



# Role of Non-Performing Loans (NPLs) and Capital Adequacy in Banking Structure and Competition

by

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**Abstract:** This paper analyses the impact of the transition from price-cap regulation (*deposit/loan rate control*) to rate-of-return regulation (*ROA, NPLs and/or BIS ratio*) on banking industry structure. A simple theoretical model of banking competition suggests that the relative dominance of the two objective functions under different regulatory regimes affects the market structure. Imposing more stringent rate-of-return regulation, whilst relaxing price-cap regulation, reduces the equilibrium number of banks. The result from the theoretical model is also supported by empirical evidence from Korea, which has undergone substantial consolidation in recent years. The empirical analysis uses a unique data set of the entire commercial banking sector in Korea between 1976 and 2003, which covers both pre- and post- banking crisis periods.

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## 1. Introduction

Banking industries around the world have experienced a major restructuring throughout the last couple of decades, mainly via mergers and acquisitions (M&As) between sound banks and ailing banks in the aftermath of respective financial crises.<sup>1</sup> For example, Korean banks have undergone a significant number of M&As in the post financial crisis period between 1998 and 2003 as shown in Table 1. The Asian financial crises in 1997 certainly put a break on new entrants into the banking industry in Korea and turned the industry structure around to a more concentrated one after a series of M&As.<sup>2</sup> During this post-crisis period, nine mergers between nationwide banks and four mergers between regional banks were undertaken only for the market share of the larger banks to become larger and the number of banks to fall by one half. Considering that nine new nationwide banks have been authorised and three specialty banks were transformed into nationwide banks prior to the early 1990s, this consolidation represents a rather drastic reversal for the banking industry structure in Korea.

Given the number of banking crises and various rescue programmes including M&As implemented following such crises, there has been a plethora of studies on banking structure. The studies so far have largely addressed the issue of how to regulate the banking industry and/or how to protect the banking sector from potential bank runs. However, most previous studies of banking structure (Cerasi *et al.* 2002; Chiappori *et al.* 1995; Dewatripont and Maskin 1995; Dewatripont and Tirole 1993) focus primarily on the impact of exogenous changes in regulation and the subsequent changes in the competition environment. One of the weaknesses of many of these earlier studies is the assumption that banks are profit-maximising entities in the neo-classical sense, subject to exogenous changes in the market condition, whereas strictly speaking, banks in many developing countries are not always profit-maximising due to their strategic role in promoting economic development. For example, some scholars (Cho 1994; Ishii 1997) point out that the banking sector in East Asia has acted as a mere financing arm for industrialisation rather than as a profit-maximising institution.

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<sup>1</sup> Focarelli and Pozzolo (2001) discuss the details of M&As in OECD countries whilst Demirguc-Kunt and Detragiache (1997) investigate the banking crises in 29 countries in the 1980s and 1990s. See Agenor *et al.* (1999) for a broader review of financial crises in the global context

<sup>2</sup> It is worth noting that there was no exit (i.e. revocation of banking license) in the process of restructuring the Korean banking industry.

The regulations adopted to facilitate the industrialisation in East Asia included deposit rate ceilings. More specifically, certain industries – those believed to be strategically beneficial for the national economy – were promoted under the deposit rate regulation while banks were given access to cheap funding to provide loans to these strategic industries at preferential rates. However, it appears that the banking behaviour changed as deposit rate regulations were liberalised and so the overall market structure with new entries of banks has slowed down in response to the liberalisation of deposit rates.

The main objective of this paper is to identify the determinants of banking structure theoretically as well as empirically when deposit rate regulation is liberalised, by looking at the banking behaviour in terms of non-performing loans (NPLs) and capital adequacy measured by BIS ratio.<sup>3</sup> The analysis set out in this paper is largely an application of industrial organisation theory to banking. Most traditional approaches used in industrial economics are designed to analyse non-financial firms, such as manufacturing firms that produce physical goods. Some economists have attempted to identify factors affecting market structure by differentiating advertising or technology-intensive industries.<sup>4</sup> However, little research has been undertaken on the service industries until recently and the idiosyncratic attributes of service industries within the banking sector are often overlooked.

A theoretical model of banking competition by Chiappori *et al.* (1995) is extended using Salop's circular (1979) model by using two competing objective functions: a revenue-maximising objective under price-cap regulation (*deposit/loan rate control*) and a profit-maximising objective under rate-of-return regulation (*ROA, NPLs and/or BIS ratio requirements*). The results show that the relative dominance of the two objective functions under different regulatory regimes affects the banking structure in terms of the equilibrium number of banks. In other words, the transition from price-cap regulation to rate-of-return regulation has an impact on banking industry structure.

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<sup>3</sup> The Basel Committee on Banking Supervision at Bank for International Settlement (BIS) set out the basics for capital adequacy in the first Basel accord 1988 (Basel I) and a revised framework for capital adequacy is set out in the second Basel accord 2005 (Basel II). This capital adequacy is also known as BIS ratio which is a ratio of bank's capital to its assets.

<sup>4</sup> Cowling (1972) discusses optimal advertising policies for a variety of market structures with empirical evidence. Sutton (1991, 1998) uses escalation mechanism in explaining the market structure of advertising and technology-intensive industries.

Finally, the validity of the results from the theoretical model has been tested empirically using information on non-performing loans and BIS ratios. The analysis is applied to a unique data set of the entire commercial banking sector in Korea, which covers both pre- and post- banking crisis periods over 28 years between 1976 and 2003.

The paper is organised into five sections. Section 2 reviews the background literature and previous evidence associated with banking regulation and liberalisation in the context. Section 3 presents a simple theoretical model of banking competition to analyse the impact of liberalisation of deposit rate regulation, non-performing loans, and capital adequacy ratio. Section 4 presents empirical results and section 5 concludes with some policy discussions.

## **2. Background literature and previous evidence**

### **2.1 Banking background in the context**

The establishment of the new banking system in Korea followed the liberation from Japan in 1945 at the end of the World War II and the inauguration of the Republic of Korea in 1948. At that time, the Korean banking system was reorganised for the purpose of financing the economic development plan more effectively. The Bank of Korea Act (1950) was amended in 1962 and various specialised banks were introduced to facilitate financial support for underdeveloped or strategically important industries exclusively. For example, Small and Medium Industry Bank, Citizens National Bank, Korea Exchange Bank, and The Korea Housing Bank were established under the tight regulation on deposit rates and credit ceilings.

In 1982, the General Banking Act was revised and commercial banks began to be privatised. These included Hanil Bank, Korea First Bank, Bank of Seoul and Trust, and Chohung Bank. One of the main revisions was the shift from direct credit controls through credit ceilings on individual banks to indirect controls through management of bank reserves. In 1984, the preferential rates on policy loans by commercial banks were abolished and the band system in loan rates was introduced, in which banks are allowed to charge different rates. The ceilings on various rates (inter-bank call rates and issuing rates of unsecured corporate bonds) were also lifted.

As a measure to provide a more competitive environment in banking, Shinhan Bank and KorAm Bank opened in 1982 and 1983 respectively. It is important to note

that Shinhan Bank was the first banking establishment financed wholly by private capital. In the 1980s, to encourage the domestic banks to improve their banking practices and managerial skills, numerous foreign bank branches were allowed to open. In 1988, interest rates were extensively deregulated in order to increase banking competition as part of the process of financial liberalisation. Entry barriers were further lowered in 1989, adding 3 new commercial banks: Dongwha Bank; Dongnam Bank, and Daedong Bank. Furthermore, Korea Exchange Bank changed its status from a specialised bank to a nationwide commercial bank. Between 1991 and 1997, a four-stage plan for interest rates deregulation was completed (see Figure 1). The main focus of liberalisation was on lifting interest rate regulation starting with short-term rates.

Further deregulation is in the process of being implemented in the aftermath of the Asian financial crisis of 1997. As one of the most significant changes of banking regulation in Korea, restrictions on foreign ownership of domestic commercial banks has been lifted and now there is virtually no restriction on foreign ownership. As a result, there have been a couple major mergers and acquisitions by foreign banks<sup>5</sup> and we expect to see several more of the kind to happen in the future. Also, mergers between domestic banks were encouraged to increase competitiveness which can be seen in the number of mergers of this kind that took place in the post-crisis period.

