

# **ESSAYS ON COMPETITION IN THE HONG KONG BANKING MARKET**

by

**KAILIN ZOU**

*A Thesis Submitted in Fulfilment of the Requirements for the Degree  
of Doctor of Philosophy of Cardiff University*

*Economics Section, Cardiff Business School, Cardiff University*

September 2014



## Declaration

This work has not been submitted in substance for any other degree or award at this or any other university or place of learning, nor is being submitted concurrently in candidature for any degree or other award.

Signed .....(candidate)      Date .....

### STATEMENT 1

This thesis is being submitted in partial fulfillment of the requirements for the degree of .....(insert MCh, MD, MPhil, PhD etc, as appropriate)

Signed .....(candidate)      Date .....

### STATEMENT 2

This thesis is the result of my own independent work/investigation, except where otherwise stated.

Other sources are acknowledged by explicit references. The views expressed are my own.

Signed .....(candidate)      Date .....

### STATEMENT 3

I hereby give consent for my thesis, if accepted, to be available for photocopying and for inter-library loan, and for the title and summary to be made available to outside organisations.

Signed .....(candidate)      Date .....

## **Abstract**

The aim of the thesis is to investigate three banking issues related to competition, which are switching costs, collusion, and the competitive conditions in the Hong Kong banking sector during the period 1997 to 2012. For this purpose, a database consisting of an unbalanced panel of annual observations for 18 licensed banks incorporated in Hong Kong is used. This thesis comprises three empirical essays as follows:

The first essay uses a structural model presented by Kim et al. (2003), which explores the significance and the magnitude of switching costs in Hong Kong's bank loan market. Overall, I find that switching costs are significant in the Hong Kong bank loan market. The average point estimate of switching costs based on the entire sample is 0.1947. The results suggest that the existence of switching costs raises the price-cost margin by 52 basis points. Furthermore, the results also suggest that the estimated switching costs during the bad times are slightly higher than that in good times. On average, 2.54% of the customer's added value is attributed to the lock-in effect generated by switching costs.

The second essay measures the degree of collusion and the nature of the competitive conditions in the Hong Kong bank loan market using the conjectural variation approach. I jointly estimate a system of a log demand function, a pricing equation, and a trans-log cost system, and use the conjectural variation parameter to identify the degree of collusion. The estimated conjectural variation parameter is insignificant, which suggests that banks in Hong Kong operate in a competitive fashion in the loan market and the behaviour of the banks is consistent with a Nash-Bertrand equilibrium in price, with no significant evidence of collusion on pricing.

The third essay investigates the degree of competition in the Hong Kong banking sector using the Panzar-Rosse approach. The novelty of this essay is to solve the problem of the system's residuals correlation in the Panzar-Rosse model by jointly estimating equations using the SUR approach. My results suggest that the Hong Kong bank market can be characterized as monopolistic competition and the level of competition of interest market is higher than competition level of the non-interest market.

## Acknowledgements

First and foremost, I wish to thank my primary supervisor, Professor Kent Matthews, Sir Julian Hodge Professor of Banking and Finance. A PhD is a tough road to take but very rewarding. It has been an honour being his student. He has been a great mentor and supporter. He has not only helped me to grow academically over the past five years, but also provided emotional support through the rough road to finish this thesis. I really appreciate his time and ideas. Without his guidance, this PhD would not have been achievable.

I would also like to thank Professor Patrick Minford, my secondary supervisor, who provided helpful comments and suggestions for my conclusion chapter. It is such great experience to work with him, and be inspired by a great and influential economist like him. My sincere thanks also go to Professor Kul Luintel, Dr. Jack Li and Dr. Zhirong Ou, for giving me useful advice on econometrics, especially for choosing instrumental variables. I have benefited from presenting in the PhD workshop and from the seminars organised at the Economics section of Cardiff Business School. I would like to say thank you to all of my colleagues who provided comments and suggestions on my research.

I gratefully acknowledge the funding received towards my PhD from Julian Hodge PhD Bursaries in Applied Macroeconomics from Cardiff Business School. Thanks to Dr. Woon Wong, who had offered me abundant teaching opportunities. I would also like to say a heartfelt thank you to all my friends over these years. And I would like to say thank you to Dr. Jonathan Evans. His proofreading greatly helped the readability of my work.

Lastly, I would like to thank my family for all their love and encouragement. For my parents, Dr. Shubin Zou and Dr. Shan Lin, who supported me in all of my pursuits and encouraged me during this challenging period. And a special thanks to my boyfriend, Mr. Hongchao Zhang, who has been at my side throughout this PhD and has inspired me to follow my dream.

# Table of Contents

Declaration .....	I
Abstract .....	II
Acknowledgements .....	III
Table of Contents .....	IV
List of Figures .....	IX
List of Tables.....	X
Abbreviations .....	XII

## Chapter 1 Introduction

1.1 The nature of this thesis .....	1
1.2 Background and motivation .....	1
1.3 Research question.....	11
1.4 Contribution of this thesis .....	12
1.5 Outline of this thesis .....	15

## Chapter 2 Crisis and Responses: The Story of Hong Kong Banking

### Industry after 1997

2.1 Introduction .....	18
2.2 The current state of the Hong Kong banking industry .....	19
2.2.1 The main regulatory and advisory bodies in Hong Kong.....	20
2.2.1.1 Hong Kong Monetary Authority (HKMA).....	20
2.2.1.2 Hong Kong Association of Banks (HKAB) .....	21
2.2.1.3 Financial Services and the Treasury Bureau (FSTB) .....	21
2.2.2 The current structure of banking system and bank consolidations.....	22
2.2.3 Market concentration in Hong Kong.....	26
2.2.4 Linked exchange rate system .....	27
2.3 The development of Hong Kong's banking System after 1997 .....	29
2.3.1 Hong Kong's banking industry after 1997 .....	30
2.3.1.1 Major indicators of the balance sheet .....	32

2.3.2	Policy responses after the Asian financial crisis .....	35
2.4	Hong Kong's Economy .....	37
2.4.1	The Economic success of Hong Kong .....	39
2.4.1.1	Economic freedom .....	39
2.4.1.2	Low taxation .....	40
2.4.1.3	Strong legal and institutional frameworks .....	41
2.4.2	Hong Kong's major Economic Indicators .....	41
2.4.3	Hong Kong banking industry .....	45
2.5	Conclusion .....	52

### **Chapter 3 Switching Costs in the Hong Kong Banking Industry**

3.1	Introduction .....	54
3.2	Literature review and methodology .....	58
3.2.1	Introduction .....	58
3.2.2	Definitions of switching costs .....	58
3.2.3	Types of switching costs .....	59
3.2.4	Theoretical literature .....	63
3.2.4.1	Models with switching cost .....	64
3.2.4.2	Aftermarkets .....	70
3.2.4.3	Market entry and exit .....	71
3.2.5	Empirical literature .....	72
3.2.5.1	Direct methods .....	72
3.2.5.2	Indirect methods .....	73
3.2.6	Methodology .....	75
3.2.6.1	Introduction .....	75
3.2.6.2	The model's framework .....	76
3.2.6.3	Demand side .....	77
3.2.6.4	Supply Side .....	83
3.2.7	Empirical methodology .....	84
3.2.8	Summary .....	86
3.3	Data and variables .....	87
3.3.1	Introduction .....	87
3.3.2	Data .....	87

3.3.3	Data cleaning rules .....	94
3.3.3.1	Interest rate on loans .....	94
3.3.3.2	The number of employees.....	96
3.3.4	Summary .....	97
3.4	Empirical study and results .....	98
3.4.1	Introduction .....	98
3.4.2	Empirical results .....	98
3.4.3	The effect of existence of switching costs on price-cost margin.....	102
3.4.4	Switching costs during good times and bad times .....	103
3.4.5	The contribution of customer's added value to the lock-in phenomenon generated by switching costs .....	104
3.4.6	Multi-outputs trans-log cost functions .....	105
3.4.7	Marginal costs .....	106
3.4.8	Economies of scale .....	108
3.4.9	Robustness test using GMM approach .....	109
3.4.10	Summary .....	113
3.5	Conclusion .....	114

**Chapter 4 Testing for Collusion and Competition in Hong Kong's Banking Sector: Conjectural Variation Approach**

4.1	Introduction .....	116
4.2	Literature reviews and methodology .....	119
4.2.1	Introduction .....	119
4.2.2	Literature reviews .....	119
4.2.2.1	Measures of competition.....	119
4.2.3	Methodology .....	130
4.2.4	Empirical model .....	133
4.2.5	The linkage between own price elasticity, $\varphi_1$ , and sensitivity of the transition probability to the bank's own interest rate, $\alpha_1$ .....	136
4.2.6	Summary .....	137
4.3	Data and variables .....	137
4.3.1	Introduction .....	137
4.3.2	Data .....	138

4.3.3	Summary .....	140
4.4	Empirical results.....	140
4.4.1	Introduction .....	140
4.4.2	Empirical results.....	140
4.4.3	Marginal costs: A comparison between Chapter 3 and 4.....	147
4.4.4	Summary .....	150
4.5	Conclusion .....	151

## **Chapter 5 Competitive Condition in the Hong Kong Banking Sector:**

### **The Panzar-Rosse Approach**

5.1	Introduction.....	153
5.2	Literature reviews and methodology.....	156
5.2.1	Introduction .....	156
5.2.2	Literature reviews.....	156
5.2.2.1	The Panzar and Rosse approach .....	156
5.2.2.2	Some earlier studies using P-R approach .....	158
5.2.2.3	Recent studies using P-R approach.....	159
5.2.2.4	The case of Hong Kong .....	161
5.2.2.5	Non-banking studies .....	162
5.2.2.6	The advantages and disadvantages of the P-R approach.....	162
5.2.3	Methodology .....	164
5.2.4	Empirical model .....	168
5.2.5	Summary .....	169
5.3	Data and variables .....	170
5.3.1	Introduction .....	170
5.3.2	Data .....	170
5.3.3	Summary .....	174
5.4	Empirical results.....	174
5.4.1	Introduction .....	174
5.4.2	Empirical results: total revenue as a dependent variable.....	175
5.4.3	Empirical results: Interest income and non-interest income as dependent variable.....	179
5.4.4	Development of H-statistic overtime .....	183



5.4.5 Summary .....	185
5.5 Conclusion .....	186

## **Chapter 6 Conclusion**

6.1 Introduction .....	189
6.2 Summary of the empirical results .....	190
6.3 Policy implication of the thesis .....	197
6.4 Limitations of this thesis .....	205
6.5 Suggestions for further research.....	207

<b>References</b> .....	211
-------------------------	-----

## **Appendix A Chapter 3 Appendix**

Appendix A.1 The derivation of the optimal interest rate strategy (equation 3.24).....	225
Appendix A.2 Sample of banks.....	229
Appendix A.3 Coefficients interpretations of normalized trans-log cost function.....	230
Appendix A.4 Coefficient variance-covariance matrix.....	232
Appendix A.5 Derivation of equation (3.37).....	234

## **Appendix B Chapter 4 Appendix**

Appendix B.1 Coefficient variance-covariance matrix.....	235
--	-----

<b>Appendix C List of Symbols</b> .....	226
---	-----

## List of Figures

Figure 1.1	The share of Hong Kong in the total foreign investment received by Mainland China for the period 1996 to 2012.....	6
Figure 1.2	The number of all authorized institutions in Hong Kong, 1997 to 2012.....	9
Figure 1.3	Herfindahl-Hirschman Index of 18 licensed banks in Hong Kong, 1997 to 2012.....	9
Figure 2.1	The changes in the number of authorized institutions in Hong Kong from 1997-2014.....	24
Figure 2.2	K-bank concentration ratios from 1997 to 2011.....	27
Figure 2.3	Hang Seng Index (Weekly, Close price), 1997 to 2012.....	32
Figure 2.4	Total assets of retail banks, 1997 to 2012 (HKD billion).....	34
Figure 2.5	Loans to customers of retail banks, 1997 to 2012 (HKD billion) ...	34
Figure 2.6	Deposits from customers of retail banks, 1997 to 2012 (HKD billion) .....	35
Figure 2.7	Real GDP growth rate (quarterly, %), 1997 to 2012.....	43
Figure 2.8	Unemployment rate (annual average, %), 1997 to 2012.....	43
Figure 2.9	Inflation rate (annual average, %), 1997 to 2012.....	44
Figure 2.10	Foreign currency reserve assets (USD billion) 1997 to 2012.....	44
Figure 3.1	Bank loans .....	48
Figure 3.2	Average lending rate.....	48
Figure 3.3	T-bill rates.....	49
Figure 3.4	Market shares measured by bank loans in 2012.....	51
Figure 3.5	Interest rate on loans for 3 banks groups.....	95
Figure 3.6	Marginal costs of three banks groups using non-linear 3SLS approach .....	107
Figure 3.7	Average lending rate in Hong Kong from 1997 to 2012.....	108
Figure 3.8	AC-MC (unit: million HKD).....	109
Figure 3.9	Marginal costs using GMM approach .....	112
Figure 4.1	Marginal costs of three bank groups in Chapter 3 using non-linear 3SLS.....	148
Figure 4.2	Marginal costs of three bank groups using non-linear 3SLS approach .....	149
Figure 4.3	Price cost margin .....	150

