab., Greg Gibb and Jeffrey Wong (2003), *Banking in Asia: Acquiring a Profit Mindset,* 2nd ed., John Wiley & Sons.

Bresnahan, Timothy F. (1982), "The Oligopoly Solution Concept is Identified," *Economic Letters*, 10: 87-92.

Bresnahan, Timothy F. (1989), "Empirical Studies in Industries with Market Power," in *Handbook of Industrial Organization,* 2: 1011-58.

Canhoto, Ana (2004), "Portuguese Banking: A Structural Model of Competition in the Deposits Market," *Review of Financial Economics,* 13: 41-63.

Cardell, N Scott (1997), "Variance Components Structures for the Extreme-Value and Logistic Distributions with Application to Models of Heterogeneity," *Econometric Theory,* 13: 185-213.

Carse, David (2001), "Bank Consolidation in Hong Kong," *Hong Kong Monetary Authority Quarterly Bulletin,* August: 52-6.

Cetorelli, Nicola and Paolo Angelini (2003), "The Effects of Regulatory Reform on Competition in the Banking Industry," *Journal of Money, Credit, and Banking*, 35(5): 663-84.

Chau K.W., S.K. Wong, C.Y. Yiu and H.F. Leung (2005), "Real estate price indices in Hong Kong," *Journal of Real Estate Literature,* 13: 337-56.

Chen, Zhian, Donghui Li and Fariborz Moshirian (2005), "China's Financial Services Industry: The Intra-Industry Effects of Privatization of the Bank of China Hong Kong," *Journal of Banking and Finance,* 29: 2291-324.

Cheng, Leonard, K. and Changqi Wu (1998), *Competition Policy and the Regulation of Business,* The City University of Hong Kong Press, Hong Kong.

Coccoresez, Paolo (2005), "Competition in Markets with Dominant Firms: A Note on the Evidence from the Italian Banking Industry," *Journal of Banking and Finance,* 29(5): May, 1083-93.

Corts, Kenneth, (1999), "Conduct Parameters and the Measurement of Market Power," *Journal of Econometrics,* 88: 227-50.

Claessens, Stijn and Luc Laeven (2004), "What Drives Bank Competition? Some International Evidence," *Journal of Money, Credit, and Banking,* 36: 563-83.

Cunningham, Alastair (2001), "Assessing the Stability of Emerging Market Economies' Banking Systems," *Financial Stability Review,* Bank of England, 11, December: 187-92.

Dick, Astrid (2005), "Demand Estimation and Consumer Welfare in the Banking Industry," Federal Reserve Bard, Finance and Economics Discussion Paper, 2002-58, revised version.

Drake, Leigh, Maximilian J.B. Hall and Richard Simper (2006), "The Impact of Macroeconomic and Regulatory Factors on Bank Efficiency: A Non-Parametric Analysis of Hong Kong's Banking System," *Journal of Banking and Finance,* 30(5): 1443-66.

Drees, Burkhard and Ceyla Pazarbasioglu (1998), "The Nordic Banking Crises: Pitfalls in Financial Liberalization?" *IMF Occasional Paper 161,* Washington, D.C.: IMF.

Fung, Michael K. and Arnold CS. Cheng (2004), "Diffusion of Off-Balance-Sheet Financial Innovations: Information Complementarity and Market Competition," *Pacific-Basin Finance Journal,* 12(5): 525-40.

Gerlach, Stefan, Wensheng Peng and Chang Shu (2005), "Macroeconomic Conditions and Banking Performance in Hong Kong: A Panel Data Study," in BIS Paper No. 22, Investigating the relationship between financial and real economy, April: 481-97.

Gruben, William C. and Robert P. McComb (2003), "Privatization, Competition, and Super-competition in the Mexican Commercial Banking System," *Journal of Banking and Finance,* 27(2): 229-49.

Huang, Dongling, Christian Rojas and Frank Bass (2006), "What Happens When Demand is Estimated with a Misspecified Model?" University of Massachusetts-Amherst, mimeo.