The current changes within the Korean banking structure are being propelled by the 1997 financial crisis, as government officials realised that Korean banks were not competitive enough to survive. To improve the banking standards, the Financial Supervisory Service (FSS hereafter)<sup>6</sup> enforced the new accounting standards in accordance with internationally accepted standards.<sup>7</sup> Changes in the management structure, in particular with the presence of foreign management,<sup>8</sup> will definitely influence the structure of the Korean banking industry. However, since changes of this

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<sup>5</sup> New Bridge Capital (US) acquired 51% stake of Korea First Bank (KFB) in Jan. 2000 and Standard Chartered Bank (Hong Kong) announced an agreement to purchase 100% stake of KFB New Bridge Holding Ltd. In Jan. 2005.

<sup>6</sup> The FSS was established on 1 Jan. 1999 by combining former supervisory bodies: the Banking Supervisory Authority (BSA hereafter), the Securities Supervisory Board, the Insurance Supervisory Board, and the Non-bank Supervisory Authority. The FSS inherited the role of the BSA.

<sup>7</sup> Kim (1999) discusses prudential regulation in detail in his BIS policy paper. Many of the changes in regulation are related to disclosure requirements on bank financial statements. One example is the forward-looking criteria for asset classification in Korea introduced in 1999 that incorporate the "Basel Core Principles for Effective Banking Supervision".

<sup>8</sup> Korea First Bank managed by New Bridge Capital and subsequently by Standard Chartered Bank as mentioned earlier in the section.

kind are on-going, the paper does not analyse the effect of foreign involvements in greater detail whilst focusing on domestic mergers and liberalisation on deposit rates.

## 2.2 Literature

Given the special attributes of the banking industry, whereby bank customers can be buyers of loan products as well as input providers with their deposits, the theory of financial intermediation indicates that measuring both the quantity and the quality of banks' outputs is not as straightforward as for non-financial firms due to the intangible nature of banking output which means that it is also difficult to account for quality.<sup>9</sup> Klein (1971) and Clark (1988) discussed the relevant concepts of bank output and input<sup>10</sup> but Klein (1971) claims that neo-classical microeconomic analysis faces conceptual difficulties in drawing the analogy between a bank and the typical firm and hence has limitations in explaining bank behaviour.

Monopolistic competition has been frequently used among various competition models in banking as the industry uses horizontal as well as vertical product differentiation (Gehrig, 1996; Matutes and Vives, 1996; 2000). On the other hand, some scholars (Freixas and Rochet, 1997) focused on imperfect information in the industry as there are information gaps among borrowers and lenders which lies at the centre of banking sector dynamics and draws attention to financial intermediaries as an information and communication network when communication possibilities across potential traders are imperfect.

In terms of banking behaviour, Klein (1971) and Monti (1972) considered a bank as a firm maximising its net present value of assets, and established a landmark model of banking. Klein (1971) assumed that banks maximise profits in the course of intermediation activity. However, the main challenge in this paper is to show that banking behaviour is not always based on profit maximisation which affects the industry structure.

Among other competition models in banking, Repullo (1995) and Chiappori *et al.* (1995) applied horizontal differentiation to banking. In these models, the main difference between banks and non-financial firms is that banks compete in two markets instead of one, i.e. deposits and loans markets. They assume that under perfectly

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<sup>9</sup> See Gordon (1990) for hedonic price adjustment.

<sup>10</sup> They define loans and deposits as output and input respectively.

competitive interbank market conditions complete independence of the two activities of the bank can be obtained. The predictions of these models are that banking industries should be fragmented, and market shares should be symmetrically distributed. On the other hand, Gehrig (1996) and Matutes and Vives (1996; 2000), introduce network externalities to explain how asymmetric configurations in market share could arise in banking. This asymmetric information paradigm has emerged as a mainstream approach for recent banking analyses.

For the empirical analysis, it is useful to investigate the traditional approach to early empirical studies of banking based on the structure-conduct-performance (SCP) paradigm.<sup>11</sup> Since Bain (1951) supposed a one-way linear relationship of causality, which runs from *structure* to *conduct* and then to *performance*, its application has been subject to considerable criticism due to the neglected feedback effects. Cowling (1976) suggests the structure-performance relationship be a recursive system of feedback with substantial lags. Berger (1995) also questioned the results obtained following the SCP paradigm. Despite the criticism, the SCP paradigm provided the foundation for the study of market structure.<sup>12</sup>

In general, the banking industry is highly concentrated. Kolari and Zardkoohi (1987) and Clark (1988) explained the concentration in the banking industry with economies of scale and scope (fixed sunk cost argument). On the other hand, one may consider the cost of loan loss provision as endogenous sunk costs which can escalate over time and it is not so surprising therefore to see that the banking sector is becoming more concentrated with more stringent regulation on loan loss provisions and capital adequacy. Whether the concentrated banking structure arises from economies of scale or pressure for loan loss provisions, it allows banks to exercise market power and to pre-empt potential rivals' entry. Although banking systems tend to be quite concentrated, in some developed countries, the United States shows a fragmented structure.<sup>13</sup> However, this fragmentation exists primarily as a result of regulation on inter-state branching designed to deal with concerns about financial power.

Perhaps the most relevant work in the field of banking market structure and competition is by Chiappori *et al.* (1995) who derived the equilibrium number of banks

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<sup>11</sup> Baltensperger (1972), Gilbert (1984) and Hannan (1991) used the SCP paradigm.

<sup>12</sup> Vector autoregression and Granger causality tests are applied to accommodate the endogeneity of this feedback system.

<sup>13</sup> See Macey (2001) and Calomiris (1997).

under various regulatory conditions and suggested the equilibrium number of banks under regulation is larger than that under free market conditions, but none of them is socially optimal. Cerasi *et al.* (2002) also looked at the impact of deregulation on concentration and branch networks in European banking. Since deregulation reduces profits for a given branching network, fewer firms find it profitable to enter the industry and therefore the degree of concentration rises. On the other hand, when the banks collude, they establish a smaller network compared with competition as opening new branches damages rivals by stealing their clients. By coordination, they will avoid this damage. However, Cerasi's empirical analysis shows the weakness in explaining the feedback process of structure-performance relation.

### 3. The model

As per bank-specific attributes, banks are considered to produce loan products by taking deposits as funding sources. Deposits might appear as one of the products that banks offer but the role of deposits in banking operation lies in the cost function. Since the interest rates are determined not entirely by market competition,<sup>14</sup> it is worth being cautious in using interest rates as a proxy for price variable in banking. The model consists of banks (*creditors*) and customers (*borrowers*). Money market activities or government intervention in banking is allowed.

In the absence of industry-specific assumptions, microeconomic theory assumes that banks maximise their profits subject to constraints. However, Asian banks showed evidence of maximising lending during the regulated period as their interest margins were protected by the deposit rate ceilings and the minimum lending rate guaranteed for strategic industries.<sup>15</sup> Asian banks started to focus more on profit maximisation as their objectives following market deregulation. This recent transformation in the Asian bank objectives is in part due to the increasing number of non-performing loans following the

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<sup>14</sup> Monetary policy can affect the benchmark inter-bank rates and therefore can shift the overall level of deposit and loan rates.

<sup>15</sup> The Banking Supervisory Authority (BSA) in Korea claims the financial crisis was rooted in this peculiar objective of banks, i.e. revenue-maximising rather profit-maximising. Thus, one of the most significant changes in the banking supervision in Korea was to guide banks to focus more on profits via published performance measure of return on asset (ROA), return on equity (ROE) and Bank for International Settlement (BIS) ratio instead of publishing deposit per employee and deposit per branch. This new guideline has only been effective from 1998 following the recent financial crisis.



economic crisis. The banks realised revenue maximising does not protect them from losses due to non-performing loans (NPLs).

Considering lending as equivalent to the revenues of non-financial firms, my model is built to incorporate both revenue maximisation and profit maximisation. A parameter  $\theta$  is used for the weight on revenue maximisation, which varies with the degree of regulation. Banks are assumed to make an optimal choice between revenue maximisation and profit maximisation by changing  $\theta$  for a given regulatory environment. Equilibrium numbers of banks are derived under various market conditions and show how regulation affects market structure.

The usual assumptions for Salop's model adopted in Chiappori *et al.* (1995) are applied as they assume banks are engaged in spatial competition providing differentiated products. This notion of monopolistic competition is often challenged as some people argue that banks offer homogeneous products, i.e. non-differentiated loans/deposits. However, even if there is no physical differentiation in banking products, we argue that there is product differentiation in terms of location, perceived quality differences in terms of after service, and fringe benefits.