## List of Tables

Table 2.1	Business scope of authorized institutions in Hong Kong .....	23
Table 2.2	Major consolidations in Hong Kong banking industry after 1997....	25
Table 2.3	The history of exchange rate systems for the HKD .....	28
Table 2.4	Industry characteristics (1997-2004) .....	46
Table 2.5	Industry characteristics (2005-2012) .....	47
Table 3.1	The definition and measurement of variables .....	90
Table 3.2	The definition and measurement of instrumental variables (apart from presented variables in Table 3.1) .....	91
Table 3.3	Summary statistics (HKD million) .....	91
Table 3.4	Summary statistics- year 1999, 2007 and 2012 (HKD million) .....	92
Table 3.7	System estimation of trans-log cost system and switching costs equations using non-linear 3SLS. Included observation=275. Standard errors are in parenthesis .....	100
Table 3.8	A contrastive analysis of switching costs during good times and bad times .....	104
Table 3.9	Correlation between bank loans ( $\ln y_1$ ), other earning assets ( $\ln y_2$ ) and net fees and commissions ( $\ln y_3$ ) .....	106
Table 3.10	System estimation of trans-log cost system and switching costs equations using GMM. Included observation=275. Standard errors are in parenthesis .....	111
Table 4.1	The definition and measurement of variables (apart from presented variables in Table 3.1 of Chapter 3).....	139
Table 4.2	Summary statistics (HKD million) .....	139
Table 4.3	Empirical results of estimating conjectural variation parameter using non-linear 3SLS. Included observation=275. Standard errors are in parenthesis.....	142
Table 4.4	Empirical results of the conjectural variation parameter using GMM. Included observation=274. Standard errors are in parenthesis .....	146
Table 5.1	The definition and measure of variables (apart from the variables presented in Chapters 3 and 4) .....	171
Table 5.2	Summary statistics (HKD million) .....	172
Table 5.3	Summary statistics- year 1999, 2007 and 2012 (HKD million) .....	173
Table 5.4	Correlation matrix of residuals between equations.....	177
Table 5.5	Panzar-Rosse H-statistic using total revenue as dependent variable 1997-2012: SUR estimation. Included observation= 204. Standard errors are in parenthesis .....	178
Table 5.6	Correlation matrix of residuals between equations.....	181
Table 5.7	Panzar-Rosse H-statistic using interest income and non-interest income as dependent variable 1997-2012: SUR estimation. Included observation= 201. Standard errors are in parenthesis .....	182

Table 5.8	Panzar-Rosse H-statistic using interest income and non-interest income as dependent variable for rolling sample.....	185
Table A.1	Coefficient variance-covariance matrix of system estimation of trans-log cost system and switching costs equations using non-linear 3SLS approach.....	232
Table A.2	Coefficient variance-covariance matrix of system estimation of trans-log cost system and switching costs equations using GMM approach .....	233
Table B.1	Coefficient variance-covariance matrix of system estimation of trans-log cost system, demand equation and pricing equation using non-linear 3SLS .....	235
Table B.2	Coefficient variance-covariance matrix of system estimation of trans-log cost system, demand equation and pricing equation using GMM .....	237

## Abbreviations

<b>Abbreviation</b>	<b>Meaning</b>
3SLS	Three-stage Least Squares
BIS	Bank of International Settlements
BLR	Best Lending Rates
C&SD	Census and Statistics Department
CHATS	Clearing House Automated Transfer System
COMPAG	Competition Policy Advisory Group
DTC	Restricted Licence Banks and Deposit-taking Companies
Fed	Federal Reserve
FSTB	Financial Services and the Treasury Bureau
FTZ	Free-trade Zone
GMM	Generalized Method of Moments
HHI	Herfindahl-Hirschman Index
HKAB	Hong Kong Association of Banks
HKBOR	Hong Kong Interbank Offered Rate
HKD	Hong Kong Dollar
HKE <sub>x</sub>	Hong Kong Exchanges and Clearing Limited
HKMA	Hong Kong Monetary Authority
HSBC	Hong Kong and Shanghai Banking Corporation Limited
IO	Industrial Organization
IRRs	Interest Rate Rules
NEIO	New Empirical Industrial Organisation
NIM	Net Interest Margins
PFA <sub>s</sub>	Pension Fund Administrators
P-R	Panzar-Rosse
RMB	Renminbi
RTGS	Real Time Gross Settlement
SCP	Structure- Conduct-Performance
SUR	Seemingly Unrelated Regressions

# **Chapter 1**

## **Introduction**

### **1.1 The nature of this thesis**

This thesis is an empirical study of banking performance in Hong Kong. It investigates three specific banking issues related to competition, which are: switching costs in the Hong Kong bank loan market, collusion in the Hong Kong bank loan market, and competition in the Hong Kong banking sector. This chapter offers a brief introduction and motivation for this thesis from following aspects: Section 1.2 describes the issue of competition in the Hong Kong banking sector and explains the motivation of this study; Section 1.3 outlines the research questions addressed in this thesis; Section 1.4 highlights the major contributions of this thesis; and, Section 1.5 shows the structure of this thesis.

### **1.2 Background and motivation**

The issue of competition in the banking sector has been extensively studied over recent years. The global financial crisis that happened in 2007-2008 once again drew the attention of policy makers to bank competition and competition policies. Increased competition in the banking sector could lower costs, improve services

quality and encourage the banks to engage more in non-traditional income activities. Furthermore, it could provide greater access to finance, promote efficiency in financial intermediation, and provide better support for the economy (Sun, 2011). However, the benefits of increasing competition are not absolute. Excessive competition may increase the risks taken by banks, thereby undermining the robustness and stability of the banking system. As Shaffer (2004a) has argued, due to the uniqueness and influence of banks, any allocative inefficiency or other market distortions in banking will have significant impacts on the whole economy.

Given the economic importance of bank competition, the present study is motivated mainly due to the uniqueness of Hong Kong. As one of the most concentrated<sup>1</sup> but competitive (concentration and competition can co-exist in a contestable market as is discussed in Chapter 5) banking industries in the world, the stature of Hong Kong as a famous financial centre is built on its free market system, low tax, well-educated labour force, a sound legal and institutional frameworks, and dense international networks (Shen, 2004a; Yeung et al. 2006). According to the Index of Economic Freedom, Hong Kong has been ranked the world's freest economy for the 20<sup>th</sup> consecutive year since the index was first published in 1995 (Government of Hong Kong, 2012). Due to the close geographical and political relationship between Hong Kong and Mainland China, Hong Kong has the irreplaceable and unique advantage to act as the bridge for linking Chinese mainland and international markets, so mainland enterprises that

---

<sup>1</sup> Reflecting this, the 3-bank concentration ratio and the 5-bank concentration ratio of Hong Kong calculated by World Bank are high at 72.15% and 81.39% respectively in 2011. According to the half-year monetary and financial stability report from HKMA 2006, the Herfindahl-Hirschman Index (HHI) of the banking sector in Hong Kong is around 0.14 in 2005. Section 2.2.3 (p.26) in Chapter 2 will discuss the degree of market concentration in Hong Kong in more detail.

seeking to engage in global operation can use Hong Kong's professional service providers to expand their global business, and the international investors might prefer to invest in Hong Kong because of its proximity to China (Ho, 2013).

Since the implement of the policy of reform and opening-up in 1978, Hong Kong has become the major fund raising centre for mainland companies. Many mainland banks and companies have been listed on the Hong Kong stock exchange after the 1997 handover (Lee and Poon, 2004). According to the statistics from the Hong Kong Stock Exchange, there were only 69 mainland companies (11.8% of the total number) were listed on the Hong Kong Stock Exchange by the end of 1996, with total market capitalization of HKD 294.8 billion (USD 38.03 billion, 8.5% of the total market capitalization). Since the return of Hong Kong to China in 1997, the economic and trade integration between Hong Kong and Mainland China enters a fast-developing period. Especially after the Asian financial crisis, the number of mainland companies listed on the Hong Kong Exchange has accelerated since 2002. As of the end of 2003, there were 249 mainland companies listed in Hong Kong. The market capitalization of these mainland companies was HKD 1,680 billion (USD 216.72 billion). But by the end of 2013, there were 1,643 listed companies on the Main Board of the Hong Kong Stock Exchange, with a total market capitalization of HKD 24,042.8 billion (USD 3,101.52 billion). Among the listed companies, 797 (49% of the total number) were Mainland companies, comprising H-share, red-chip and Mainland private enterprises with total market capitalization of HKD 13,690.57 billion (USD 1,766.08 billion). The share of mainland companies' capitalization in total market capitalization rising from 30% to 57% during 2003 to 2013. Industrial and Commercial Bank of China



(ICBC) is a significant case that Mainland banks listed in Hong Kong after handover. ICBC was simultaneously listed on both the Hong Kong Stock Exchange and Shanghai Stock Exchange on 27 October 2006. It was the world's largest initial public offering at that time valued at USD 21.9 billion. These mainland banks and companies issue bond in Hong Kong market and seek trade finance from Hong Kong's bank. Along with a rapid expansion of banking activities by these mainland banks in Hong Kong, the level of competition in Hong Kong bank market is changing. Competition from new entrants have resulted in the changing of market share. Compared with the banks owned by the other regions like Japan, US and Europe, the mainland Chinese banks now occupy the largest market share in terms of deposits and loans in 2013<sup>2</sup>. Therefore, the study of bank competition in Hong Kong especially after its handover becomes meaningful.

After Hong Kong's return to China in 1997, the general public in Hong Kong expressed strong reservations about economic integration with Mainland China<sup>3</sup> (Shen, 2008). However, the Asian Financial Crisis happened in 1997 made people understand the need for careful economic planning in order to ease the transition and promote greater economic integration (Shen, 2004b). Therefore, a large number of cooperation at government level began especially after China's entry

---

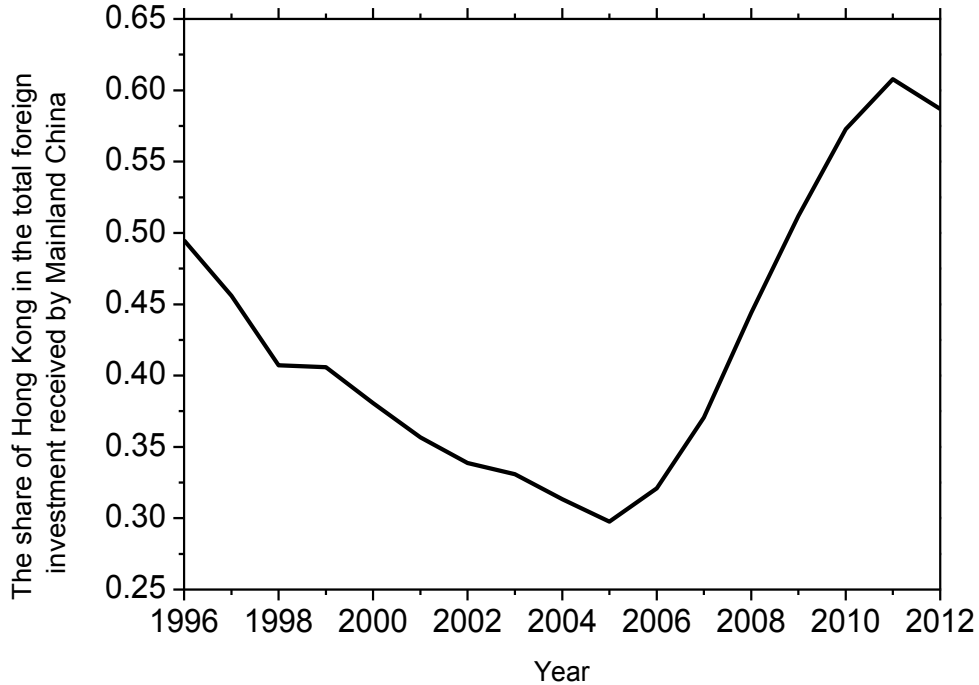
<sup>2</sup> In 2013, the deposits from customers of Mainland Chinese banks, Japanese banks, US banks and European banks in Hong Kong was HKD 2,760 billion, HKD 166 billion, HKD 440 billion, HKD 1334 billion respectively. And the loans to customers of Mainland Chinese banks, Japanese banks, US banks and European banks in Hong Kong was HKD 2,052 billion, HKD 466 billion, HKD 230 billion, HKD 983 billion respectively. (Data Source: HKMA Annual Report 2013)

<sup>3</sup> An examination of the broad money supply figures at the time of the handover in 1997 revealed the following patterns of deposit movements. Sight deposits fell by 11.45% in 1997 suggesting a withdrawal by Hong Kong residents because of the political uncertainty of the handover. However time deposits increased by 10.07 %, indicating an inflow of corporate deposits from the Mainland. Overall broad money increased by 9.95%. (Data source: Oxford Economics)

into the World Trade Organization (WTO) in 2001. Hong Kong is the largest foreign direct investment (FDI) source for Mainland China. But after the handover in 1997, the flow of FDI from Hong Kong to Mainland China declined in the period from 1996 to 2000. According to the statistics from National Bureau of Statistics of China, in 1996, Hong Kong invested USD 20.85 billion in the Mainland China.

Due to the financial crisis and people's expectation about the handover of Hong Kong, in 2000, the investment from Hong Kong declined to USD 15.50 billion. Figure 1.1 below shows the changes of share of Hong Kong in the total foreign investment received by Mainland China from 1996 to 2012. The share of Hong Kong in the total foreign investment received by Mainland China declined from 49.49% in 1996 to 29.75% in 2005. But after 2005, this ratio began to rise. The close economic integration between Hong Kong and Mainland China and the changes of public expectation make the study of bank competition in Hong Kong after handover more important.