Ho, Chun-Yu (2007), "Market Power of State Commerical Banks in China," Boston University, mimeo.

Ivaldi, Marc and Frank Verbonen (2005), "Quantifying the Effects from Horizontal Mergers in European Competition Policy," *International Journal of Industrial Organization,* 23(9-10): 669-91.

Jao, Y. C. (1997), *Hong Kong as an International Financial Center: Evolution, Prospects and Policies,* City University of Hong Kong Press, Hong Kong.

Jiang, G, N. Tang, E. Law and A. Sze (2003), "Determinants of Bank Profitability in Hong Kong," *Hong Kong Monetary Authority Quarterly Bulletin,* September: 5-14.

Jiang, G., J. Wong, N. Tang and A. Sze (2004), "Banking Sector Competition in Hong Kong - Measurement and Evolution over Time," *Hong Kong Monetary Authority Research Memorandum,* April.

Klein, Michael (1971), "A Theory of the Banking Firm," *Journal of Money, Credit and Banking,* 3: 205-18.

Knittel, Christopher and Victor Stango (2007), "Incompatibility, Product Attributes and Consumer Welfare: Evidence from ATM," *BE Journal of Economic Analysis and Policy, Advances,* forthcoming.

Kreps, David M and Jose A. Scheinkman (1983), "Quantity Precommitment and Bertrand Competition Yield Cournot Outcomes," *Bell Journal of Economics,* 14(2): 326-37.

Kwan, Y. K. and F. T. Lui (1999), "Deregulation, Profit, and Cost in Commercial Banking: The Case of Hong Kong," in Takatoshi Ito and Anne O. Krueger eds., *Deregulation and Interdependence in the Asia-Pacific Region* (NBER-East Asian Seminar on Economics, volume 8), Chicago: University of Chicago Press.

Kwan, Simon (2003), "Impact of Deposit Rate Deregulation in Hong Kong on the Market Value of Commercial Banks," *Journal of Banking and Finance,* 27: 2231-48.

Kwan, Simon (2006), "The X-Efficiency of commercial banks in Hong Kong," *Journal of Banking and Finance,* 30(4): 1127-47.

Kumbhakar, Subal C. and Subrata Sarkar (2003), "Deregulation, Ownership, and Productivity Growth in the Banking Industry: Evidence from India," *Journal of Money, Credit and Banking,* 35(3): 403-24.

Lau, Lawrence (1982), "On Identifying the Degree of Competitiveness from Industry Price and Output Data," *Economics Letters,* 10: 93-9.

McFadden, Daniel (1981), "Econometric Models of Probabilistic Choice," in C. Manski and D. McFadden, eds., *Structural Analysis of Discrete Data,* Cambridge: MIT Press: 198-272.

Molnar, Jozsef, Marton Nagy and Csilla Horvoth (2007), "A Structural Empirical Analysis of Retail Banking Competition: the Case of Hungary," MNB Working Papers 2007/1, Magyar Nemzeti Bank.

Nankane, Marcio I, Leonardo S. Alencar and Fabio Kanczuk (2006), "Demand for Bank Services and Market Power in Brazilian Banking," Banco Central do Brazil, Working Paper No.107.

Neven, Damien and Lars-Hendrik Roller (1999), "An Aggregate Structural Model of Competition in the European Banking Industry," *International Journal of Industrial Organisation,* 17: 1059-74.

Nevo, Aviv (1998), "Identification of the Oligopoly Solution Concept in a Differentiated-Products Industry," *Economics Letters,* 59: 391-95.

Nevo, Aviv (2000), "Mergers with Differentiated Products: the Case of the Ready-To-Eat Cereal Industry," *Rand Journal of Economics,* 31: 395-421.

Panzar, John C and James N. Rosse (1987), "Testing for monopoly equilibrium," *Journal of Industrial Economics,* 25: 443-56.

Rysman, Marc (2004), "Competition between Networks: A Study of the Market for Yellow Pages," *Review of Economic Studies,* 71: 483-512.