Although Chiappori's model is suitable in explaining banking competition and its market structure, it does not capture the fundamental issues of banking operation regarding NPLs and their loss provision, nor the regulatory impacts on banking. Hence, we depart from their model in the following respects:

1. asymmetric information between the lender and the borrower i.e. lenders do not have full information about the quality of the project they are financing; therefore
2. loss provision associated to NPLs is taken into consideration, and finally
3. banks are considered not always to be profit-maximising.<sup>16</sup>

A continuum of customers, both borrowers and depositors, is assumed to be uniformly located around a unit circle with a unit density in an economy. There are  $N$  banks located on the circle and each installation has a fixed cost of  $C$ . Banks are assumed to be identical and can freely enter or exit. For simplicity, each customer on the circle has one unit of cash that must be deposited in a bank. The typical bank will pay an interest rate  $t$ . The depositors are supposed to incur a transportation cost  $\alpha$  per unit length. In other

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<sup>16</sup> Imperfect information and non-performing loans are very important issues in banking and they naturally provide another crucial topic to investigate

words, a depositor has to incur extra costs of travelling to a bank further away from its vicinity.<sup>17</sup>

Each bank can now make loans to customers using the collected funds. The lending rate is  $r$  and  $\beta$  is the unit transportation cost for loans. Inequality is allowed in the respective price elasticities of loans and deposits, i.e. the transportation costs of  $\alpha$  and  $\beta$  are not necessarily the same. The transportation costs of  $\alpha$  and  $\beta$  include the costs of gathering relevant information in searching appropriated banking services. A fraction  $\lambda$  of the total population is supposed to borrow and these borrowers are uniformly distributed around the unit circle. A crucial assumption here is that borrowers are also depositors as banking is usually established in a bundled form of loans and deposits. The size of each loan is  $L$  and the surplus generated by the loan is supposed to be large enough to justify borrowing at the prevailing rate. The prevailing technology is assumed linear. The money market rate  $\rho$  is exogenously set by monetary authorities.<sup>18</sup>

Aggregate net demand of the banking sector on the money market is equal to  $\lambda L - 1$  considering a unit circle of deposits. If aggregate net demand on the money market is zero, the total volume of loans made by banks is equal to the total volume of deposits,  $V = \lambda L = 1$

It is important to note that each bank has a proportion  $\phi$  of the total loans in NPLs, on which the banks have to build provisions. Using the provision rate  $\delta$  on NPLs, the loss function related to NPLs becomes  $(\delta + r)\phi$  of loans.

The objective function of profit maximisation was derived based on the Klein-Monti (Klein, 1971; Monti, 1972) type of approach.<sup>19</sup> However, given the deposit rate regulations and due to an industrial policy which was common knowledge for the public, banks behaved as revenue-maximising firms subject to minimum requirement on the rate of return. As a majority of economic growth came from the strategic industries, banks were bound to provide more credits to them and this led banks to become revenue maximisers rather than profit maximisers. In my model, a convex combination of the two, a weighted average of revenue maximisation and profit maximisation is used for

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<sup>17</sup> There are many other conventional ways to interpret the transportation cost and this paper adopts most of them e.g. information cost, search cost, cost of inconvenience, etc.

<sup>18</sup> The parameter  $\rho$  is considered to be a weighted average of non-banking rates which include any exogenously set rates such as the money market rate, the rate on government bonds and etc.

<sup>19</sup> Klein and Monti consider a bank in monopolistic competition for a competitive model.

the objective function while maintaining interest rates (price) as a strategic variable for competition.

Banks enter the market when profits cover their fixed costs of entry. A typical customer will search between bank  $i$  and  $i_0$  and then the marginal depositor condition ( $x$  distance away from the bank) for the bank is:

$$\alpha x - t_i = \alpha \left( \frac{1}{n} - x \right) - t_0 \quad (1)$$

where, the supply of deposits for the bank is:

$$2x = \frac{1}{n} + \frac{t_i - t_0}{\alpha} \quad (2)$$

Therefore, as the market becomes more fragmented with a larger number of banks ( $n$ ), the supply of deposits per banks becomes smaller under competition. On the other hand, the higher deposit rates ( $t_i$ ) offered, the more depositors the bank can attract. However, the supply of deposits would decline as the transportation cost increases.

Equivalently, the marginal borrower condition ( $y$  distance away from the bank) for the bank is:

$$\beta y + r_i L = \beta \left( \frac{1}{n} - y \right) + r_0 L \quad (3)$$

Hence, the total volume of demand for loans for the bank is:

$$2y \cdot V = \left( \frac{1}{n} - \frac{r_i - r_0}{\beta} \cdot L \right) \cdot V \quad (4)$$

The interpretation for the equilibrium condition for the loans is much the same as in the deposit market condition. As the market becomes more fragmented with a larger number of banks ( $n$ ), the demand of loans per banks becomes smaller under

competition. On the other hand, the higher loan rates ( $r_i$ ) offered, the fewer borrowers the bank attracts. However, as in the deposit market case, the demand for loans would decline as the transportation cost increases.

### 3.1 Profit-maximising free competition

NPLs enter the loss function and thus affect the profit function in the model. Assume a proportion  $\phi$  of the total loans are NPLs, on which the banks have to build provisions of  $(\delta + r)\phi$  proportion on loans at a provision rate  $\delta$ .<sup>20</sup> Then, the profit function of bank  $i$  becomes

$$\begin{aligned} \pi_i = (r_i - \rho) \left( \frac{V}{n} - \frac{r_i - r_0}{\beta} VL \right) + (\rho - t_i) \left( \frac{1}{n} + \frac{t_i - t_0}{\alpha} \right) \\ - C - (\delta + r_i) \phi \left( \frac{V}{n} - \frac{r_i - r_0}{\beta} VL \right) \end{aligned} \quad (5)$$

Differentiating the profit function with respect to  $t_i$  and  $r_i$  and applying a symmetry by substituting to  $t_i = t_0$  and  $r_i = r_0$  into the first-order conditions leads to the following symmetric equilibrium condition:

*Proposition 1. At the symmetric equilibrium, unregulated short-term rates with consideration of NPLs are given by*

$$t_n^s = \rho - \frac{\alpha}{n} \quad \text{and} \quad r_n^s = \frac{\rho}{1 - \phi} + \frac{\phi}{1 - \phi} \delta + \frac{1}{n} \frac{\beta}{L} \quad (6)$$

*Under the free-entry condition ( $\pi = 0$ ), the number of banks in the market  $n_n$  and the long-run equilibrium values for  $t$  and  $r$  are:*

$$n_n = \sqrt{\frac{\alpha + \beta(1 - \phi)V / L}{C}} \quad (7)$$

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<sup>20</sup> Assume  $0 < \delta < 1$ ,  $0 < \phi < 1$  as neither provisions nor NPLs can be larger than the total volume of loans.

$$t_n^L = \rho - \alpha \sqrt{\frac{C}{\alpha + \beta(1-\phi)V/L}} \quad (8)$$

$$r_n^L = \frac{\rho}{1-\phi} + \frac{\phi}{1-\phi} \delta + \frac{\beta}{L} \sqrt{\frac{C}{\alpha + \beta(1-\phi)V/L}} \quad (9)$$

In the above equations 6 to 9, a subscript  $n$  refers to free competition with NPL consideration. A superscript  $S$  was used for short-term values obtained for a given number of  $n$  banks whereas a superscript  $L$  refers to long-term values in the case that the number of banks is endogenous.

First of all, the NPL ratio does not affect the short-term deposit rates, but affects the loan rates positively. The provision rate is also positively related to the loan rates. Higher loan rates can be interpreted as the banks' reaction towards risky assets to offset the potential loss in non-accrual interest payments and the loan provisions.

Second, the deposit and loan rates are positively related to the money market rates. The mark-down and mark-up are not simple any more. The margin is also positively related to the NPL ratio. It is important to note that any change in  $\rho$  due to some monetary policy will be passed on to rates offered by banks, but the magnitude of impact on the loan rates is larger as the NPL ratio increases. Even if banks do not participate in the money market ( $V = \lambda L = 1$ ),  $\rho$  still remains as a dominant factor for the equilibrium rates offered by banks.

Finally, the endogenous number of banks in the long-run is positively related to the short-term profits, thus negatively related to NPL ratio.