**Figure 1.1 The share of Hong Kong in the total foreign investment received by Mainland China for the period 1996 to 2012.**



*Data Source: China Statistical Yearbook 1996 to 2012.*

In the past two decades, the operating environment in the Hong Kong banking sector has experienced great changes. The Hong Kong Monetary Authority (HKMA) has implemented a series of financial reform measures to promote the market competition and efficiency after 1997, such as deregulation of the Interest Rate Rules (IRRs) in 2001, which allowed the banks in Hong Kong to set any interest rates on the deposits and loans that they wish to offer. Prior to deregulation, the banks in Hong Kong had to comply with a uniform lending rate (prime rate) and a set of uniform deposits rates under the regulated by the IRRs issued by Hong Kong Association of Banks (HKAB). In the same year, in order to provide a level playing field for all of the banks, HKMA removed the restrictions on the number

of branches and offices for foreign banks. Furthermore, HKMA have relaxed some of the market entry criteria since 2002, including reducing the asset size criteria for overseas-incorporated bank and shortening the requisite period of locally restricted licensed banks and deposit-taking companies to upgrade to licensed bank status. In 2012, the HKMA and the Treasury Bureau revised the Banking Ordinance again to update certain market entry criteria for the banking sector in Hong Kong. These amendments make it easier for domestic and international financial institutions to operate as fully licensed banks. There have been signs of increasing competition in the Hong Kong banking sector after these measures of market liberalization were implemented. According to the statistics from the World Bank, the net interest margins (NIM) of Hong Kong banks have declined from 4.48% in 2002 to 0.93% in 2004.

Increased competition from domestic and global players, deregulation, financial innovation, and shareholder pressure to improve wealth have led to the consolidation process in Hong Kong (BIS, 2001). A number of bank mergers and acquisitions have taken place in Hong Kong during and after financial crisis 2008. For example, China Merchants Bank acquired Wing Lung Bank in 2009. After that, the Wing Lung Bank was delisted from the Hong Kong Stock Exchange. The Yuxiu Group acquired Chong Hing Bank, which was the second largest family-run bank in Hong Kong in 2013. In addition, Singapore's Oversea-Chinese Banking Corporation Limited completed its buyout of Wing Hang Bank July 2014 for HKD 38.4 billion (USD 4.95 billion)<sup>4</sup>.

---

<sup>4</sup> 1 HKD= 0.1290 USD. Data source: Bloomberg. Date: 4 June 2014. This exchange rate is used in the whole thesis.

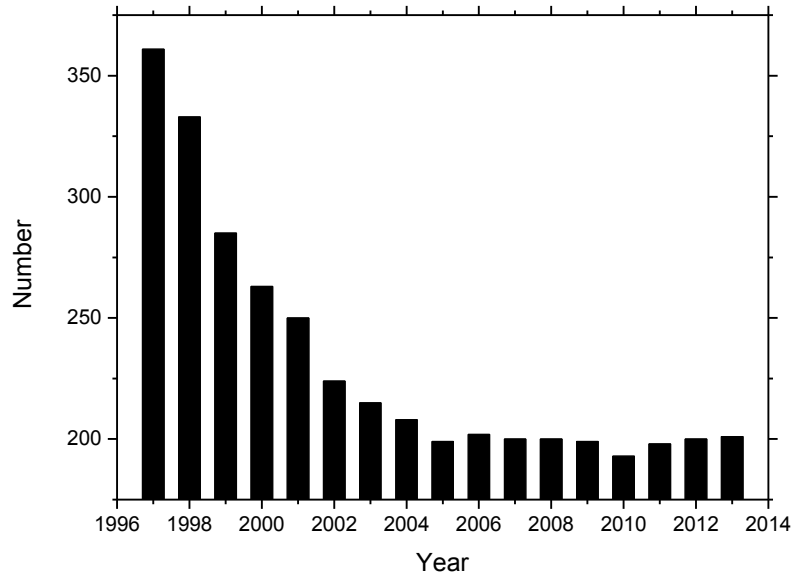
Merger and acquisition has always been a significant force in the restructuring of the banking market. The number of banks in the market is the simplest measure of market concentration. Followed by the Structure- Conduct-Performance (SCP) paradigm (Bain, 1956), a more concentrated market will stimulate collusion among the banks and so reduce the degree of competition (increase market power) in the market. According to the Statistics from HKMA, the number of all authorized institutions in Hong Kong reduced by about 44%, or from 361 in 1997 to 201 in 2013. Figure 1.2 below shows the changes in the number of all authorized institution in Hong Kong from 1997 to 2013. As can be seen from the figure, great changes have been taken place during 1997 to 2003. The decreasing number of banks in Hong Kong results in more consideration in bank collusion in Hong Kong. Some other indicators, such as the Herfindahl-Hirschman Index (HHI),<sup>5</sup> also measure market concentration. According to Figure 1.3, the HHI of 18 licensed banks in Hong Kong<sup>6</sup> indicates a relatively high degree of market concentration in Hong Kong. Although there was a sharp decrease in HHI after 2008, the value of HHI of 18 licensed banks in Hong Kong still retained a high level of around 0.19 in 2012. Oligopolistic coordination allows the colluded banks to obtain higher profits; however, it hurts the interests of customers and other competitors, and it may also reduce economic efficiency. Therefore, the issue of collusion has caught the attention of policy maker in recent years.

---

<sup>5</sup> The HHI is the sum of the squared of the market shares of the firms in the market. The number can range from zero to one. A huge number of very small firms lead to an HHI close to zero. A single monopolistic firm with 100% market share produces an HHI equal to one.

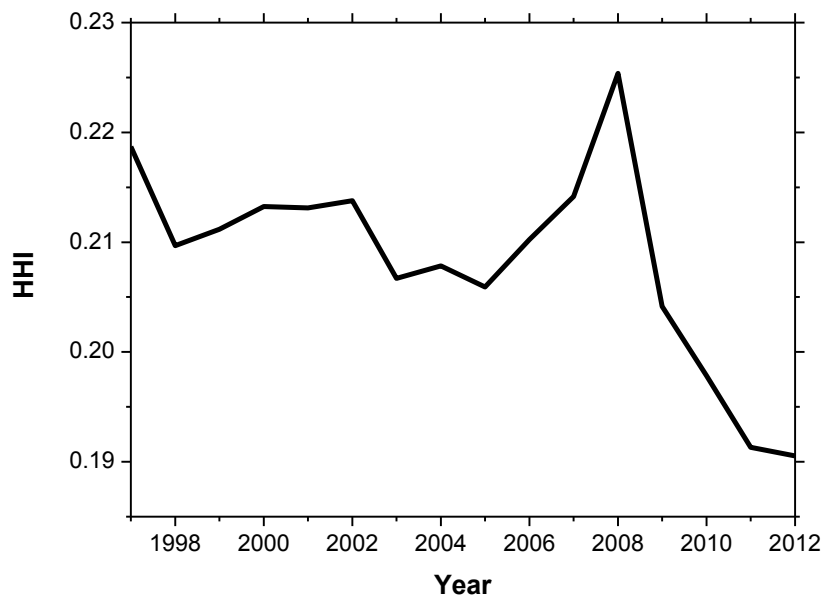
<sup>6</sup> In this thesis, I use a sample covers 18 licensed banks in Hong Kong for the period 1997 to 2012. I use the total assets of these 18 banks to calculate an HHI of my sample. This reflects the degree of market concentration in Hong Kong banking sector in some way.

**Figure 1.2 The number of all authorized institutions in Hong Kong, 1997 to 2012**



*Data Source: HKMA*

**Figure 1.3 Herfindahl-Hirschman Index of 18 licensed banks in Hong Kong, 1997 to 2012**



*Data Source: Bankscope and Annual Reports*

Switching costs, which can be described as barriers to a customer's changing of suppliers, affect market competition. These barriers include financial costs and nonfinancial costs (e.g., psychological costs). Klemperer (1995), and Farrell and Klemperer (2007) suggest a presumption that switching costs make markets less competitive. A large amount of theoretical literature has studied the impact of switching costs on price competition. In general, the existence of switching costs gives firms a degree of market power. Therefore, each firm faces a trade-off between increasing market share by charging low prices to attract new customers who will become repeat-purchasers in the future while gaining super-normal profits by charging high prices from locked-in customers (Klemperer, 1995). The extant literature has found that in infinite horizon games, prices are likely to be raised by the presence of switching costs in equilibrium (Farrell and Shapiro 1988, Beggs and Klemperer 1992, Padilla 1995, and Anderson et al. 2004). Consequently, in the long-run equilibrium, firms are found to be more likely to harvest their existing customers than invest in their market share. Due to the lack of appropriate data, the empirical literature on switching costs is sparse and more recent. Only a small number of studies have demonstrated a positive relationship between switching costs and prices in equilibrium; for example, Stango (2002) for the credit card market and Shi et al. (2006) for the wireless telecommunication industry. These empirical studies have verified the presumption that switching costs make markets less competitive. Although switching costs have become a recognized issue in the banking markets around the world, in many countries, including Hong Kong, regulators have so far given them limited attention. There is no research on switching costs of Hong Kong market, until now. The present study is motivated

by the above empirical gaps in the extant literature. It intends to explore the magnitude of switching costs in Hong Kong bank loan market.

### **1.3 Research question**

The general purpose of this thesis is to shed some light on bank competition in Hong Kong. In this thesis I estimate the significance and magnitude of switching costs, the degree of bank collusion, and the level of competition in Hong Kong banking sector. I classify the research questions into three groups, according to the three empirical chapters (Chapter 3, 4 and 5). The main questions addressed in the thesis are as follows:

1. What are the significance and magnitude of switching costs in the Hong Kong bank loan market? What are the impacts of switching costs on price? Do switching costs make markets less competitive in the sense that prices are higher with switching costs than without, as found in the theoretical literature? Are there any differences in the magnitude of switching costs during the good times and bad times?
2. Is there any evidence of collusion between banks in Hong Kong bank loan market?
3. How competitive are Hong Kong's banks? Do switching costs influence bank competition in Hong Kong? If so, what is the relationship between them?

In recent years, only a limited number of empirical studies have investigated these issues using data from Hong Kong. Some empirical studies focus on the



competitive condition of Hong Kong banking sector using the Panzar-Rosse (1987) approach, such as Jiang et al. (2004), Wong et al. (2006) and Chu et al. (2013). Other papers have attempted to infer the degree of market competition based on the conjectural variation approach, which was introduced by Iwata (1974), Bresnahan (1982) and Lau (1982); for example, Wong et al. (2007). Overall, their findings suggest that the Hong Kong banking sector remains highly competitive with no significant sign of collusion on pricing. However, no empirical studies have been carried out to estimate the significance and magnitude of switching costs.

## **1.4 Contribution of this thesis**

In order to provide answers to the aforementioned research questions, this thesis investigates a database consisting of an unbalanced panel of annual observations for the Hong Kong banking industry, spanning 16 years from 1997 to 2012. The sample covers 18 licensed banks in Hong Kong in that period. It is expected that this thesis can contribute to the extant literature in several ways.

Firstly, the main contribution of this thesis is to fill several gaps in the empirical literature. This thesis identifies the switching costs in the Hong Kong bank loan market based on a model developed by Kim et al. (2003). This model is the only structural model available for econometric estimation of the magnitude and significance of switching costs that uses an aggregated panel data that does not contain customer-specific information. Overall, the point estimates of switching costs based on the entire sample are statistically significant. The effect of the

existence of switching costs is equivalent to a rise in the price-cost margin by 52bps. In terms of size of loans, using the total loans of the whole sample in 2012 for calculation, the existence of switching costs decreases the total loans by about 26,512.52 HKD million<sup>7</sup>. The results also show that the magnitude of estimated switching costs during the bad times is slightly higher than that in good times. Chapters 4 and 5 contribute to the literature by extending the limited number of studies analysing the degree of collusion and competitive condition in the Hong Kong banking sector. This thesis also extends the sample period from 1997 to 2012, which includes the year 2008, when the global financial crisis happened. Chapter 4 measures the degree of collusion and the nature of the competitive conditions in the Hong Kong bank loan market using the conjectural variation approach. According to the results of Chapter 4, Hong Kong remains competitive even after handover, there is no significant evidence of collusion on pricing during the period 1997 to 2012. Using the Panzar-Rosse approach, the results of Chapter 5 suggest that Hong Kong bank market can be characterized as monopolistic competition and the level of competition in the loan market is higher than competition level of the bank financial services market.

Secondly, this thesis contributes to the literature by improving the empirical models and estimation approaches. In general, two innovations in this thesis are worth mentioning. The first one is the application of system estimation using both non-linear three-stage least squares (3SLS) and generalized method of moments

---

<sup>7</sup> According to the results of Chapter 4, the own price elasticity,  $\varphi_1$ , is negative and significant at -1.0778 using non-linear 3SLS approach. Therefore the changes of aggregate loans can be calculated as  $0.0052 * (-1.0778)$  which is about -0.56%. Since the total loans of the whole sample is 4,730,545 HKD million in 2012. Then, the existence of switching costs decreases the total loans by  $4,730,545 * (-0.56\%)$ , which is about 26,512.62 HKD million.

(GMM) approaches for estimating the conjectural variation parameter, as shown in Chapter 4. This system contains a log demand function, a trans-log cost system including share equations, and a pricing equation. Most previous studies based on the conjectural variation approach do not employ the share equations in the system. Furthermore, Chapter 4 follows a non-linear 3SLS and GMM system estimation instead of applying the single-equation methods. The 3SLS estimator combines two stage least squared (2SLS) with seemingly unrelated regressions (SUR) by taking account of the residual correlations between equations. Therefore, the estimator is asymptotically more efficient than other single equation estimators. The system GMM estimator is used as a robustness test.