Sealey, Calvin W. and James T. Lindley (1977), "Inputs, Outputs, and a Theory of Production and Cost at Depository Financial Institutions," *Journal of Finance,* 32: 1251-66.

Shaffer, Sherrill (1989), "Competition in the US Banking Industry," *Economics Letters,* 29: 321-23.

Shaffer, Sherrill (1993), "A Test of Competition in Canadian Banking," *Journal of Money Credit and Banking,* 25: 49-61.

Small, Kenneth A. and Harvey S. Rosen (1981), "Applied Welfare Economics with Discrete Choice Models," *Econometrica,* 49: 105-30.

Spiller, Pablo T. and Edgardo Favaro (1984), "The Effects of Entry Regulation on Oligopolistic Interaction: The Uruguayan Banking Sector," *Rand Journal of Economics,* 15: 244-54.

Toolsema, Linda (2002), "Competition in the Dutch Consumer Credit Market," *Journal of Banking and Finance,* 26: 2215-29.

Wong, Jim, Eric Wong, Tom Fong and Ka-Fai Choi (2006), "Competition in Hong Kong's Banking Sector: A Panzar-Rosse Assessment," *Hong Kong Monetary Authority Research Memorandum* 16/2006, October.

Wong, Jim, Tom Fong, Eric Wong and Ka-Fai Choi (2007a), "Determinants of the Performance of Banks in Hong Kong," *Hong Kong Monetary Authority Working Paper* 6/2007, April.

Wong, Jim, Eric Wong, Tom Fong and Ka-Fai Choi (2007b), "Testing for Collusion in the Hong Kong Banking Sector," *Hong Kong Monetary Authority Working Paper* 1/2007, March.

**Table 1. Bank Characteristics, 1997 - 2004**

| *Item* | *Listed-1* | *Listed-2* | *Listed* | *Non-listed* |
|---|---|---|---|---|
| *Assets* | 669 | 45.0 | 326 | 34.0 |
| | (668) | (19.3) | (544) | (27.8) |
| *Customer Loans* | 301 | 24.8 | 149 | 17.0 |
| | (274) | (9.91) | (229) | (13.4) |
| *Interest Incomes* | 300 | 2.42 | 14.9 | 1.79 |
| | (304) | (0.96) | (24.5) | (1.55) |
| *Interest Expenses* | 16.3 | 1.41 | 8.15 | 1.00 |
| | (19.2) | (0.76) | (14.8) | (1.01) |
| *Personnel Expenses* | 4.04 | 0.30 | 1.99 | 0.22 |
| | (4.51) | (0.10) | (3.55) | (0.18) |
| *Total Operating Expenses* | 9.05 | 0.71 | 4.47 | 0.51 |
| | (9.46) | (0.28) | (7.56) | (0.43) |

*Note: The group is defined by specification Nlogit1 & Nlogit2*

*Unit: Billion HKD. The figures are means and standard deviations*

*Sources: BANKSCOPE.*

**Table 3. Estimation of Demand & Marginal Cost**

| | | *Coefficient* | | | | *Coefficient* | |
|---|---|---|---|---|---|---|---|
| *Demand* | *Nlogit1* | *Nlogit2* | *Nlogit3* | *Supply* | *Nlogit1* | *Nlogit2* | *NLogit3* |
| *p* | -13.8* | -13.9* | -13.3* | *AC* | 2.46* | 1.81* | 1.86* |
| | (2.10) | (1.63) | (1.80) | | (0.84) | (0.74) | (0.73) |
| $ln(s_{j\|g})$ | 0.04** | 0.09** | 0.08* | *A Clogq* | -0.26** | -0.16 | -0.17 |
| | (0.02) | (0.05) | (0.03) | | (0.14) | (0.12) | (0.12) |
| *dln Y* | 3.14* | 3.21* | 2.88* | *A Clog W1* | -0.59* | -0.36** | -0.38** |
| | (0.93) | (0.79) | (0.88) | | (0.26) | (0.21) | (0.22) |
| *dlnPh* | -1.26* | -1.25* | -1.14* | *A Clog W2* | 0.09 | -0.13 | -0.09 |
| | (0.26) | (0.21) | (0.24) | | (0.21) | (0.17) | (0.17) |
| *lnAsset* | 0.88* | 0.86* | 0.86* | *A Clog W3* | 0.49* | 0.49* | 0.48* |
| | (0.02) | (0.02) | (0.02) | | (0.09) | (0.10) | (0.09) |
| *Year* | -368* | -368* | -359* | *Asset* | 0.20 | 0.17 | -0.16 |
| | (35.7) | (27.4) | (30.6) | | (0.16) | (0.13) | (0.14) |
| *Constant* | 739* | -738* | 720* | *Year* | -0.25* | -0.24* | -0.24* |
| | (71.7) | (55.1) | (61.5) | | (0.11) | (0.10) | (0.10) |
| | | | | *Obs* | 169 | 169 | 169 |
| | | | | *GMM* | 57.5 | 64.6 | 67.6 |