A market where the Government imposes a deposit rate ceiling is considered as most East Asian countries used to have regulations on deposit rates to promote their industrial policy goals. Let us consider a revenue-maximising bank with initial capital of  $A$ .

### 3.2 Revenue maximising competition under regulation

Banks in East Asia tried to maximise revenue only under regulation prior to the recent restructuring and the objective function becomes:

$$R_i = A + (1 + r_i) \left( \frac{V}{n} - \frac{r_i - r_0}{\beta} VL \right) - C - (\delta + r_i) \phi \left( \frac{V}{n} - \frac{r_i - r_0}{\beta} VL \right) \quad (10)$$

Differentiating the revenue function with respect to  $r_i$  and applying a symmetry by substituting to  $r_i = r_0$  into the first-order conditions leads to the following symmetric equilibrium condition:

*Proposition 2.* *At the symmetric equilibrium for revenue maximising banks, unregulated short-term loan rates with consideration of NPLs are given by*

$$r_r^s = \frac{\delta\phi - 1}{1 - \phi} + \frac{1}{n} \frac{\beta}{L} \quad (11)$$

Again, loan rates are positively related to the NPL ratio and the provision rate. We were able to derive the loan rate for revenue-maximising banks but the number of banks for a given market size was indeterminate. The market can support infinite amounts of banks when the banks are revenue-maximising. There are some examples of an unnecessarily high number of banks in the market, particularly in developing countries.

### 3.3 Mixed competition

Now we introduce the parameter  $\theta$  into the objective function as a weight for revenue maximisation so that we can incorporate both revenue and profit maximisation under regulation, using the weight  $\theta$  for revenue maximisation and the residual weight  $1 - \theta$  for profit maximisation.

We assume that banks are more likely to revenue-maximise under a price-cap regulation whereby interest rates on loans and deposits are predetermined by the regulator (*deposit/loan rate control*) and hence, these interest rates are no longer their strategic variables. By contrast, under a rate-of-return regulation, banks are more likely to profit-maximise in order meet the guideline for return on asset (*ROA*) and/or capital adequacy ratio (*BIS ratio*).

$$\pi_i^w = \theta * R_i + (1 - \theta) * \pi_i, \quad \text{where } 0 < \theta < 1 \quad (12)$$

Differentiating the new profit function with respect to  $t_i$  and  $r_i$  and applying a symmetry by substituting to  $t_i = t_0$  and  $r_i = r_0$  into the first-order conditions leads to the following symmetric equilibrium condition:

*Proposition 3. At the symmetric equilibrium, short-term rates are given by*

$$t_w^s = \rho - \frac{\alpha}{n} \quad \text{and} \quad r_w^s = \frac{\rho}{1 - \phi} + \frac{\delta\phi - (1 + \rho)\theta}{1 - \phi} + \frac{1}{n} \frac{\beta}{L}. \quad (13)$$

A subscript  $w$  (weighted) indicates mixed competition with NPL consideration. Deposit rates are the same as in previous cases but loan rates are now negatively related to  $\theta$ . This can be interpreted as banks offering lower loan rates to increase the revenue via a larger volume of loans.

*Under the free-entry condition ( $\pi = 0$ ), the number of banks in the market  $n_w$  and the long-run equilibrium values for  $t$  and  $r$  are:<sup>21</sup>*

$$n_w = \sqrt{\frac{\alpha(1 - \theta) + \beta(1 - \phi)V / L}{C - \theta(A + C)}} \quad (14)$$

$$t_w^L = \rho - \alpha \sqrt{\frac{C - \theta(A + C)}{\alpha(1 - \theta) + \beta(1 - \phi)V / L}} \quad (15)$$

$$r_w^L = \frac{\rho}{1 - \phi} + \frac{\delta\phi - (1 + \rho)\theta}{1 - \phi} + \frac{\beta}{L} \sqrt{\frac{C - \theta(A + C)}{\alpha(1 - \theta) + \beta(1 - \phi)V / L}} \quad (16)$$

where  $0 < \theta < \frac{C}{A + C} \leq 1$  (condition for non-negative capital)

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<sup>21</sup> Recall the subscript  $m$  represents usual monopolistic competition outcome without considering NPL factor whereas the subscript  $n$  is for the outcome with NPL consideration and the subscript  $w$  is mixed competition of revenue and profit maximisation.

First, the initial capital  $A$  is positively related to the number of banks as this provides a lower bound in the profit function and this increases incentives for new banks to enter the market.

Second, the effect of  $\theta$  parameter is not independent of the size of capital  $A$ . If of the size of capital  $A$  is large enough, then  $\theta$  is positively related to the number of banks. Therefore, for a reasonably capitalised market for banks, the number of banks increases with the regulation, while deposit and loan rate spread becomes smaller.

Finally, the NPL ratio affects the number of banks negatively whereas the provision rate has no impact on the number of banks. However, the loan rate rises with the NPLs and provisions.

### 3.4 Comparison

$$\begin{aligned}
 n_m &> n_n \\
 n_w &= n_n, & \text{if } \theta = 0 \\
 n_w &> n_n, & \text{if } 0 < \theta < \frac{C}{A+C} \leq 1
 \end{aligned} \tag{17}$$

A subscript  $m$  (market) indicates free competition values without NPL consideration. As shown in the previous section, the equilibrium number of banks in the market is smaller if we take NPLs into consideration ( $n_m > n_n$ ). On the other hand, when banks behave more like a profit maximiser i.e. focusing more on their performance measures such as ROA and BIS ratios, the market equilibrium would support a smaller number of banks as shown in the equations 17.

In summary, as banks focus more on revenue maximisation, the equilibrium number of banks tends to be unnecessarily large compared to the profit-maximising case. In other words, a shift in competition environment from revenue-maximising to profit-maximising triggered by changes in regulatory regime affects the number of banks downwards and makes banks strategically less competitive i.e. merge with one another in order to maintain a high rate of return or capital basis. A higher capital base,  $A$ , decreases the upper bound for  $\theta$  implying the sound capital base encourages banks to profit-maximise more than to revenue-maximise. Figure 2 illustrates the simulation results for the upper bound of  $\theta$  when the paid-in-capital size,  $A$ , is increased from 0.01 to 0.1 *ceteris paribus*. Figure 3 summarises the inverse relationship between the paid-in-



capital size ( $A$ ) and the relative weight assigned to revenue maximisation ( $\theta$ ). Thus, the probability of profit maximisation increases for banks with larger paid-in-capital. When  $\theta$  is equal to zero, the results are identical to the case of unregulated competition.

The figures suggest that the equilibrium number of banks increases with the parameter  $\theta$  but there is an upper bound for  $\theta$  as  $n$  grows exponentially after a certain point, which may not be feasible. Higher paid-in-capital ( $A$ ) sets this upper bound at a lower level as well as the level of equilibrium number of banks. In an extreme case, where banks have no paid-in-capital, i.e.  $A=0$ , the upper bound is equal to 1. On the other hand, if banks have an extremely large amount of paid-in-capital ( $A \rightarrow \infty$ ), the upper bound converges to zero asymptotically. Thus, a better-capitalised banking sector tends to have a smaller number of banks, i.e. more concentrated. This could explain the reason why stricter BIS ratio induced more mergers or exits and therefore created a more concentrated banking environment in East Asia.<sup>22</sup>

#### 4. Empirical analysis of banking structure and NPLs

In this section, the results of the theoretical model are tested empirically using a vector autoregression (VAR) model in order to incorporate endogenous feedback between structure, conduct and performance variables (see eqn.18). In principle, a VAR can be viewed as the reduced form of a system of dynamic simultaneous equations. The feedback can be exemplified within the regulatory framework. Tougher competition leads to lower profits and thus many firms are driven out of the industry, hence raising concentration.

$$y_t = v + A_1 y_{t-1} + B X_t + u_t \quad (18)$$

where  $y_t = (y_{1t}, \dots, y_{kt})'$  is a  $K \times 1$  random vector

##### 4.1 The Data

Aggregate time-series data for Korea were constructed using 18 nationwide banks and 10 regional banks in Korea (28 banks). Hence the panel of all 28 commercial

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<sup>22</sup> The current guideline for BIS ratio is 8% minimum set by Basel Accord 1988. Most G7 countries show 9-10% BIS ratio. Redrafting of the BIS Capital Accord was announced in Jan.2001. A revised framework for the New Basel Capital Accord (Basel II) was published in June 2004 followed by addition revision in 2005, which suggests stricter regulation on risky assets (<http://www.bis.org/publ/bcbs107.htm>).

banks over the 28 year period from 1976 to 2003 were used in the calculation of the time-series data for the analyses. However, one should note that this data set has only time-series features as the panel attributes were lost when calculating the market structure variables such as concentration in aggregate. When a bank changed its name after restructuring, it was recorded as a new entry in the data set. Changes in the number of commercial banks in Korea are shown in Table 1 with a substantial number of mergers.