The second methodological innovation is related to the Panzar-Rosse (P-R) approach, which has been applied to estimate the competitive condition in Hong Kong banking sector in Chapter 5. Due to the residuals correlation between revenue equation and equilibrium condition equation, I estimate the P-R model as a system using the SUR approach. Previous studies that were based on a single-equation estimation did not take account of the residual correlations between equations.

Thirdly, from the policy aspect, this thesis studies switching costs and competitive conditions in the banking sector in Hong Kong, providing insight into the current operating environment and overall effects of financial reform measures in Hong Kong. The empirical results may help policymakers to understand the evolution of the competitive condition, including the financial crisis period, in the banking sector in Hong Kong.

## 1.5 Outline of this thesis

This thesis is structured into six chapters, which consists of an overview of Hong Kong banking industry in Chapter 2, and three separate empirical chapters related to the three different topics: switching costs, collusion, and competition, in Chapters 3, 4, and 5, respectively. All of the empirical chapters are self-contained. Each empirical chapter contains its own literature view. Below, I discuss the structure of my thesis in more detail.

*Chapter 2* gives a very brief overview to the Hong Kong banking industry, especially after 1997. Although Hong Kong's economy and banking system have remained in good health, they have not been totally immune to the Asian financial crisis and the global financial crisis. This chapter introduces the current state of Hong Kong banking industry in terms of the main regulatory and advisory bodies, the current structure of banking system, the market concentration, and the linked exchange rate system in Hong Kong. It also discusses how the banking system has development after the Asian and global financial crisis, and the policy responses that followed it. In addition, it presents the macroeconomic environment in Hong Kong after 1997.

*Chapter 3* estimates the significance and the magnitude of switching costs in Hong Kong's bank loan market. It uses the model presented by Kim et al. (2003), which is a structural model, including: a first order condition for maximization banks' present value, a market share equation, and a trans-log cost system. Both non-linear 3SLS and GMM approaches are applied to estimate the model. My findings suggest that switching costs are significant in the Hong Kong bank loans

market. The average point estimate of switching costs based on an entire sample is 0.1947. The existence of switching costs increases the price-cost margin by 0.52% (52bps), which is approximately 8.26%<sup>8</sup> of the average interest rate on the loans' value. This provides empirical evidence that switching costs make the market less competitive in the sense that the prices are higher with switching costs than without. I also compare the magnitude of switching costs during good times and bad times, and find that the estimated switching costs are higher during the bad times due to the "Lemons Problem". Furthermore, the GMM approach is applied to test the robustness of major findings.

*Chapter 4* examines the degree of collusion and competition in the Hong Kong banking sector based on the conjectural variation approach, which was established on the belief that rival banks may react if a bank varies its own output or price, this approach was introduced by Iwata (1974), Bresnhan (1982) and Lau (1982). The empirical model contains a log demand function, a trans-log cost system, and pricing equations follows Coccoresse (2005). The system is jointly estimated using non-linear 3SLS and GMM approaches. The empirical results suggest that banks in Hong Kong operated in a competitive fashion in the loan market and this behaviour is coherent with a Nash- Bertrand equilibrium in prices, which is consistent with the previous literature, and there is no significant evidence of collusion on pricing.

---

<sup>8</sup> The average interest rate on loans of my sample is equal to 6.30%, the details of how to calculate interest rate on loans are discussed in section 3.3.4.1 of Chapter 3. The number 8.26% is obtained by using 0.52% divided by 6.30%.

*Chapter 5* investigates competition in Hong Kong banking market using P-R approach. The revenue equation and equilibrium condition equation are jointly estimated using a SUR approach. My findings suggest that the Hong Kong bank market can be considered as monopolistic competition. These results are consistent with those of the previous studies. Furthermore, the competitive condition of interest and non-interest market is estimated. By estimating the model for a six years rolling sample, the time evolution of competition for interest and non-interest market is presented. In addition, the relationship between switching costs and competition is discussed in this chapter.

*Chapter 6* summarizes the major findings of this thesis and discusses its policy implications. It also identifies some limitations of this study and makes suggestions for future research.

# Chapter 2

## Crisis and Responses: The Story of Hong Kong Banking Industry after 1997

### 2.1 Introduction

Hong Kong, officially known as the Hong Kong Special Administrative Region of the People's Republic of China, is located in the extreme southeast of China and is surrounded by the Pearl River Delta and South China Sea (Census and Statistics Department, 2007). After the First Opium War (1839-42), Hong Kong became a colony of the British Empire for nearly 155 years - it reverted to Chinese sovereignty on 1 July 1997. Under the principle of 'one country, two systems',<sup>9</sup> the city retains its own capitalist economic and political systems and enjoys a "high degree of autonomy" in all areas, except defence and foreign affairs (Basic Law: Chapter II, 1997). Since 1997, China has become Hong Kong's largest trading

---

<sup>9</sup> 'One country, two systems' is a policy originally proposed by Deng Xiaoping, the Paramount Leader of the People's Republic of China, for the reunification of China during the early 1980s. He suggested that where would be only one China, but areas such as Hong Kong, Macau and Taiwan could have their own capitalist economic and political systems, while the rest of China uses the socialist system.

partner. Its share of Hong Kong's global trade has increased significantly from 9.3% in 1978 to 51.1% (HKD 3,891.4 billion or USD 501.7 billion) in 2013.<sup>10</sup>

Hong Kong is one of the most densely populated areas in the world. At mid-2012, the population of Hong Kong was 7.15 million<sup>11</sup> (Census and Statistics Department, 2013) but the land area is only 1104 square kilometres (Census and Statistics Department, 2007). As a result, crowded Hong Kong has extremely high house prices. A large number of foreigners also live in Hong Kong, including Indonesians, Filipinos, and Americans.<sup>12</sup>

In order to set the stage for the later empirical research, this chapter gives a brief introduction to the Hong Kong banking industry. Section 2.2 describes the current state of Hong Kong banking industry. Section 2.3 shows how the banking system has development after the Asia financial crisis and the policy responses that followed it. Section 2.4 gives an overview of macroeconomic environment in Hong Kong. Section 2.5 concludes the chapter.

## **2.2 The current state of the Hong Kong banking industry**

Hong Kong is one of the most important international financial centres in the world.

The banking industry is an essential ingredient of the financial system of Hong

---

<sup>10</sup> Data source: The Census and Statistics Department of Hong Kong.

<sup>11</sup> This number is including 6.94 million Usual Residents and 0.22 million Mobile Residents.

<sup>12</sup> These are the three largest foreign groups in Hong Kong. In mid-2012, the population number of these three groups was 164,850, 160,850 and 28,290, respectively (Census and Statistics Department, 2013).



Kong. This section introduces the main regulatory and advisory bodies in the Hong Kong banking industry, the current structure of the Hong Kong banking system, the bank consolidation in Hong Kong, the degree of market concentration in Hong Kong banking sector, and the linked exchange rate system.

## **2.2.1 The main regulatory and advisory bodies in Hong Kong**

### **2.2.1.1 Hong Kong Monetary Authority (HKMA)**

The Hong Kong Monetary Authority (HKMA) was established on 1 April 1993 by merging the offices of the Commissioner of Banking and the Exchange Fund. Although there is no central bank in Hong Kong, the HKMA is almost regarded as the central bank in Hong Kong and it reports directly to the Financial Secretary. The main responsibility of the HKMA is to maintain the stability of both the Hong Kong dollar (HKD) and the banking system. Its major functions can be divided into several aspects. Firstly, maintaining the stability of HKD under the Linked-Exchange Rate system, which will be elaborated later. Secondly, directly supervising the three-tier financial system and also monitoring the operations of the banking industry. Banking licences are granted by the HKMA and authorized banks are required to submit monthly statements showing assets and liabilities to the HKMA. Thirdly, helping to maintain the status of Hong Kong as an international financial centre by the maintenance and development of the financial infrastructure. Lastly, managing the Exchange Fund.

### **2.2.1.2 Hong Kong Association of Banks (HKAB)**

According to The Hong Kong Association of Banks Ordinance in 1981, the Hong Kong Association of Banks (HKAB) was established to replace the Exchange Banks's Association. In contrast to the bank associations in many countries, all of the licensed banks in Hong Kong are required to join as part of the conditions for granting a bank license. The major roles of the HKAB can be described as follows. First, HKAB stands for the interests of fully licensed banks in Hong Kong and it makes rules for the conduct of banking business after consulting with the government. Second, HKAB acts as an advisory body to its members in matters concerning the business of banking. Thirdly, HKAB provides a sounding-board for the government and other relevant bodies on banking issues. Fourthly, HKAB binds on all member banks by offering a channel of communication. Fifthly, HKAB provides information services, such as issuing circulars. Lastly, HKAB also organises conferences on topical issues in banking.

### **2.2.1.3 Financial Services and the Treasury Bureau (FSTB)**

The Financial Services and the Treasury Bureau (FSTB) is a part of the Hong Kong Special Administrative Region government. It was created on 1 July 2002 by merging the Financial Services Bureau and Finance Bureau. The major responsibilities of the FSTB are to develop and execute government policy on finance and treasury to maintain an appropriate economic and legal environment for Hong Kong. It also provides a full range of advisory and administrative support to the government in relation to financial markets.

In addition to these three major bodies, there are also some other regulatory and advisory bodies in Hong Kong. For example, The DTC Association<sup>13</sup>, which was established in 1981 under the Companies Ordinance, has the objective of promoting the general interests of restricted licence banks and deposit-taking companies.

### **2.2.2 The current structure of banking system and bank consolidations**

The banking system in Hong Kong is characterized by its 3-tier system of deposit-taking institutions made up of licensed banks, restricted licensed banks, and deposit-taking companies. Table 2.1 shows the difference between these three authorised institutions. As of February 2014, there are 157 licensed banks, 21 restricted licence banks, 23 deposit-taking companies, and 62 local representative offices of overseas banks in Hong Kong. A wide range of wholesale and retail banking services are provided by these authorised institutions under the control of the HKMA.

---

<sup>13</sup> The Hong Kong Association of Restricted Licence Banks and Deposit-taking Companies.

**Table 2.1 Business scope of authorized institutions in Hong Kong**

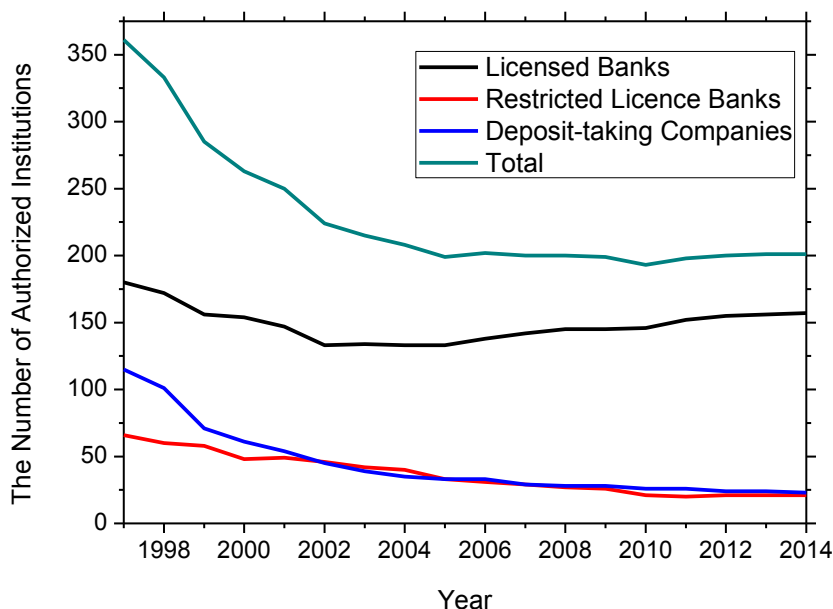
<b>Authorized Institution</b>	<b>Business Scope</b>
Licensed Banks	Operate current and savings accounts
	Accept any size and maturity deposits from public
	Pay or collect cheques
Restricted Licence Banks	Take deposits of any maturity of HKD 500,000 and above
Deposit-taking Companies	Consumer finance
	Securities business
	Take deposits of HKD 100,000 or above with an original term of maturity of at least three months

*Information source: HKMA*

The number of banks in the market is the simplest measure of market concentration. As can be seen from Figure 2.1, the numbers of these three authorized institutions have declined in the past few years. In 1997, there were 180 licensed banks, 66 restricted licence banks, and 115 deposit-taking companies in Hong Kong. But in 2014, the numbers of licensed banks, restricted licence banks, and deposits-taking companies decreased to 157, 21 and 23, respectively. The decline in the number of authorized institutions is mainly due to bank consolidations in Hong Kong. Table 2.2 summarises the major mergers and acquisitions activities taken place in Hong Kong after 1997. It can be seen from the table that the Hong Kong banking sector has experienced a high level of merger and acquisition activities after 2000. Some representative deals include the consolidation of the ten banks in Hong Kong that originally belonged to the Bank of China Group into the Bank of China (Hong Kong) in 2001 while the China Merchants Bank became the largest shareholder of Wing Lung Bank in 2008, and then acquired the remaining shares in 2009. It is generally believed that cost savings and revenue enhancement are significant

reasons for mergers and acquisitions (Fröhlich and Kavan 2000). Bank consolidations can lead to cost reductions for the reasons of economies of scale, economies of scope, improving efficient resources allocation, tax reduction. It can also increase revenues through increasing size and increasing product diversification (Bank of International Settlements, 2010). It would seem that the 3-tier banking system resulted in the survival of the fittest in the banking industry. Although the large deposit-taking companies upgraded to restricted licence banks, the small companies that had a low anti-risk capacity were eliminated. Thus, the benefits of depositors can be protected. The 3-tier banking system plays an active role in developing the banking industry and it helps Hong Kong to maintain its status as an international financial centre.