*Note: The $\beta_3 + \beta_4 + \beta_5 = 0$ is imposed. Standard errors are in parentheses.*

*Asterisk * and ** represent significances at 5% and 10% levels, respectively.*

*Sources: BANKSCOPE.*

## Table 4. Price Elasticities

| | *Nlogit1* | | | *Nlogit2* | | | *Nlogit3* | | |
|---|---|---|---|---|---|---|---|---|---|
| ***Group*** | ***Own*** | ***C-w/i*** | ***C-b/w*** | ***Own*** | ***C-w/i*** | ***C-b/w*** | ***Own*** | ***C-w/i*** | ***C-b/w*** |
| *Listed1* | | | | 1.30 | 0.40 | 0.02 | 1.01 | 0.26 | 0.07 |
| | | | | (0.53) | (0.22) | (0.01) | (0.42) | (0.23) | (0.03) |
| *Listed2* | | | | 1.60 | 0.04 | 0.38 | 1.48 | 0.10 | 0.44 |
| | | | | (0.57) | (0.02) | (0.15) | (0.54) | (0.05) | (0.18) |
| *Listed* | 1.41 | 0.36 | 0.01 | | | | | | |
| | (0.54) | (0.16) | (0.01) | | | | | | |
| *Non-Listed* | 1.55 | 0.02 | 0.36 | 1.63 | 0.04 | 0.36 | 1.55 | 0.03 | 0.34 |
| | (0.72) | (0.01) | (0.14) | (0.77) | (0.01) | (0.14) | (0.73) | (0.01) | (0.14) |

*Figures are mean and standard deviations are in parentheses.*

*Own=Own-price elasticities; C-w/i=Within-group cross-price elasticities;*

*C-b/w=Between-group cross-price elasticities; Sources: BANKSCOPE.*

## Table 5. Conduct Parameters

| ***Lamda*** | ***Nlogit1*** | ***Nlogit2*** | ***Nlogit3*** |
|---|---|---|---|
| $\varphi_0$ | 7.93** | 7.21* | 7.32* |
| | (4.27) | (3.45) | (3.61) |
| $\varphi_t$ | -3.40** | -3.05** | -3.10** |
| | (2.17) | (1.75) | (1.84) |
| $\varphi_a$ | -0.01** | -0.00 | 0.01** |
| | (0.00) | (0.00) | (0.01) |

*The bracket indicates the range of conduct parameters*

*Sources: BANKSCOPE. Standard errors are in parentheses.*

### Table 6. Changes in Markup, 1997–2004

| *Group* | *Nlogit1* | *Nlogit2* | *Nlogit3* |
|---|---|---|---|
| *Listed1* | | 0.974<br>(0.039) | 0.937<br>(0.023) |
| *Listed2* | | 1.005<br>(0.004) | 1.003<br>(0.009) |
| *Listed* | 0.993<br>(0.031) | | |
| *Non-Listed* | 1.009<br>(0.007) | 1.008<br>(0.006) | 1.008<br>(0.007) |
| *Average* | 1.000<br>(0.025) | 0.998<br>(0.024) | 0.998<br>(0.024) |