The data came from the Bank of Korea (BOK), Financial Supervisory Services (FSS) and Maekyung-Annual Corporation reports. This paper follows the classification of deposit institutions set by the Bank of Korea. The econometric model is tested on commercial banks (i.e. nationwide city banks and regional banks), as foreign bank branches and specialised banks do not participate in the majority of competitive activities given the prevailing regulation. Moreover, city and regional banks represent nearly 50% of the deposit market and they are the ones that compete in the more realistic sense.

#### 4.2 Description of Variables

Variables of proxy measures are chosen for respective areas within the SCP paradigm: 1/ Structure; 2/ Conduct, and 3/ Performance. The level of concentration and market size are included in *Structure* as shown in Table 2. Deposit and loan rates together with interest margins are taken for *Conduct*. Return on deposits, NPLs and BIS ratios were included in *Performance*.

The Herfindal Hirschman Indices (HHIs) are calculated on the basis of deposit market share and scaled by 100 for: 1/ all commercial banks ( $HHI_t$ ); 2/ nationwide banks ( $HHIN_t$ ), and 3/ regional banks ( $HHIR_t$ )<sup>23</sup> for the benefit of investigating the impact of size distribution of market concentration and compare the results from nationwide banking with those from regional banking.

The deposit market size ( $MKS_t$ ) was computed in index form in order to deflate for changes in prices and currency devaluation. The total deposit size includes local

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<sup>23</sup> All three  $HHI_t$ ,  $HHIN_t$ , and  $HHIR_t$  are obtained by e.g.  $HHI_t = \frac{\sum_{i=1}^n s_{it}^2}{100}$

currency deposits in current, savings and time deposit accounts at city and regional banks, i.e. ordinary banks.<sup>24</sup>

$$MKS_t = \ln \left( \frac{\text{Total Deposit Size}_t}{GNP_t} \right) \quad (19)$$

Interest rates on deposits (IRD<sub>t</sub>)<sup>25</sup> and loans (IRL<sub>t</sub>)<sup>26</sup> were directly taken without transformation as IRD<sub>t</sub> and IRL<sub>t</sub> are already normalised with respect to the size of deposits by taking the weighted average of market interest rates.<sup>27</sup> The same applies to interest margins (IRM<sub>t</sub>). For the performance measure, Return on deposits (ROD<sub>t</sub>) was computed as a ratio of net profits over total deposits.<sup>28</sup> It is important to note that the performance measure cannot be simply the interest margin. Return on deposits (ROD<sub>t</sub>) is a measure of banks' soundness as non-accrual interests and provisions for non-performing loans were taken into account for which NPLs and BIS ratios are also included in the analysis. Therefore, return on deposits (ROD<sub>t</sub>) should definitely be distinguished from interest margins. Figure 6 shows evidence for this.

In addition to three groups of variables according to the SCP paradigm, 4-stage deregulation dummy variables are used in the analysis: D<sub>1t</sub> for the first stage deregulation on deposit interest rates, D<sub>2t</sub> for the second stage, D<sub>3t</sub> for the third stage and D<sub>4t</sub> for the final fourth stage deregulation on deposit interest rates. An aggregate measure of progressive deregulation on deposit rates was also calculated by adding the all four stage deregulation dummies. This aggregate deregulation dummy variable takes a progressive form based on the gradual deregulation processes, between 0 and 4, with 0 being complete regulation versus 4 being complete deregulation. In addition, the estimation can benefit from the aggregate deregulation dummy by relatively smaller loss in degree of freedom.

<sup>24</sup> The deposit size data were taken from 'Bank Management Statistics' published by FSS Korea.

<sup>25</sup> Indicative interest rate on time deposits in Korea for more than 1 year and less than 2 years (but effective for 1 year or more before Dec. 5, 1988) published by BOK is used, where the rate is an average weighted by amount from 1996.

<sup>26</sup> Indicative interest rate on loans of general funds in Korea up to 1 year for general enterprises at the end of the period, where the rate is an average weighted by loan of banking funds from 1996.

<sup>27</sup> IRD<sub>t</sub> and IRL<sub>t</sub> are taken from 'Money and Banking' published by BOK for Korea (<http://ecos.bok.or.kr/>).

<sup>28</sup> No logarithmic transformation is taken, as the distribution of residuals is normal with the simple ratio form.

### 4.3 Results

Clearly the liberalisation of deposit rates in Korea has put downward pressure on both deposit rates and loan rates as competition on interest rates has become more severe (see Figure 5) and made interest rates and interest margins more volatile as shown in Figure 6. In terms of banking structure, the number of banks increase until 1997 and declines after a series of mergers. The market concentration measured by HHI also show similar trends in Figure 4 although the concentration in the regional banking sector has not fallen prior to 1997 as the local geographical market power had been maintained. Another interesting observation to make is that non-performing loans (NPLs) declined dramatically since the 1997 crisis whilst the banking sector has become more concentrated (HHI). However, capital adequacy ratio (BIS ratio) has not improved in the same magnitude (see Figure 7). One explanation for the contrasting trends between NPLs and BIS ratios is that stricter loan loss provisions perhaps forced to write off NPLs but these write-offs did not translate into improvements in capital adequacy ratio if not adverse effects.

The deregulation dummy variables are considered to be exogenous given the initial reason for deregulation in Korea lies in the outside pressure from the international organisations such as G7, OECD, IMF and World Bank. Hence, they are dropped from the VAR estimation.

The results from the VAR estimation are reported in Table 4. One of the most noticeable results is the relationship between the degree of concentration and the market size which is significantly positive. Assuming cost of loan loss provision as endogenous sunk costs as put forward by Sutton (1991), there is evidence of escalation in the banking concentration as market size increases and the Granger causality tests suggest that market structure is predominantly affected by the market size although all the variables used in the analysis according to the SCP paradigm are jointly affecting the market concentration (see Table 5). However, market size itself seems to be affected by all the SCP variables which challenges the assumption of its exogeneity by previous studies.

The only conduct variable which has been included in the VAR analysis does not seem to be affected by any variables, which is disappointing. However, all the performance variables show significant coefficients: in particular the estimation

confirms the feedback system in the SCP paradigm as the impact on to the structure variables (HHI and MKS) are significant.

The performance measured by return on deposits (ROD) suggests that profitability of banks decreases as market gets more concentrated which contrasts the traditional view on market power. However, this result should be interpreted in association with the commonly used banking sector rescue programmes, e.g. M&As, to write off bad loans. Nonetheless, profitability is positively associated with interest margins, negatively associated with non-performing loans, and positively associated with capital adequacy as expected.

On the other hand, NPLs show a negative relationship with market size, i.e. relative NPL ratios decline as market becomes bigger. BIS ratios show a positive association with the market size as well as interest margins and the Granger causality tests shows strong evidence that the direction of causality flows from interest margins to BIS ratios.

## **5. Conclusions**

In order to understand banking structure, the determinants of the industry concentration were analysed both theoretically and empirically. The theoretical model suggests that concentration depends on the market size for given set up costs as well as banks' conduct and their performance. This recursive process is affected by regulation to some degree. Predictions suggested by the simple theoretical model are also tested on a time-series sample of the Korean commercial banking industry.

There is strong evidence that concentration rises when deposit market size increases as a consequence of deregulation process in banking industry. Although we have not found a convincing impact of deregulation on banking structure since the deregulation dummy variables are dropped from the VAR analysis given the exogeneity and because it is not straightforward to single out the effect from the theoretical model due to the impact of deregulation already being implicitly factored in to the model via banking behaviour: 1/ profit maximising or 2/ revenue maximising. However, all the results, both theoretical and empirical reaffirm that banking industry structure does not conform to standard convergence theory in concentration with a given sunk cost and the evolution of banking concentration has been non-monotonic in Korea which indicates possible explanation for endogenous sunk costs of loan loss provision.