**Figure 2.1 The changes in the number of authorized institutions in Hong Kong from 1997-2014**



*Data source: HKMA Annual Reports*

**Table 2.2 Major consolidations in Hong Kong banking industry  
after 1997**

<b>Year</b>	<b>Bank Consolidation</b>
<b>2000</b>	The Bank of East Asia acquired the First Pacific Bank. The Industrial and Commercial Bank of China (Asia) acquired Union Bank of Hong Kong. Standard Chartered Bank acquired Chase Manhattan's retail banking and credit card business
<b>2001</b>	The Bank of East Asia merged with United Chinese Bank. The Development Bank of Singapore (DBS) acquired Dao Heng Bank and its subsidiary Overseas Trust Bank. The merger of ten member banks of Bank of China (BOC) Group <sup>14</sup> .
<b>2002</b>	CITIC Ka Wah Bank acquired Hong Kong Chinese Bank and became a whole-owned subsidiary of CITIC International Financial Holdings.
<b>2003</b>	DBS Bank merged Dao Heng Bank, DBS Kwong On Bank and Overseas Trust Bank to form DBS Bank (Hong Kong) Limited.
<b>2004</b>	Wing Hang Bank merged with Chekiang First Bank. The Industrial and Commercial Bank of China (Asia) acquired the retail banking business of Fortis Bank Asia (Hong Kong). Hang Seng Bank acquired Industrial Bank.
<b>2006</b>	China Construction Bank (Asia) acquired Bank of America. Public Financial Holdings Limited acquired Public Bank (Hong Kong) Limited.
<b>2007</b>	Wing Hang Bank acquired Inchroy Credit Corporation, a financial institution engaged in the hire purchase and the lease financing business. Dah Sing Bank acquired Chongqing Commercial Bank.
<b>2009</b>	China Merchants Bank acquired Wing Lung Bank. Fubon Bank acquired Xiamen City Commercial Bank.
<b>2013</b>	Yuxiu Group acquired Chong Hing Bank.
<b>2014</b>	Singapore's Oversea-Chinese Banking Corporation acquired Wing Hang Bank.

*Information Source: HKMA*

<sup>14</sup> Bank of China (Hong Kong) combined the businesses of ten of the twelve banks in Hong Kong originally under the Bank of China (BOC) Group including Bank of China (Hong Kong), Kwangtung Provincial Bank, Sin Hua Bank Limited, China & South Sea Bank Limited, Kincheng Banking Corporation, Chia State Bank Limited, National Commercial Bank Limited, Yien Yieh Commercial Bank Limited, Hua Chiao Commercial Bank Limited and Po Sang Bank Limited.

### **2.2.3 Market concentration in Hong Kong**

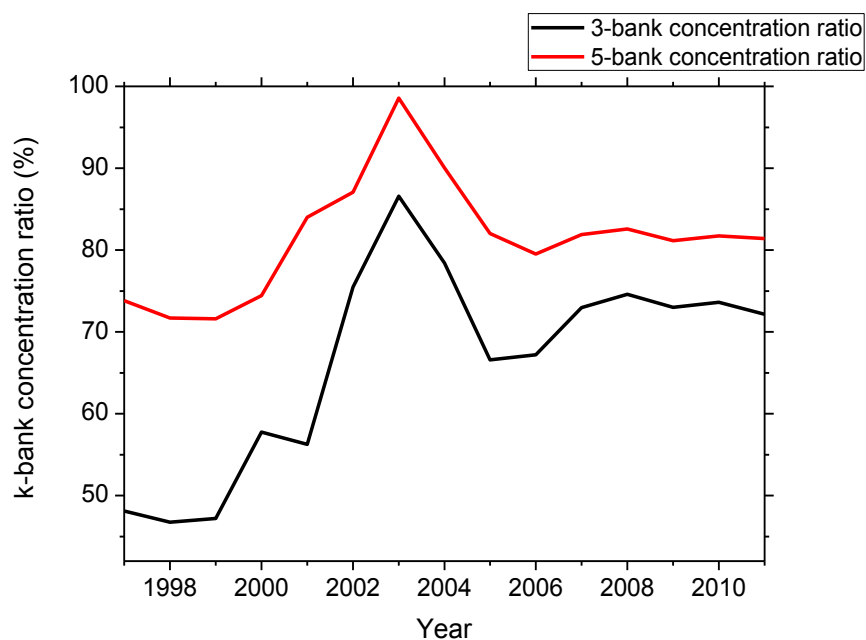
Hong Kong has one of the highest concentrations of banking institutions in the world. Reflecting this, Figure 2.2 describes the trend of 3-bank concentration ratio<sup>15</sup> and 5-bank concentration ratio of Hong Kong, as calculated by the World Bank, over the period from 1997 to 2011. The five largest banks in Hong Kong measured by total assets in 2011 are Hong Kong and Shanghai Banking Corporation Limited (HSBC), Bank of China (Hong Kong), Hang Seng Bank, Standard Chartered Bank (Hong Kong) and the Bank of East Asia.<sup>16</sup> The 3-bank concentration ratio of Hong Kong was at 72.15% in 2011 and the 5-bank concentration is also high at 81.39% in 2011. Furthermore, according to the half-yearly monetary and financial stability report of HKMA in 2006, the Herfindahl-Hirschman Index (HHI) of Hong Kong banking sector is around 0.14 in 2005. The HHI of 18 licenced banks in Hong Kong calculated in Chapter 1 (p.9) also shows evidence of a relatively high degree of market concentration in Hong Kong.

---

<sup>15</sup> The k-bank concentration ratio is defined as the sum of the market shares measured by total assets of the k largest banks in the market.

<sup>16</sup> Data source: Bankscope.

**Figure 2.2 K-bank concentration ratios from 1997 to 2011**



*Data Source: World Bank*

### **2.2.4 Linked exchange rate system**

Hong Kong is one of the few places in the world implementing a linked exchange rate system. This type of exchange rate regime, which is in essence a Currency Board system, links the exchange rate of a currency to another. In contrast to a fixed exchange rate system that simply fixes a currency's value against another, the government or central bank does not interfere in the foreign exchange market through monetary policies in order to affect the exchange rate. If the exchange rate begins to shift from the fixed ratio, then banknotes will be issued or taken out of circulation to bring the ratio back. However, new banknotes can only be issued when an equivalent value reserve in the linked currency are deposited into the



central bank. The Hong Kong dollar is pegged to the US dollar at an internal fixed rate of HKD 7.8 = USD 1.

Several different types of exchange rates systems have been implemented in Hong Kong from 1863 until the present day. Table 2.3 summaries the history regarding Hong Kong's exchange rate systems. The floating exchange rate regime raises investor's risks and costs, which does not suit Hong Kong's economy.

**Table 2.3 The history of exchange rate systems for the HKD**

<b>Date</b>	<b>Exchange rate regime</b>	<b>Reference rate</b>
1863- 4 November 1935	Silver Standard	Silver dollars as legal tender
December, 1935-November 1967	Link to Sterling	HKD16=GBP1
November 1967-June 1972	Link to Sterling	HKD14.55=GBP1
6 July 1972-13 February 1973	Link to the US dollar with plus or minus 2.25% intervention bands around a central rate	HKD5.65=USD1
14 February 1973-24 November 1974	Link to US dollar	HKD5.085=USD1
25 November 1974-16 October 1983	Free Float	Exchange rates on selected dates HKD4.965=USD1 (25 November 1974) HKD9.600=USD1 (24 September 1983)
17 October 1983-Now	Link to the US dollar	HKD7.80=USD1

Since the linked exchange rate system was implemented in 1983, Hong Kong's markets have fluctuated many times, such as during the Asian financial crisis of 1997 and the US subprime crisis of 2008. However, this exchange rate system has constantly operated smoothly, mainly because of the highly standard of market transparency and the public confidence that has persuaded the Hong Kong government to insist on this system. Hong Kong's economy is highly externally oriented and prudent fiscal policies are applied by the Hong Kong government. The linked exchange rate system suits Hong Kong's economic conditions. The banking system is strong and solvent, and it has the ability to deal with fluctuations in interest rates. In addition, Hong Kong has large foreign currency reserves. According to the statistics from HKMA, as of September 2013, Hong Kong's foreign currency reserves (in convertible foreign currencies) had reached US\$293,134 million. These large reserves were used to support the peg to the USD.

## **2.3 The development of Hong Kong's banking**

### **System after 1997**

Hong Kong's banking industry can trace its history back to 1845. The Oriental Bank Corporation, which had its headquarters in London, became Hong Kong's first bank and it was the first bank to issue banknotes in Hong Kong. In 1865, The HSBC was established in Hong Kong to finance the growing trade between Europe, India, and China. It became the first registered bank that was incorporated locally in Hong Kong and it was authorised to issue banknotes for Hong Kong in 1866.

HSBC is still one of the three commercial banks that are authorised to issue currency notes in Hong Kong. The other two are the Bank of China (Hong Kong) and the Standard Chartered Bank (Hong Kong). After over 100 years of development, Hong Kong has now become one of the most important international financial centres in the world. This section provides a brief account of the development of the Hong Kong banking sector following the Asian financial crisis of 1997 to 1998. It also discusses the policy responses to the crisis.

### **2.3.1 Hong Kong's banking industry after 1997**

In July 1997, the Asian financial crisis erupted in Thailand. This financial storm quickly swept through many Asian countries, including Malaysia, Singapore, Japan and South Korea. The Asian financial crisis almost paralyzed Asian economy and the banking systems in many Asian countries suffered catastrophic failure mainly because of the lack of supervision and regulation. The banks in these countries had granted excessive loans to risky projects, such as real estate lending that had poorly supervised the background of the borrowers. Therefore, the big drop of prices of property and stocks due to the Asian financial crisis led to the insolvency of many borrowers and the banks in turn faced a liquidity crisis.

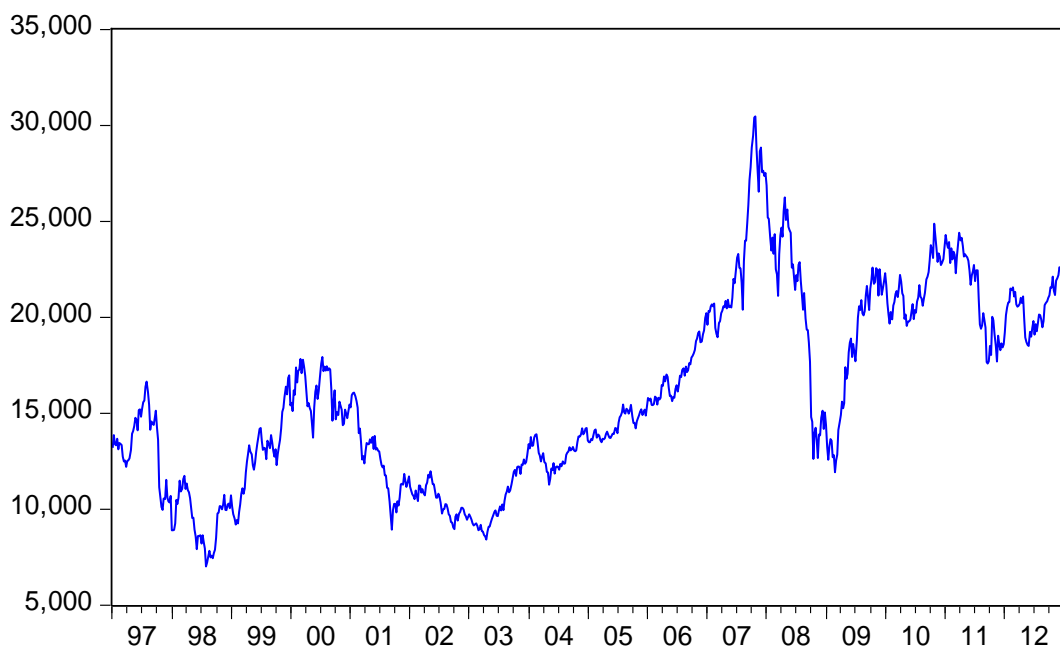
Hong Kong was less affected during the crisis, mainly because the Hong Kong banking industry has a sound risk control and legal system. Hong Kong's banks are well regulated; for example, the amount of assets in property should be less than 40% of total assets. Furthermore, the capital adequacy ratio of banks in Hong Kong is around 18%, which is much higher than the international requirement.