*Figures are mean and standard deviations are in parentheses. Sources: BANKSCOPE.*

### Table 7. Consumer Welfare

| *Year* | *Nlogit1* | *Nlogit2* | *Nlogit3* |
|---|---|---|---|
| $CV_{i1}$ | -0.01 | -0.07 | -0.11 |
| $CV_{i2}$ | 6.98 | 6.62 | 6.92 |

*Sources: BANKSCOPE. Unit: %*

**Table 8. Log-linear Specification**

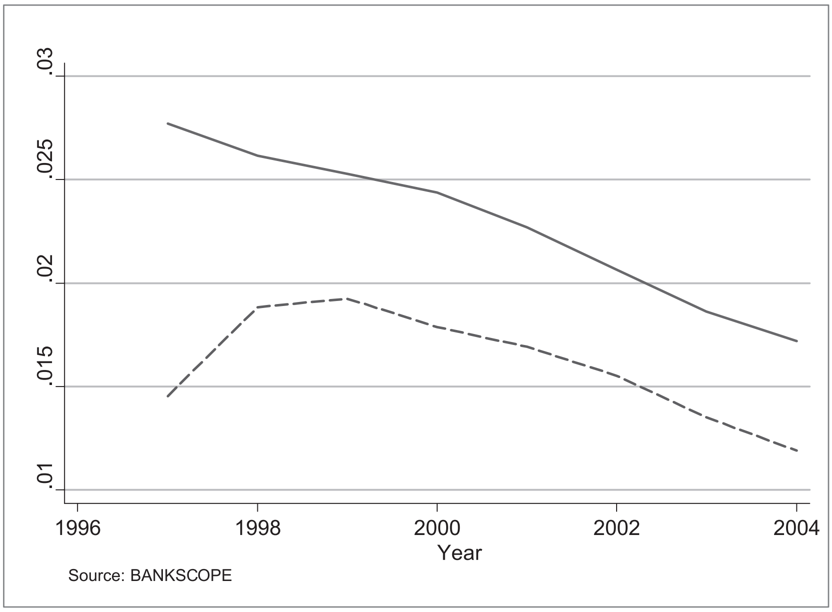
| | Coefficient | | | Coefficient | |
|---|---|---|---|---|---|
| ***Demand*** | ***Constant*** | ***Heter*** | ***Supply*** | ***Constant*** | ***Heter*** |
| $\log p_{jt}$ | -2.84* | -3.05* | *A C* | 3.27* | -0.12 |
| | (0.22) | (0.19) | | (0.94) | (0.82) |
| $\log p_{-jt}$ | 2.65* | 2.93* | *A Clogq* | -0.44 | -0.06 |
| | (0.34) | (0.34) | | (0.94) | (0.11) |
| *dln Y* | -1.14 | -1.48 | *A Clog W1* | -0.81* | -0.03 |
| | (1.20) | (1.24) | | (0.17) | (0.12) |
| *dln Ph* | 0.25 | 0.32 | *A Clog W2* | 0.16 | -0.08 |
| | (0.31) | (0.32) | | (0.15) | (0.09) |
| *InAsset* | 0.95* | 0.94* | *A Clog W3* | 0.66* | 0.05 |
| | (0.02) | (0.02) | | (0.20) | (0.16) |
| *Year* | -156* | -144* | *Asset* | 0.06* | -0.02 |
| | (43.6) | (45.1) | | (0.02) | (0.04) |
| *Constant* | 325* | 302* | *Year* | 0.03* | 0.02* |
| | (86.6) | (89.5) | | (0.01) | (0.00) |
| | | | $\varphi_0$ | 0.26** | 18.2 |
| | | | | (0.16) | (23.1) |
| | | | $\varphi_t$ | | -8.80 |
| | | | | | (11.6) |
| | | | $\varphi_a$ | | 0.45* |
| | | | | | (0.08) |
| | | | *Obs* | 169 | 169 |
| | | | *GMM* | 65.1 | 27.4 |