There are several limitations in this analysis. First of all, some of the conclusions are based on weak evidence due to the limited number of observations available, especially where NPLs and BIS ratios are used given the short time-series available. Another limitation is that the restructuring process has had a short history and long-term effects have to be further studied. However, the research presented in this paper is useful on its own in discussing the short-term impact of deregulation and changes in NPLs and BIS ratios on the structure of banking system.

In this paper, I have investigated the banking structure with respect to changes in regulatory regimes and the associated NPLs and BIS ratios. Level of NPLs reduced over time especially after the rescue programmes were implemented in the post 1997 period. By contrast, both the theoretical and empirical results suggest that the relationship between market concentration and the NPL ratios are positive which can only be explained by adverse effects of market power achieved via expansion into risky loans. Another consistent result between the theoretical and empirical analyses is that capital adequacy ratios are positively associated with the market concentration. An immediate concern arises here regarding M&As which have been commonly used in the bank rescue programmes. The analysis in this paper confirms that the M&A type of rescue measure would improve banks' BIS ratios but it does have adverse effect on their NPLs. If banks try to reduce NPLs given their BIS ratios, credit rationing is inevitable and the knock-on effects will fall onto small and medium size enterprises (SMEs), who will eventually be squeezed out of the traditional financial industry such as banking. It is perhaps time to revisit the question raised by Hellman *et al.* (2000) - Are capital requirements enough?

In addition to the threat of credit rationing, I do, however, believe it is worth having a closer and broader look at the on-going process of deregulation and restructuring in the banking sector. For instance, alongside the mergers between domestic commercial banks, M&A activity by foreign banks has just started to become politically and socially acceptable in rescuing distressed Korean commercial banks. The impact of different types of consolidation, for instance cross-financial sector mergers, will most likely be an interesting area for future investigation.

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## Appendix

**Table 1. Changes in the number of commercial banks in Korea**

	Peak			M&A	R	T	A
	Dec-76	Dec-97	Dec-03				
<i>(Total No. = 28)</i>							
<b>Nationwide (18)</b>	5	<b>16</b>	8	<b>-9</b>	0	+3	+9
<b>Regional (10)</b>	10	<b>10</b>	6	<b>-4</b>	0	0	0

Source: Japanese Banks – Principal Financial Institutions by Zenginkyo, and Korean Bank Management Statistics by Financial Supervisory Service (FSS).

N.B.:

- 1) M&A: mergers and acquisition; R: revocations; T: transformations; A: authorisation of new entities.
- 2) In case of M&As and a subsequent change of bank name for a newly merged one, it has been counted as only one M&A instead of counting as two M&As and an authorisation of a new entity.
- 3) When a bank changed its name, the data set recorded as a new bank although it is not counted as an authorisation of new entity in the above table.

**Table 2. Description of variables**

Variables	Type	Operational Definition
Year	C	1976 - 2003
<b>Structure variables</b>		
HHI <sub>t</sub>	C	Banking concentration rescaled by HHI/100
HHIN <sub>t</sub>	C	Concentration in nationwide banking rescaled by HHIN/100
HHIR <sub>t</sub>	C	Concentration in regional banking rescaled by HHIR/100
MKS <sub>t</sub>	C	Log of total deposit market size rescaled and deflated by GNP
<b>Conduct variables</b>		
IRD <sub>t</sub>	C	Market average interest rates on deposits (1-2 year time & savings)
IRL <sub>t</sub>	C	Market average interest rates on loans (3 year fixed term)
IRM <sub>t</sub>	C	Market average interest margin
<b>Performance variables</b>		
ROD <sub>t</sub>	C	Average return on deposits
NPL <sub>t</sub>	C	Non-performing loan ratio for all commercial banks
NPLN <sub>t</sub>	C	Non-performing loan ratio for nationwide banks
NPLR <sub>t</sub>	C	Non-performing loan ratio for regional banks
BIS <sub>t</sub>	C	BIS capital adequacy ratio for all commercial banks
BISN <sub>t</sub>	C	BIS capital adequacy ratio for nationwide banks
BISR <sub>t</sub>	C	BIS capital adequacy ratio for regional banks
<b>Deregulation dummy variables</b>		
D <sub>t</sub>	L/D	Aggregate deregulation dummy index
D <sub>it</sub>	L/D	Four-stage deregulation measures on deposit interest rates where i=1,...,4 for 1991, 1993, 1994, and 1995 respectively

N.B.: Binary (B), Likert (L), Continuous (C), and Discrete (D)

**Table 3. Descriptive summary**

<b>Variable</b>	<b>Obs</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>Min</b>	<b>Max</b>
Year	28	1989.5	8.2260	1976	2003
<i>Structure variables</i>					
HHI <sub>t</sub>	28	13.6659	3.1491	8.3284	18.1700
HHIN <sub>t</sub>	28	15.4520	4.0916	8.6010	21.2986
HHIR <sub>t</sub>	28	15.9626	3.8017	12.5641	23.5518
MKS <sub>t</sub>	28	-.9263	.2503	-1.3535	-.2942
<i>Conduct variables</i>					
IRD <sub>t</sub>	28	10.6711	4.0151	4.15	19.50
IRL <sub>t</sub>	28	12.5400	3.6178	6.24	20.00
IRM <sub>t</sub>	28	1.8375	.8030	.4	3.5
<i>Performance variables</i>					
ROD <sub>t</sub>	28	.1904	.7774	-2.98	.76
NPL <sub>t</sub>	10	5.04	2.1996	1.9	8.3
NPLN <sub>t</sub>	10	5.04	2.1803	2.0	8.4
NPLR <sub>t</sub>	10	5.06	2.9852	1.7	10.1
BIS <sub>t</sub>	12	9.9692	1.2758	7.04	11.18
BISN <sub>t</sub>	12	9.7275	1.2717	6.66	10.81
BISR <sub>t</sub>	12	11.5950	2.2301	8.31	16.40
<i>Deregulation dummy variables</i>					
D <sub>t</sub>	28	1.5357	1.8556	0	4
D <sub>1t</sub>	28	.4643	.5079	0	1
D <sub>2t</sub>	28	.3929	.4973	0	1
D <sub>3t</sub>	28	.3571	.4880	0	1
D <sub>4t</sub>	28	.3214	.4756	0	1