Although Hong Kong's banking industry escaped disaster, they still had a difficult time during and after the Asian financial crisis. The economic imbalance problem was revealed during the crisis, especially in 1997. The property market expanded rapidly because of the growing public confidence in Hong Kong following the handover of sovereignty. In 1997, the average growth rate of property prices in Hong Kong reached to 48%. The main reason of asset price inflation was the increasing level of bank loans. In addition, the stock market became increasingly volatile. Figure 2.3 shows the Hang Seng Index in the Hong Kong stock market for the period 1997 to 2012. On 7 August 1997, the Hang Seng Stock Market Index reached a high of 16,820 points. Obviously, the soaring asset price and the explosion of bank loans could not be sustained. In late October 1997, Hong Kong's stock market crashed, mainly due to high selling pressure from foreign funds and high interest rates. Between 20 and 23 October 1997, the Hang Seng Index dropped by 23%. The HKMA had to intervene in the market to protect the currency. In late January 1998, affected by a sharp depreciation of the Indonesian rupiah, the Hang Seng Index fell to a further low of 7,904 points. It then dropped again to 6,600 points on 13 August 1998. The stock market crash became an enormous drag on the property market. In May 1998 house prices in Hong Kong had decreased by 35% compared with the market high in 1997. Bank profits then declined significantly because of the drastic fall in the demand for loans. Therefore, the banks needed to cut their expenses and they tried to find new sources of income other than lending. Consequently, many banks expanded their services into insurance, financial products, etc. After the Asian financial crisis, the Hong Kong stock market also faced some other challenges, including the bursting

of the dot.com bubble in 2000, SARS in 2003 and, more recently, the global financial crisis that happened during 2007 to 2008. It can be seen from the Figure 2.3 that in 2007 the Hang Seng index closed the year at 27,519 points but in November 2008 the index decreased by about 54% to 12,659 points.

**Figure 2.3 Hang Seng Index (Weekly, Close price), 1997 to 2012**

Hang Seng Index (Weekly, Close price)



*Data Source: Bloomberg*

### **2.3.1.1 Major indicators of the balance sheet**

Figures 2.4, 2.5 and 2.6 provide some balance sheet details regarding retail banks in Hong Kong from 1997 to 2012. It can be seen from the figures, the Asian financial crisis and the global financial crisis has a certain impacts on the retail banks in Hong Kong. According to Figure 2.5, following the Asian financial crisis, the total loans to customers in the retail market declined slightly after 1997,

reaching a figure of HKD 1,369 billion<sup>17</sup> (USD 177 billion) in 2003. However, the total assets and the total deposits from customers increased steadily during 1997 to 2003. This was mainly due to the attraction from high domestic interbank and deposit rates. This led to an increase of funding costs and a decrease of interest margins. After 2003, all of the indicators revealed a trend of fast increase. In 2012, the total assets of retail banks in the Hong Kong banking industry amounted to HKD 8,774 billion<sup>18</sup> (USD 1132 billion), the total deposits of retail banks in Hong Kong banking industry peaked at HKD 6623 billion (USD 854 billion), and the total loans of retail banks reached to HKD 3,632 billion (USD 469 billion). The rise in these numbers show that in recent years the Hong Kong banking industry has grown steadily under the 3-tier banking system. It also seems that the global financial crisis of 2007 to 2008 has had a limited impact on Hong Kong's retail banks market.

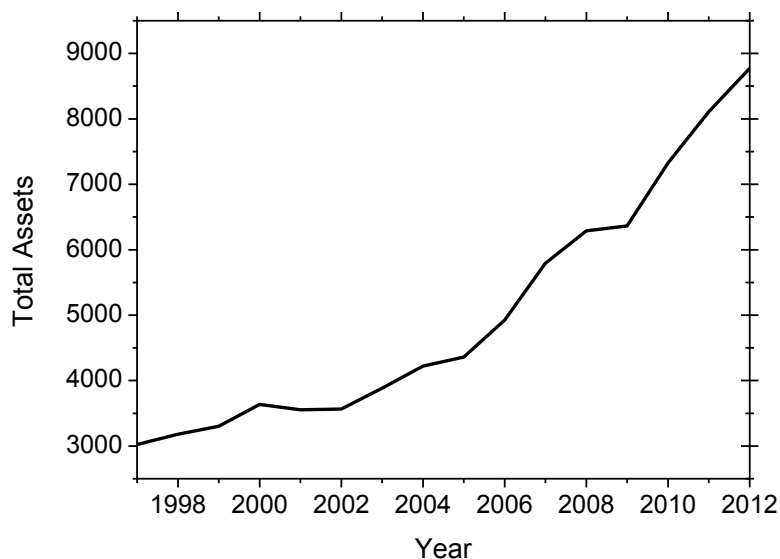
Interest-generating activities have been traditional in Hong Kong's commercial banking sector for many years. Not surprisingly, most banks still rely mainly on income from traditional banking. Hong Kong banks invest relatively more in loans and less in securities. Take HSBC as an example, the ratio of net loans to total earning assets was 60.29% in 1997. Although this ratio decreased to 46.47% in 2012, compare with the ratio of net fees and commission to total earning assets which was 0.89%, this ratio is much higher. In addition, except HSBC, Standard

---

<sup>17</sup> 1 HKD= 0.1290 USD. Data source: Bloomberg. Date: 4 June 2014. This exchange rate is used in the whole thesis.

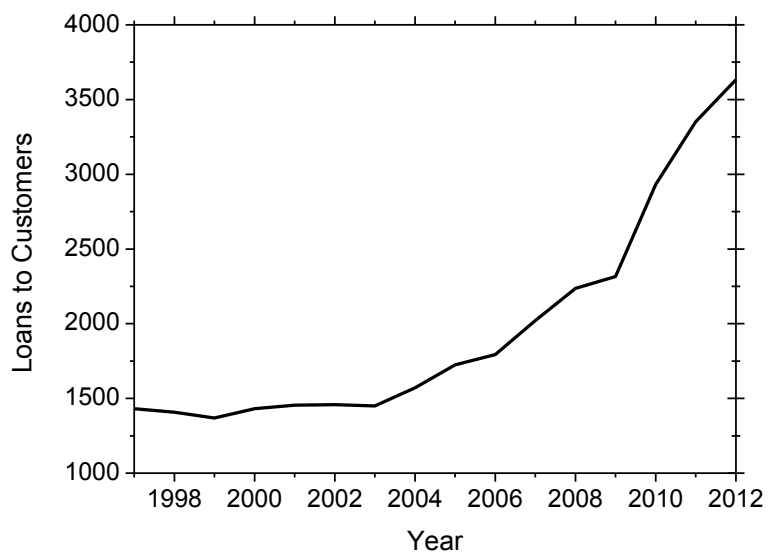
Chartered, Shanghai Commercial and Fubon, the ratios of net loans to total earning assets of the other banks in the sample were higher than 50% in 2012.

**Figure 2.4 Total assets of retail banks, 1997 to 2012 (HKD billion)**



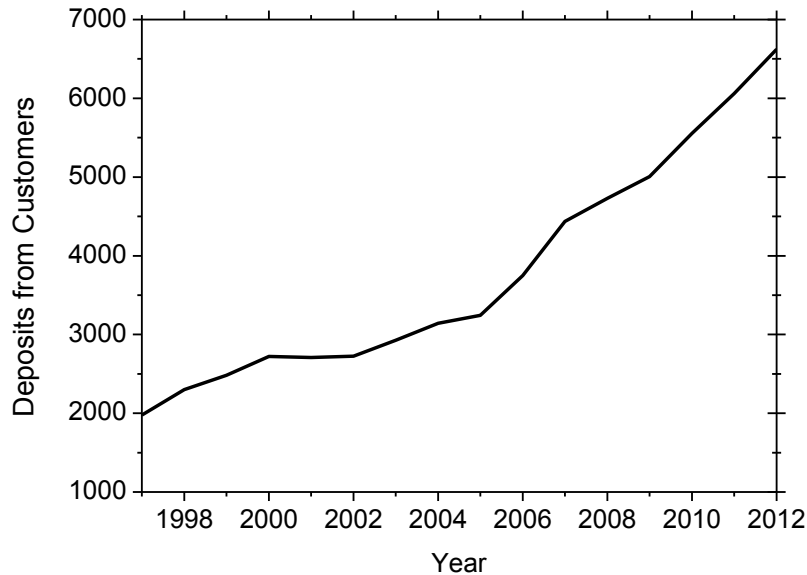
*Data Source: HKMA Annual Reports*

**Figure 2.5 Loans to customers of retail banks, 1997 to 2012 (HKD billion)**



*Data Source: HKMA Annual Reports*

**Figure 2.6 Deposits from customers of retail banks,  
1997 to 2012 (HKD billion)**



*Data Source: HKMA Annual Reports*

### **2.3.2 Policy responses after the Asian financial crisis**

Hong Kong's banking system has been undergoing major reforms following the Asian financial crisis, with the aim of increasing banking sector competition and improving safety and soundness of the banking system. In the light of the 1998 Banking Sector Consultancy Study undertaken by KPMG and Barents, a Bank Sector Reform Programme has been undertaken by the HKMA since 1999. In particular, a package of policies were implemented in Hong Kong. In order to encourage market liberalisation and enhance market competition in Hong Kong's banking sector, a two-phase plan to deregulate the Interest Rate Rules (IRRs) was announced by HKMA in 1999. The IRRs was established by Hong Kong Exchange



Banks Association<sup>19</sup> in July 1964. This is a cartel type agreement between the banks, which prescribes the maximum rate of interests offered on certain Hong Kong dollar deposits. The IRRs are only applied to licensed banks in Hong Kong. Deposit-taking companies and restricted banks are subject to stricter rules on receiving deposits from the public. After the IRRs were abolished in 2001, banks in Hong Kong are allowed to set any interest rates on deposits so that they can compete and the interest rates on deposits are determined by competitive market forces.

In order to provide a level playing field for all banks, the HKMA removed the restrictions on the numbers of branches and offices for foreign banks in 2001. In 1999, this policy was partially relaxed by allowing foreign banks to open up to three branches instead of one. From 2001, there have been no restrictions on the number of branches and offices for foreign banks.

For the purpose of settling Clearing House Automated Transfer System (CHATS) payments, restricted licence banks have been allowed to access the Real Time Gross Settlement (RTGS) system since 1999. The RTGS system was introduced in 1996, and it ensures the safe and efficient settlement of interbank payments in the Hong Kong dollar. It also conducts payments arising from the HKMA's monetary operations.

Since 2002, HKMA has also relaxed some of the market entry criteria, including reducing the asset size criteria for overseas-incorporated banks, and shortening the requisite period of locally restricted licensed banks and deposit-taking companies

---

<sup>19</sup> Currently known as the Hong Kong Association of Banks.

to upgrade to licensed bank status. In 2012, the HKMA and the Treasury Bureau revised the Banking Ordinance again to update certain market entry criteria for Hong Kong's banking sector. The amendments removed the restrictions on applying for a bank license which stated that a bank licence must have total customer deposits of not less than HKD 3 billion and total assets of not less than HKD 4 billion. They also removed the restrictions on foreign banks who entered the market through establishing a locally incorporated subsidiary.

## **2.4 Hong Kong's Economy**

Hong Kong has the most competitive economy in Asia. It is a free market economy that is highly dependent on international trade and service sector. The traditional four key industries in Hong Kong are financial services, trading and logistics, tourism, and professional and producer services. These four industries drive the development of other industries, creating job opportunities in Hong Kong. According to the data from Census and Statistics Department (C&SD), in 2012 the value of Hong Kong's total merchandise trade was HKD 7,346.5 billion (USD 947.7 billion), which was more than three times the GDP in that year. The value of imports and exports has reached HKD 3,912.2 billion (USD 504.7 billion) and HKD 3,434.3 billion (USD 443 billion), respectively. It is worth mentioning that Hong Kong ranked in the ninth place in the global trading economy in 2012.<sup>20</sup> Apart from trading, the services sector also plays an important role in the Hong

---

<sup>20</sup> This ranking is worked out based on trade values.

Kong economy. It contributed to 93% of the GDP and 88% of total employment in 2012.<sup>21</sup> In order to meet the challenges posed by the rapid development of science and technology, as well as the fierce competition among countries because of globalization, Hong Kong's economy has shifted toward to high value-added economic activities that are focused on providing high value-added services and knowledge-based activities. At the same time, the increasing economic integration between Hong Kong and mainland China results in boundless business opportunities for Hong Kong's service industry. These developments have led to the sustained and rapid growth of the services industry in Hong Kong over the years.

Over the past two decades, the economy of Hong Kong has developed rapidly. The average annual GDP growth rate reached to 4.5% in real terms (Hong Kong Economic Analysis Division, 2014), which is better than most economies in the world. The Hong Kong dollar is the eighth most traded currency in the world (Bank of International Settlements, 2010). Furthermore, Hong Kong has the sixth largest foreign exchange market, the seventh largest banking centre in the world and also has the second largest stock exchange in Asia<sup>22</sup>. All of the above achievements are creditable to the “appropriately proactive” governance. Hong Kong's government adopts “appropriately proactive”<sup>23</sup> economic policies to create a level playing field.

---

<sup>21</sup> Data source: C&SD, Hong Kong government.

<sup>22</sup> Until 28 February 2014, there were 1,660 listed companies in the Hong Kong Stock Exchange, 744 of which are from Hong Kong, 812 from mainland China and 104 from other countries (HKEx, 2014).

<sup>23</sup> In his 2013 policy address Hong Kong's Chief Executive, Chunying Leung, indicated that in order to promote economic development, the Hong Kong government must be “appropriately proactive”. He believed when the market is functioning efficiently, the government could limit intervention, and would only take action to ensure a level playing field. But when the market fails, the government should make a difference to solve the problems.

These policies aim to strengthen the international standing and influence of Hong Kong as a regional headquarters and logistics, shipping, aviation and tourism hub. The government will also reinforce cooperation with other countries, invest in infrastructure, enhance human resource and improve people's living standards.