*Note: The $\beta_3 + \beta_4 + \beta_5$ = 0 is imposed. Heter = heterogeneous.*

*Asterisk * and ** represent significances at 5% and 10% levels, respectively. Standard errors are in parentheses.*

*Sources: BANKSCOPE*

**Figure 1.**


.03
.025
.02
.015
.01
1996
1998
2000
2002
2004
Year
Source: BANKSCOPE

# Appendix 1. Sample of Banks

| Bank | Begin | End | Obs | Nlogit1 | Nlogit2 | Nlogit3 |
|---|---|---|---|---|---|---|
| *Asia Commercial Bank Ltd* | 1997 | 2004 | 8 | *Non-listed* | *Non-listed* | *Non-listed* |
| *Bank of America (Asia) Ltd* | 1997 | 2004 | 8 | *Non-listed* | *Non-listed* | *Non-listed* |
| *Bank of China (Hong Kong) Ltd* | 2000 | 2004 | 5 | *Listed* | *Listed-1* | *Listed-1* |
| *Bank of East Asia Ltd* | 1997 | 2004 | 8 | *Listed* | *Listed-1* | *Listed-2* |
| *CITIC Ka Wah Ltd* | 1997 | 2004 | 8 | *Listed* | *Listed-2* | *Listed-2* |
| *Canadian Eastern Finance Ltd* | 1997 | 2003 | 7 | *Non-listed* | *Non-listed* | *Non-listed* |
| *Chekiang First Bank Ltd* | 1997 | 2003 | 7 | *Listed* | *Listed-2* | *Listed-2* |
| *China Construction Bank* | 1997 | 2004 | 8 | *Non-listed* | *Non-listed* | *Non-listed* |
| *Chiyu Banking Corp. Ltd* | 1997 | 2004 | 7 | *Non-listed* | *Non-listed* | *Non-listed* |
| *DBS BANK (Hong Kong) Ltd* | 1997 | 2004 | 8 | *Listed* | *Listed-1* | *Listed-2* |
| *DBS Kwong On Bank* | 1997 | 2002 | 6 | *Listed* | *Listed-2* | *Listed-2* |
| *Dah Sing Bank Ltd* | 1997 | 2004 | 8 | *Non-listed* | *Non-listed* | *Non-listed* |
| *Fubon Bank (Hong Kong) Limited* | 1997 | 2004 | 8 | *Non-listed* | *Non-listed* | *Non-listed* |
| *HSBC* | 1997 | 2004 | 8 | *Listed* | *Listed-1* | *Listed-1* |
| *HangSeng Bank* | 1997 | 2004 | 8 | *Listed* | *Listed-1* | *Listed-2* |
| *Hua Chiao Commercial Bank Ltd* | 1997 | 2000 | 4 | *Non-listed* | *Non-listed* | *Non-listed* |
| *ICBC* | 1997 | 2004 | 8 | *Non-listed* | *Non-listed* | *Non-listed* |
| *Liu Chong Hing Bank Ltd* | 1997 | 2004 | 8 | *Listed* | *Listed-2* | *Listed-2* |
| *Nanyang Commercial Bank Ltd* | 1997 | 2004 | 7 | *Listed* | *Listed-2* | *Listed-2* |
| *Shanghai Commercial Bank Ltd* | 1997 | 2004 | 8 | *Listed* | *Listed-2* | *Listed-2* |
| *Tai Sing Bank Ltd* | 1999 | 2004 | 6 | *Non-listed* | *Non-listed* | *Non-listed* |
| *Wing Hang Bank* | 1997 | 2004 | 8 | *Listed* | *Listed-2* | *Listed-2* |
| *Wing Lung Bank* | 1997 | 2004 | 8 | *Listed* | *Listed-2* | *Listed-2* |
| *Obs* | | | 169 | | | |

*Note 1: Nanyang recorded negative total operating expense in 2003 Chiyu recorded missing personnel expense in 2001*