**Table 4. Vector autoregression (VAR) results**

	Coef.	Std. Err.	z-value	P> z
<i>Dependent variable = HHI</i>				
HHI lag 1 (HHI <sub>t-1</sub> )	-.6927	.9887	.70	.484
MKS lag 1 (MKS <sub>t-1</sub> )	11.9612	3.9802	3.01***	.003
IRM lag 1 (IRM <sub>t-1</sub> )	.4026	1.1653	.35	.730
ROD lag 1 (ROD <sub>t-1</sub> )	1.9181	1.8174	1.06	.291
NPL lag 1 (NPL <sub>t-1</sub> )	1.5277	1.1398	1.34	.180
BIS lag 1 (BIS <sub>t-1</sub> )	-1.2366	1.4271	-.87	.386
constant	16.3778	7.4510	2.20*	.028
<i>Dependent variable = MKS</i>				
HHI lag 1 (HHI <sub>t-1</sub> )	.0958	.0220	4.36***	.000
MKS lag 1 (MKS <sub>t-1</sub> )	.8598	.0884	9.72***	.000
IRM lag 1 (IRM <sub>t-1</sub> )	-.1021	.0259	-3.94***	.000
ROD lag 1 (ROD <sub>t-1</sub> )	.1054	.0404	2.61***	.009
NPL lag 1 (NPL <sub>t-1</sub> )	.0801	.0253	3.16***	.002
BIS lag 1 (BIS <sub>t-1</sub> )	-.1082	.0317	-3.41***	.001
constant	-.2258	.1655	-1.36	.173
<i>Dependent variable = IRM</i>				
HHI lag 1 (HHI <sub>t-1</sub> )	-.3421	.3261	-1.05	.294
MKS lag 1 (MKS <sub>t-1</sub> )	1.6239	1.3129	1.24	.216
IRM lag 1 (IRM <sub>t-1</sub> )	-.0533	.3844	-.14	.890
ROD lag 1 (ROD <sub>t-1</sub> )	.1740	.5995	.29	.772
NPL lag 1 (NPL <sub>t-1</sub> )	-.2159	.3760	-.57	.566
BIS lag 1 (BIS <sub>t-1</sub> )	.1488	.4708	.32	.752
constant	6.7229	2.4578	2.74***	.006
<i>Dependent variable = ROD</i>				
HHI lag 1 (HHI <sub>t-1</sub> )	-.6876	.3464	-1.99*	.047
MKS lag 1 (MKS <sub>t-1</sub> )	.0331	1.3945	.02	.981
IRM lag 1 (IRM <sub>t-1</sub> )	1.1077	.4083	2.71***	.007
ROD lag 1 (ROD <sub>t-1</sub> )	-1.3976	.6367	-2.19*	.028
NPL lag 1 (NPL <sub>t-1</sub> )	-.8885	.3993	-2.23*	.026
BIS lag 1 (BIS <sub>t-1</sub> )	1.9727	.5000	3.95***	.000
constant	-9.8796	2.6104	-3.78***	.000
<i>Dependent variable = NPL</i>				
HHI lag 1 (HHI <sub>t-1</sub> )	.5883	.6804	.86	.387
MKS lag 1 (MKS <sub>t-1</sub> )	-6.978	2.7393	-2.55**	.011
IRM lag 1 (IRM <sub>t-1</sub> )	-1.2186	.8020	-1.52	.129
ROD lag 1 (ROD <sub>t-1</sub> )	.0484	1.2508	.04	.969
NPL lag 1 (NPL <sub>t-1</sub> )	.5593	.7844	.71	.476
BIS lag 1 (BIS <sub>t-1</sub> )	-1.2312	.9822	-1.25	.210
constant	4.5348	5.1280	.88	.377
<i>Dependent variable = BIS</i>				
HHI lag 1 (HHI <sub>t-1</sub> )	.1259	.2314	.54	.586
MKS lag 1 (MKS <sub>t-1</sub> )	3.2548	.9315	3.49***	.000
IRM lag 1 (IRM <sub>t-1</sub> )	.9689	.2727	3.55***	.000
ROD lag 1 (ROD <sub>t-1</sub> )	-.7237	.4254	-1.70	.089
NPL lag 1 (NPL <sub>t-1</sub> )	.2521	.2667	.95	.345
BIS lag 1 (BIS <sub>t-1</sub> )	.7049	.3340	2.11*	.035
constant	.4458	1.7438	.26	.798
No. of observations	9			
AIC	-133.0344			
Log likelihood	-640.655			

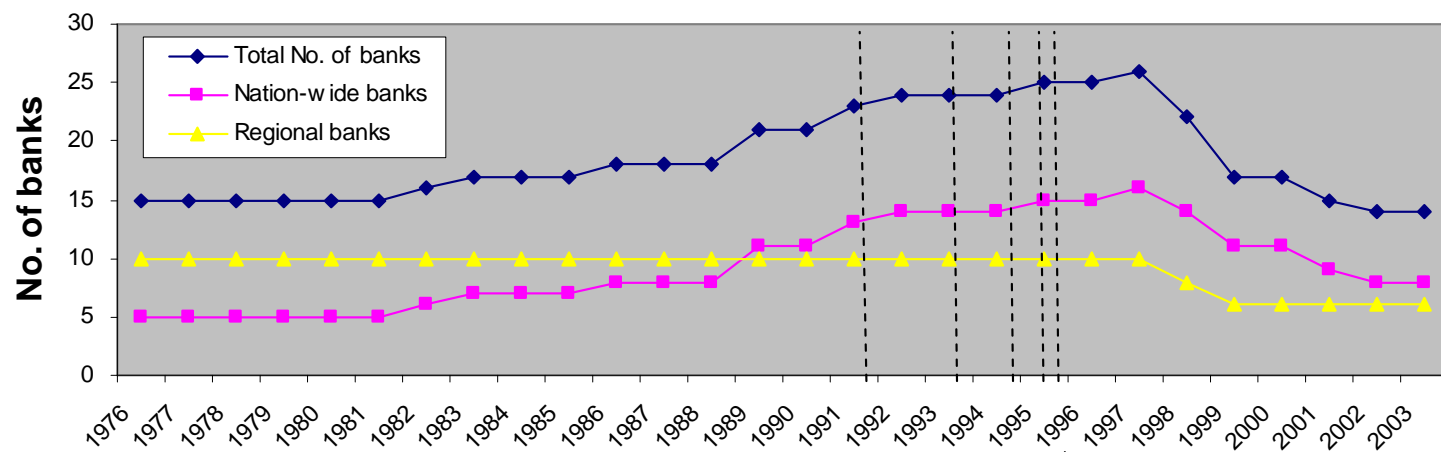
N.B.: z-values \*\*\*, \*\*, \* significant at 0.5%, 1%, 2.5% levels respectively.

**Table 5. Granger causality Wald tests**

<b>Equation</b>	<b>Excluded</b>	$\chi^2$	<b>df</b>
HHI	MKS	9.031**	1
HHI	IRM	.119	1
HHI	ROD	1.114	1
HHI	NPL	1.797	1
HHI	BIS	.751	1
HHI	ALL	14.419*	5
MKS	MKS	19.014***	1
MKS	IRM	15.552***	1
MKS	ROD	6.811**	1
MKS	NPL	10.001**	1
MKS	BIS	11.653***	1
MKS	ALL	38.019***	5
IRM	MKS	1.100	1
IRM	IRM	1.530	1
IRM	ROD	.084	1
IRM	NPL	.330	1
IRM	BIS	.100	1
IRM	ALL	20.230**	5
ROD	MKS	3.941*	1
ROD	IRM	.001	1
ROD	ROD	7.361**	1
ROD	NPL	4.951*	1
ROD	BIS	15.566***	1
ROD	ALL	51.537***	5
NPL	MKS	.748	1
NPL	IRM	6.489*	1
NPL	ROD	2.309	1
NPL	NPL	.002	1
NPL	BIS	1.571	1
NPL	ALL	33.736***	5
BIS	MKS	.296	1
BIS	IRM	12.208***	1
BIS	ROD	12.621***	1
BIS	NPL	2.895	1
BIS	BIS	.893	1
BIS	ALL	167.520***	5

N.B.: Chi-squared values \*, \*\*, \*\*\* significant at 5%, 1%, 0.1% levels respectively.

## Overview of banking restructuring and liberalisation in Korea



**Nov 1991**  
short-term interest rates & 3-yr or over time deposit rates liberalised

**Nov 1993**  
2-yr or over time deposit rates liberalised

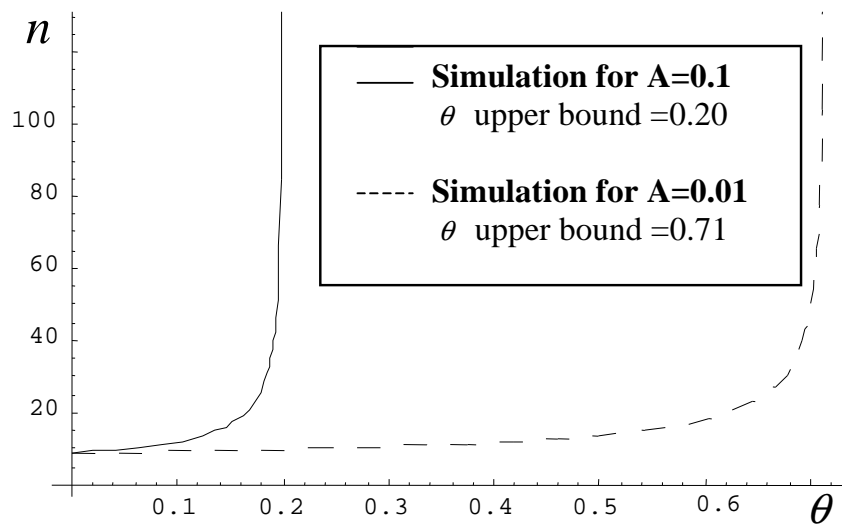
**Dec 1994**  
strategic loan rates partially liberalised & 1-yr or over time deposit rates liberalised