## **2.4.1 The Economic success of Hong Kong**

The stature of Hong Kong as a famous financial centre is built on its economic freedom, low taxation and strong legal and institutional frameworks to supervise financial institutions prudently.

### **2.4.1.1 Economic freedom**

According to the Index of Economic Freedom, Hong Kong has been ranked the world's freest economy for the 20<sup>th</sup> consecutive year since the index was first published in 1995 (Government of Hong Kong, 2012). Milton Friedman (1990) also described Hong Kong's economy as 'the best example of a free market economy' in his book "Free to Choose: A Personal Statement". An extremely important manifestation of this free enterprise system is the freedom of contract and the private ownership of property.

Hong Kong's government does not differentiate between local and foreign companies and welcomes both to invest in Hong Kong. Although the policy of

“positive non-interventionism”<sup>24</sup> has not been applied since 2006, the Hong Kong government still allows market forces to determine economic development, only with prudential supervision. Furthermore, Hong Kong has been a free port since 1841, which does not levy a customs tariff and has limited excise duties. This has allowed Hong Kong to become an ideal platform for doing business in Asia, especially for small-and medium-sized firms.

#### **2.4.1.2 Low taxation**

Due to the simple and low tax system in Hong Kong, a large number of investors are attracted to register companies in Hong Kong. The profits tax is around 16.5%, the salaries tax is set to a maximum of 15%, and the property tax is 15%.<sup>25</sup> These are the only three direct taxes imposed by the government. Compared with the tax rates in mainland China, Hong Kong’s main taxes rates are approximately only half of the tax rates of mainland China<sup>26</sup>. Moreover, Hong Kong does not impose a sales tax or VAT. This low taxation policy has accelerated economic growth. In 2011 and 2012, Hong Kong overtook the US and the UK and was at the top of the World Economic Forum’s Financial Development Index.

---

<sup>24</sup> Positive non-interventionism was the economic policy of Hong Kong implemented by former Financial Secretary Sir John James Cowperthwaite. He recognized the free markets power and believes the economy was doing well in the absence of government intervention. But sometimes proper physical infrastructure and regulations are also important to market decision making.

<sup>25</sup> Data source: C&SD, Hong Kong.

<sup>26</sup> Data source: National Bureau of Statistics of the People’s Republic of China.

### **2.4.1.3 Strong legal and institutional frameworks**

One of the most important features of Hong Kong's economy is its high standard of market transparency, stringent requirements of disclosure, and prudent supervision of its financial institutions. The banking sector has maintained a 3-tier banking system since 1990.

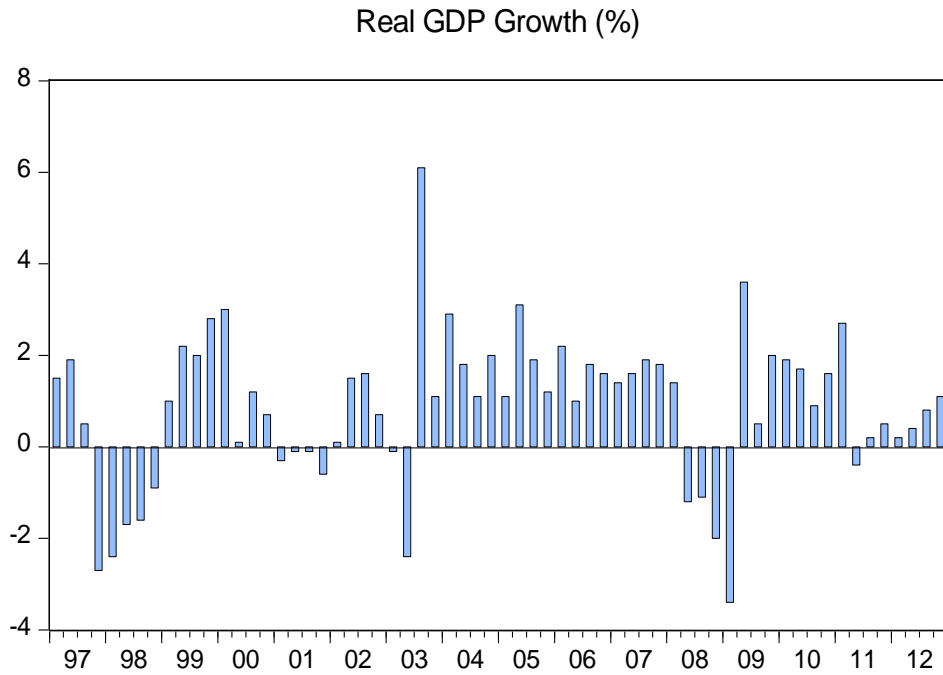
Hong Kong is also the world's premier offshore Renminbi (RMB) business centre. The RMB business in Hong Kong started in 2004 and Hong Kong was the first offshore market to launch a RMB business. Banks and other financial institutions in Hong Kong now offer various kinds of RMB services, including deposit-taking, currency exchange, wealth management and so on. Hong Kong is currently the largest offshore RMB centre in the world. In Hong Kong, the average daily settlement of RMB has reached 400 billion yuan, it holds 75% of the world's overseas RMB reserves, and total RMB deposits (including CDs) have amounted to 1 trillion yuan (HKMA, 2013).

### **2.4.2 Hong Kong's major Economic Indicators**

Figures 2.7 to 2.11 show Hong Kong's major economic indicators. The slowing down of the economy seems to be due to the Asian financial crisis. As is shown in the figures, in 1998 Hong Kong's economy experienced a large contraction. Real GDP shrank, inflation rate rose, unemployment increased, foreign currency assets decreased. After a short-lived recovery in 1999 and 2000, the real GDP growth rate fluctuated during 2001 to 2003: it was -0.6% in 2001Q4 and 6.1% in 2003Q3. The unemployment rate peaked at 7.9% in 2003 and it has been tending towards

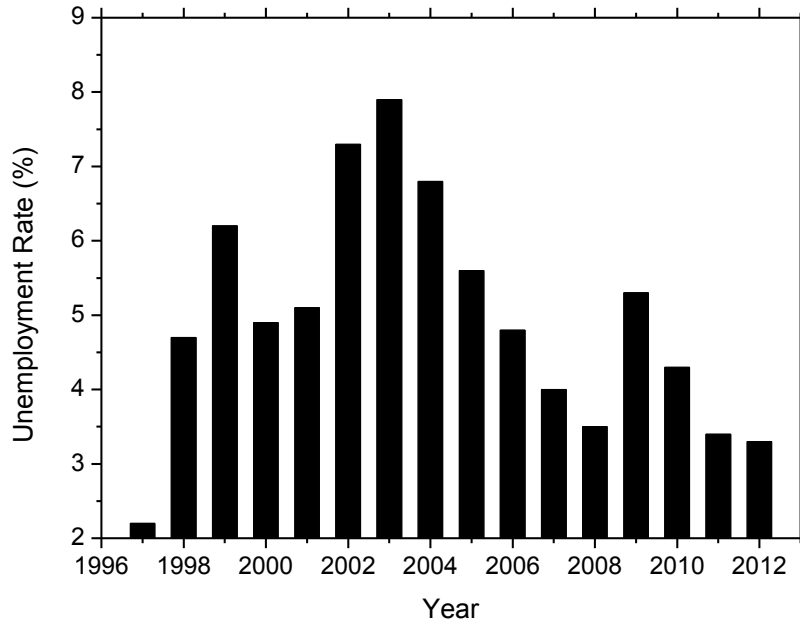
stability in the recent years. After the Asian financial crisis, deflation continued from 1999 to 2004. Under the linked exchange rate system, the HKD cannot be devalued. Hence, deflation can be used as an adjustment mechanism when the currency is overvalued. Compared with the other Asian countries, the value of HKD became relatively stronger after the financial crisis. This reduced the level of Hong Kong's exports. Consequently, prices had to be reduced in order to deal with this problem and soon wages also had to be cut. This caused a process of deflation, which will continue until prices and wages have fallen enough to make Hong Kong's goods competitive again. Following great efforts by the HKMA, the foreign currency reserve assets in Hong Kong have maintained a momentum of fairly rapid growth, except for the year 1998. Hong Kong's economy has also been hit by the global financial crisis. It can be seen from Figure 2.7 that, affected by the global financial crisis, the real GDP growth rate in Hong Kong fell from late 2007, and the recovery began in 2009 Q3. According to Figure 2.8, the unemployment rate has a sharply increase from 3.6% in 2008 to 5.4% in 2009, and then reduced to 4.4% in 2010, which is lower than its level of 2005.

**Figure 2.7 Real GDP growth rate (quarterly, %), 1997 to 2012**



*Data Source: Census and Statistics Department, Hong Kong*

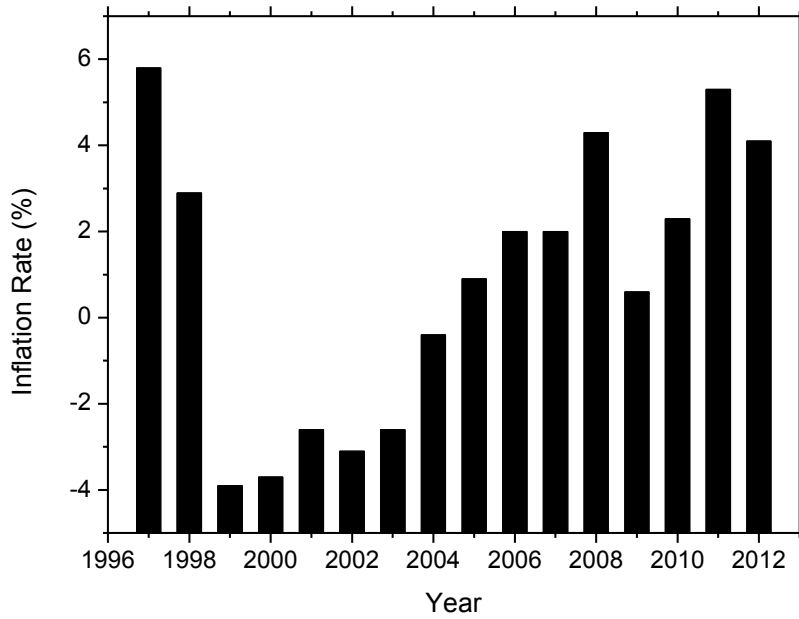
**Figure 2.8 Unemployment rate (annual average, %), 1997 to 2012**



*Data Source: HKMA Annual Reports*

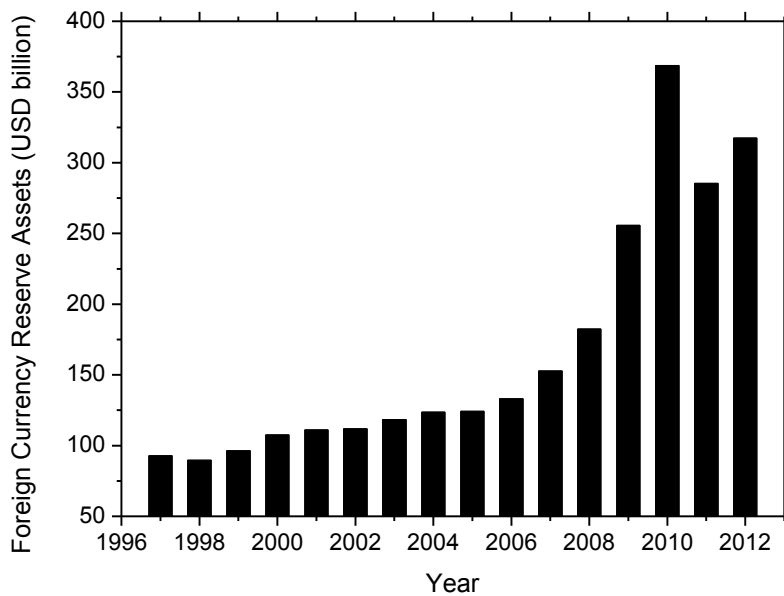


**Figure 2.9 Inflation rate (annual average, %), 1997 to 2012**



*Data Source: HKMA Annual Reports*

**Figure 2.10 Foreign currency reserve assets (USD billion) 1997 to 2012**



*Data Source: HKMA Annual Reports*

### **2.4.3 Hong Kong banking industry**

Tables 2.4 and 2.5 describe the characteristic details of the Hong Kong banking industry using the collected data covers 18 licensed banks incorporated in Hong Kong in that period from 1997 to 2012. Figure 2.11 plots the natural logarithm of bank loans in the whole market. Figure 2.12 describes the trend of average lending rates from 1997 to 2012. Figure 2.13 shows the trend of T-bill rate over the period from 1997 to 2012. Figure 2.14 presents the market shares of loans for each bank in that period.

According the Table 2.4 and Table 2.5, after a considerable decrease occurred in 1998, due to the Asia financial crisis, the banks' main indicators (including the total bank loans, the average loans per banks, total assets per banks and total customer deposits per bank) increased year by year from 1998 to 2012.