*Note 2: Wing Hang acquired Chekiang First Bank in 2003. DBS Bank merged with DBS Kwong On Bank in 2003. Hua Chiao Commercial Bank was merged into Bank of China in 2003.*

*Note 3: Asia Commercial Bank Ltd was renamed to Public Bank (Hong Kong) Ltd in 2006. Liu Chong Hing Bank Ltd was renamed to Chong Hing Bank Ltd in 2006. Bank of America (Asia) Ltd was renamed to China Construction Bank (Asia) in 2007.*

*Note 4: DBS Bank lists in Stock Exchange of Singapore*

*Sources: BANKSCOPE*

# Appendix 2. Descriptive Statistics on Economy

| Year | HIBOR | Wage Index | real GDP | Property Price |
|---|---|---|---|---|
| 1997 | 7.13 | 104.2 | 1216 | 223 |
| 1998 | 8.09 | 104.4 | 1150 | 155 |
| 1999 | 5.84 | 108.3 | 1196 | 136 |
| 2000 | 6.12 | 112.2 | 1315 | 119 |
| 2001 | 3.57 | 116.0 | 1323 | 105 |
| 2002 | 1.79 | 117.5 | 1347 | 94 |
| 2003 | 0.96 | 117.7 | 1391 | 83 |
| 2004 | 0.39 | 116.4 | 1510 | 105 |

*For HIBOR, Wage index & GDP: Sources: CEIC*

*Unit: % p.a., year1991=100 & Billion HKD*

*For property price: Sources: Chau et al. (2005)*

*Unit: year1991=100*

# Appendix 3. Estimation of Demand & Pricing with Constant Conduct

| | Coefficient | | | | Coefficient | | |
|---|---|---|---|---|---|---|---|
| **Demand** | **Nlogit1** | **Nlogit2** | **Nlogit3** | **Supply** | **Nlogit1** | **Nlogit2** | **Nlogit3** |
| *p* | -12.6* | -14.2* | -13.3* | *AC* | 3.82* | 3.89* | 3.80* |
| | (2.27) | (1.59) | (1.78) | | (0.79) | (0.79) | (0.79) |
| $ln(s_{j\|g})$ | 0.04** | 0.10* | 0.09* | *A Clogq* | -0.42* | -0.44* | -0.42* |
| | (0.02) | (0.05) | (0.03) | | (0.12) | (0.12) | (0.12) |
| *dln Y* | 2.82* | 3.26* | 2.86* | *A Clog W1* | -0.85* | -0.87* | -0.85* |
| | (1.00) | (0.77) | (0.87) | | (0.20) | (0.21) | (0.21) |
| *dlnPh* | -1.14* | -1.27* | -1.13* | *A Clog W2* | -0.13 | -0.11 | -0.12 |
| | (0.28) | (0.21) | (0.24) | | (0.20) | (0.20) | (0.20) |
| *lnAsset* | 0.88* | 0.86* | 0.86* | *A Clog W3* | 0.97* | 0.98* | 0.97* |
| | (0.02) | (0.02) | (0.02) | | (0.15) | (0.14) | (0.14) |
| *Year* | -348* | -371* | -358* | *Asset* | 0.01 | 0.02 | 0.01 |
| | (38.6) | (26.8) | (30.3) | | (0.08) | (0.07) | (0.07) |
| *Constant* | 697* | -745* | 717* | *Year* | -0.05 | -0.04 | -0.04 |
| | (77.5) | (53.8) | (60.7) | | (0.47) | (0.45) | (0.39) |
| | | | | $\lambda$ | 0.71 | 0.73 | 0.71 |
| | | | | | (3.14) | (3.18) | (2.71) |
| | | | | *Obs* | 169 | 169 | 169 |
| | | | | *GMM* | 89.5 | 93.1 | 93.6 |

*Note: The $\beta_3 + \beta_4 + \beta_5 = 0$ is imposed. Standard errors are in parentheses.*

*Asterisk * and ** represent significances at 5% and 10% levels, respectively.*

*Sources: BANKSCOPE.*