**July 1995**  
strategic loan rates fully liberalised & 6-month or over time deposit rates liberalised

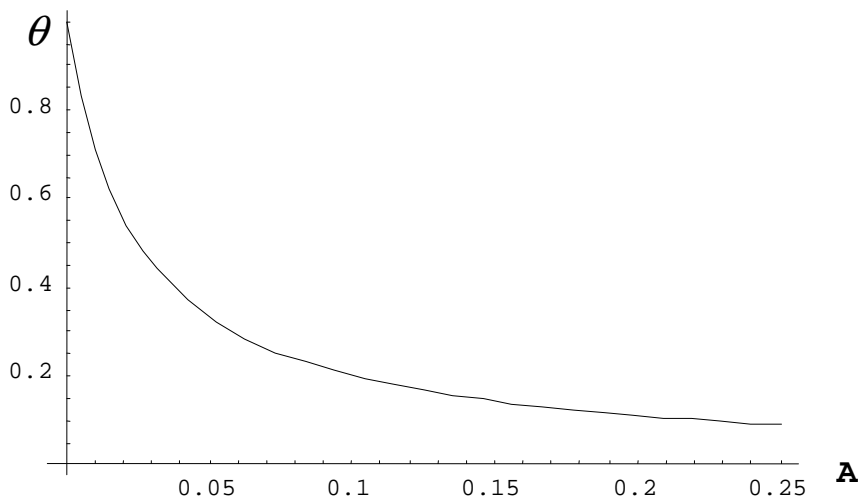
**Nov 1995**  
4-stage interest rate deregulation completed as 6-month below time deposit rates liberalised

Source: Financial Supervisory Service (FSS)

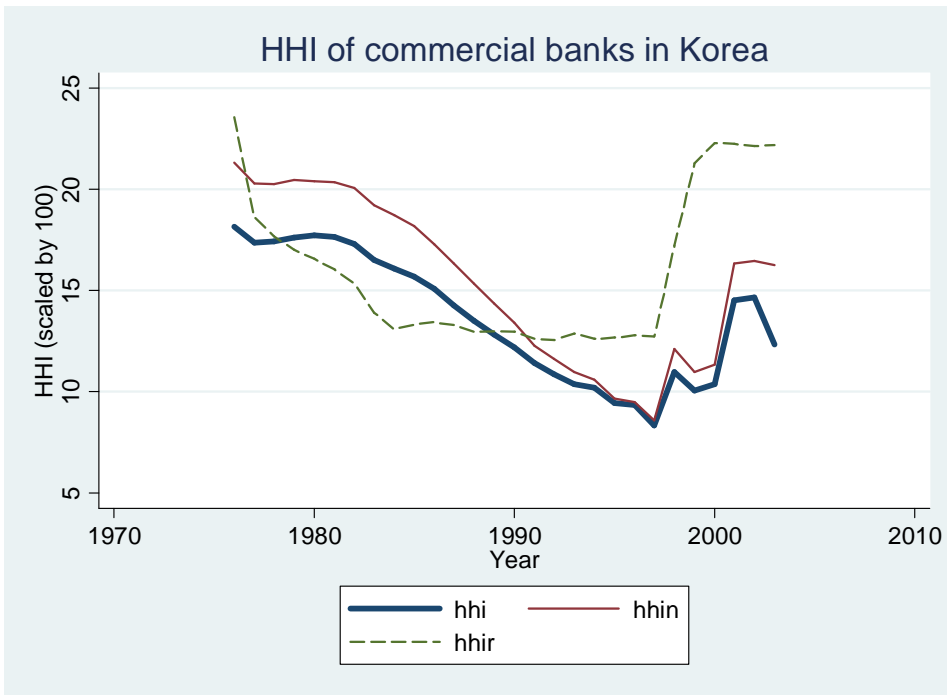
Figure 1: Overview of banking restructuring and liberalisation in Korea



**Figure 2. Equilibrium Number of Banks ( $n$ ) vs. Regulation on Interest Rates ( $\theta$ )**



**Figure 3. Regulation on Interest Rates ( $\theta$ ) vs. Paid-in-Capital Size ( $A$ )**

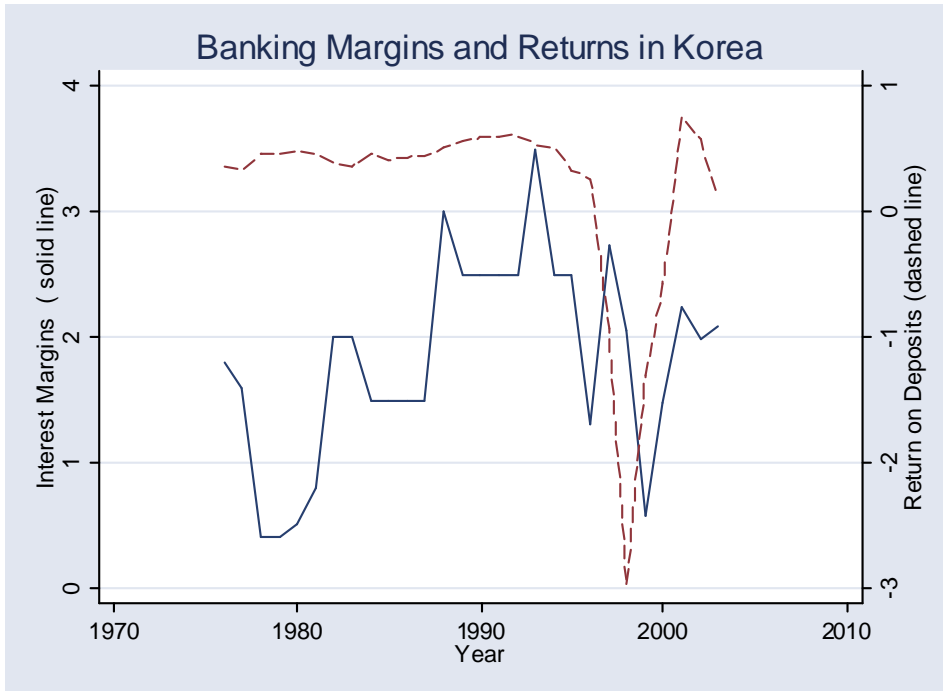


**Figure 4: Banking concentration (HHI<sub>t</sub>) in Korea**

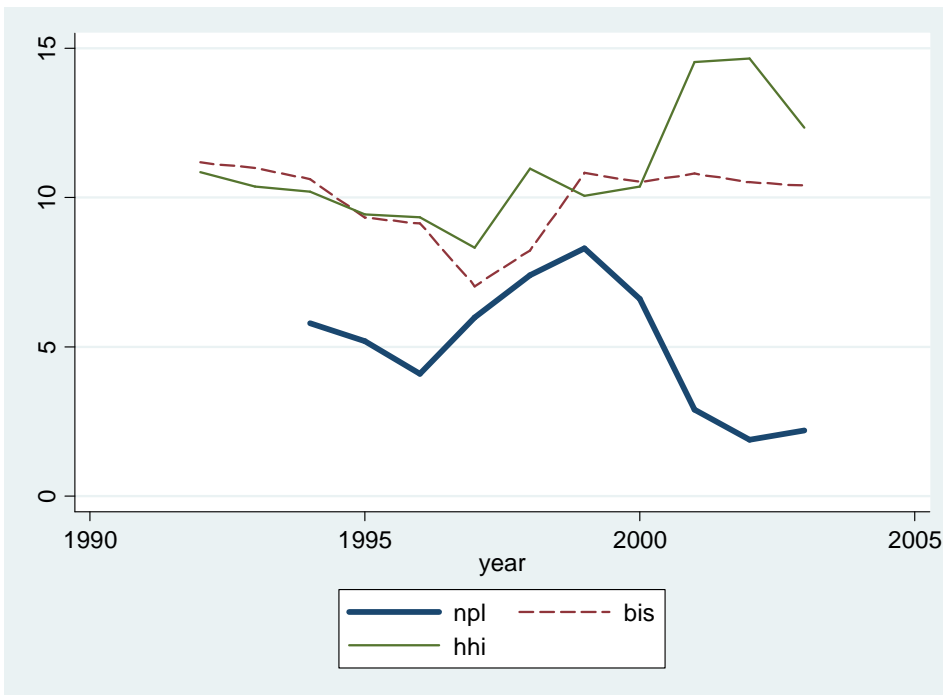


**Figure 5: Interest Rates in Korea**





**Figure 6: Banking Margins and Returns in Korea**



**Figure 7: Overview of the Korean banking structure (HHI) with respect to non-performing loans (NPL) and the capital adequacy ratio (BIS)**

N.B.: FSS reports NPLs and BIS ratios only from 1994 and 1992 respectively.