**Table 2.4 Industry characteristics (1997-2004)**

	1997	1998	1999	2000	2001	2002	2003	2004
<b>Bank loans (mil.HKD)<sup>27</sup></b>	1,610,277.00	1,506,405.00	1,440,907.00	1,475,913.00	1,512,044.00	1,580,907.00	1,863,394.00	1,913,231.00
<b>Loans per bank (mil.HKD)</b>								
<b>Mean</b>	101,042.10	66,966.56	64,094.79	82,050.71	84,002.46	87,828.18	103,521.30	106,290.60
<b>std. dev.</b>	1,69,667.10	116,813.60	110,141.70	120,310.80	122,843.00	128,745.30	149,771.50	149,464.20
<b>Total Assets per bank (mil.HKD)</b>								
<b>mean</b>	196,836.00	135,653.30	145,522.70	197,994.80	195,616.20	204,613.60	237,844.40	257,790.50
<b>std. dev.</b>	343,807.00	259,409.00	283,645.90	343,234.10	338,983.70	355,330.30	403,677.40	439,199.70
<b>Deposits per bank (mil.HKD)</b>								
<b>mean</b>	152382.90	111002.80	118478.30	159286.10	157104.70	163425.70	192691.20	209559.20
<b>std. dev.</b>	252492.60	205150.60	222509.10	273231.60	270455.80	279970.40	310946.40	344842.50
<b>Average lending rate<sup>28</sup></b>	9.50	9.00	8.50	9.50	5.13	5.00	5.00	5.00
<b>T-bill rate(pct.)</b>	6.43	7.29	5.36	5.93	3.29	1.62	0.75	0.26
<b>Exchange fund bill rate (pct.)</b>	6.22	7.29	5.30	5.89	3.42	1.62	0.79	0.25

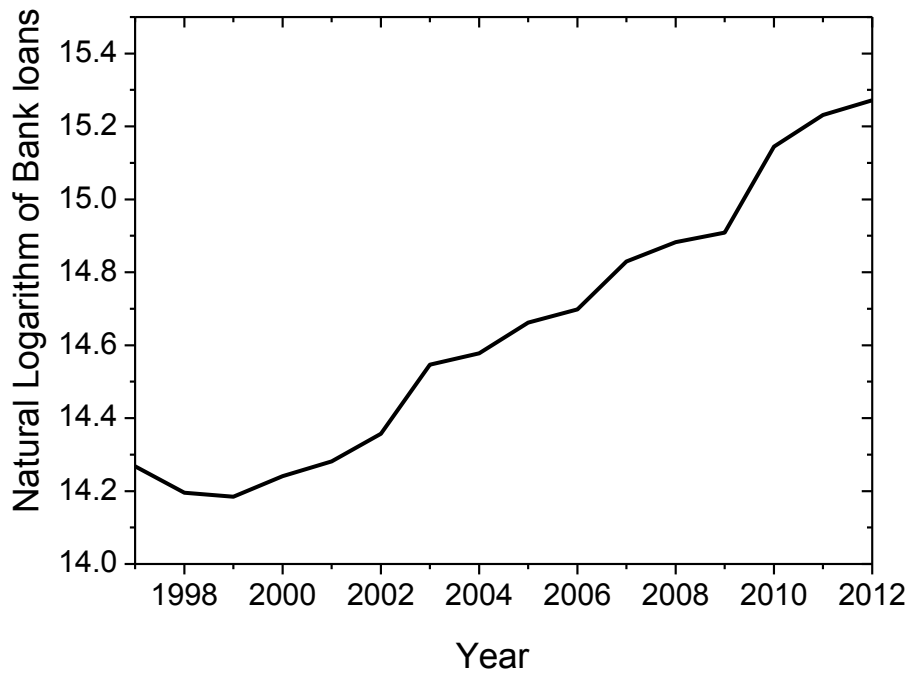
<sup>27</sup> Because of the missing data, the bank loans for some banks in some years are forecasted. I use the real data of bank loans for the other years to calculate the growth rate. Then, the values of missing observations can be calculated based on the growth rate. For example, for Bank of China (Hong Kong), the data of banks loans is missing from 1997 to 1999. First bank loans growth rate is calculated at about -4.6% in 2001, and the 2000 net loans is HKD 321,080 mil., then the net loans of 1997 can be obtained as  $321,080 / (1 - 4.6\%)^3 = 369,802.2$  mil.HKD. Similar, 1998 and 1999 net loans can be calculated as 352,790.93 mil.HKD and 336,562.2 mil.HKD respectively.

<sup>28</sup> Data Source: IMF

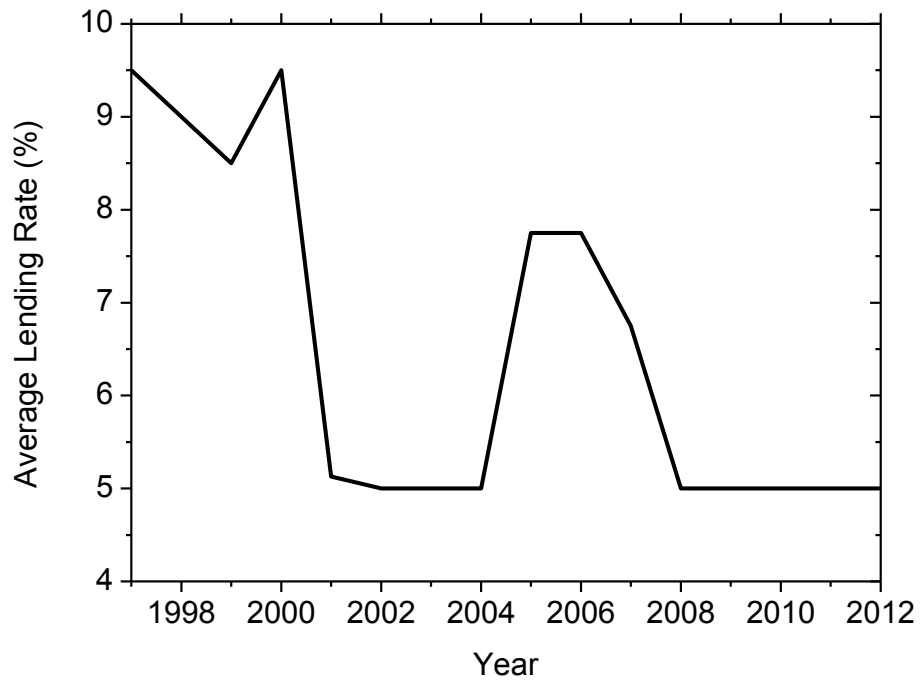
**Table 2.5 Industry characteristics (2005-2012)**

	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>
<b>Bank loans (mil.HKD)</b>	2,099,919.00	2,223,533.00	2,586,184.00	2,843,280.00	2,937,416.00	3,804,305.00	4,366,856.00	4,730,545.00
<b>Loans per bank (mil.HKD)</b>								
<b>mean</b>	116,662.20	123,529.60	143,676.90	157,960.00	163,189.80	211,350.30	242,603.10	262,808.10
<b>std. dev.</b>	163,652.60	169,413.10	185,425.80	204,250.80	197,925.90	264,092.40	303,589.30	332,068.00
<b>Total Assets per bank (mil.HKD)</b>								
<b>mean</b>	273,730.30	315,962.90	378,420.80	411,899.60	420,342.30	490,592.40	545,066.80	588,556.50
<b>std. dev.</b>	463,397.30	542,524.50	657,915.00	741,052.70	707,414.10	807,834.50	876,765.00	943,980.90
<b>Deposits per bank (mil.HKD)</b>								
<b>mean</b>	217344.70	248590.70	289306.30	306945.60	322516.60	377186.30	420049.90	452702.00
<b>std. dev.</b>	350639.10	402534.60	462545.00	484416.30	497028.80	570555.30	613047.80	661953.20
<b>Average lending rate</b>	7.75	7.75	6.75	5.00	5.00	5.00	5.00	5.00
<b>T-bill rate(pct.)</b>	2.69	3.64	3.13	0.71	0.07	0.23	0.14	0.12
<b>Exchange fund bill rate (pct.)</b>	2.54	3.67	3.16	0.85	0.05	0.21	0.14	0.13

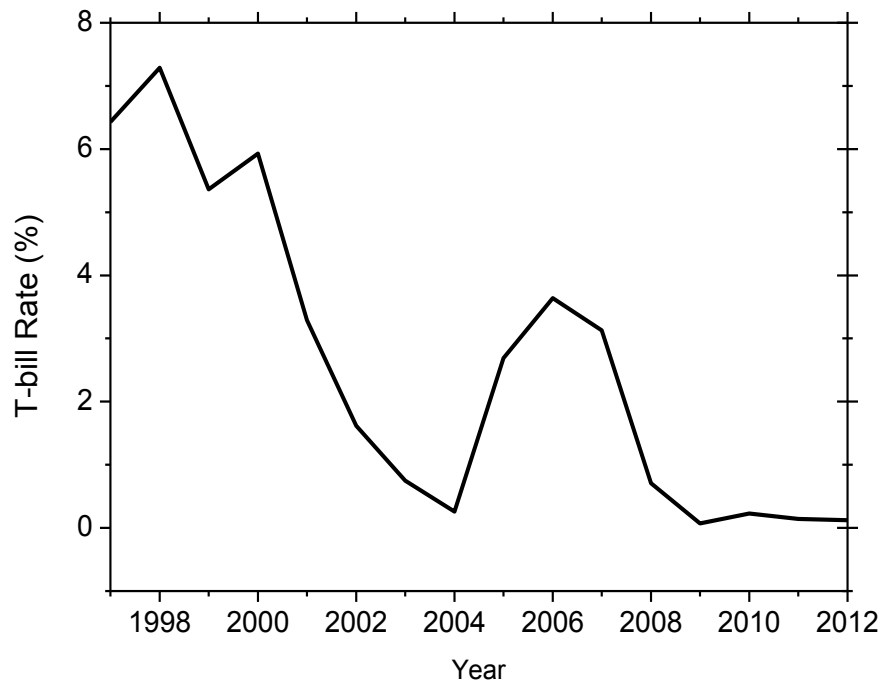
**Figure 2.11 Bank loans**



**Figure 2.12 Average lending rate**



**Figure 2.13 T-bill rates**



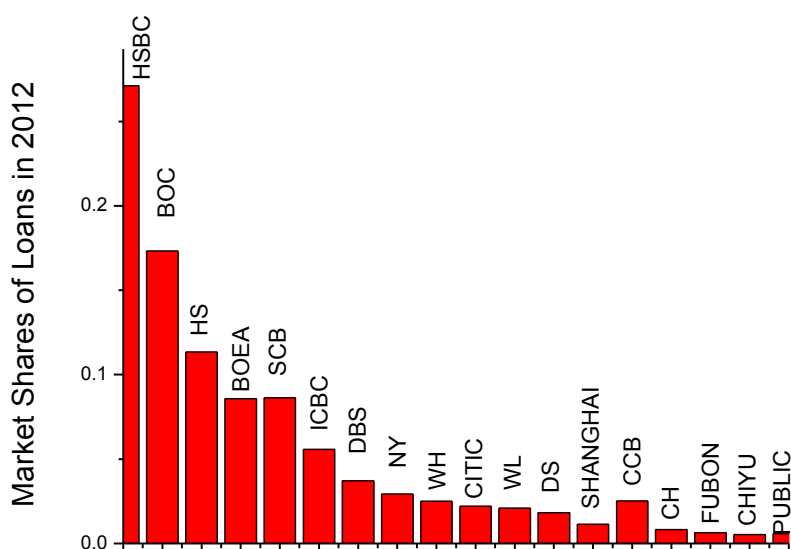
According to these figures, the shock wave from the Asian financial crisis still has an effect on the Hong Kong banking industry. The banks' funding, liquidity, loans growth and profitability are all inevitably affected. As can be seen from Figure 2.11, the bank loans show a trend of slightly declining over the period from 1997 to 2000, it hit a bottom at HKD 1,440,907 mil. in 1999. After that, the economy began recovering, especially after the second half of 2009, the market growth rate of loans reached to 29.51% in 2010. This recovery was helped by significant and timely government stimulus programmes, supported mainly by private consumption, government investment and net exports. As a result of improved customer confidence and labour market conditions, domestic demand strongly recovered in 2010. According to the statistics from HKMA, in 2010 the private consumption growth rate reached to 5.8% and the government consumption also

grew by 2.7%. Meanwhile, supported by strong economic performance in Mainland China and other emerging market economies, external demand also recovered in 2010, which is reflected by the growth of merchandise exports, exports of services and imports of goods and services. The conditions of the labour market also improved after 2009.

Under the linked exchange rate system, which was established in 1983, the Hong Kong dollar is pegged with the US dollar at an internal fixed rate of HKD 7.80 = USD 1. Therefore, the US plays a dominant role in Hong Kong monetary conditions and the HKD interest rates should track closely those of the US. As shown in Figure 2.12, the average lending rate increased at 9.5% affected by the Asian financial crisis. The Hong Kong Interbank Offered Rate (HIBOR) is the benchmark rate is used for loans between banks. According to the statistics from HKMA, at the beginning of 1997, the 3-month HIBOR was 5.41% per annum. As the Asian financial crisis swept over the Hong Kong banking industry, the 3-month HIBOR continues to show an upward tendency, and rose to 10.49% in November 1997. Although the rates fell to 9.25% in December 1997, the crisis in Indonesia pushed it up again to a new record at 11.51% in January 1998. As the result of the higher cost of funds, commercial banks had to raise the Best Lending Rates (BLR) twice at that time. After 1998, the average lending rate decreased steadily until 2005. Over the period from the end of 2003 to 2005, owing to the dollar weakness while there was a strong economic recovery in Hong Kong, and also market speculation about revaluation of the RMB, huge amounts of hot money flocked into Hong Kong. Although the interest rates of HKD were below the USD interest rates for a long period, there was no evident outflow. As a result, the aggregate

balance expanded sharply, to a peak at about 55 billion HKD in early 2004, pushing HIBOR downward to almost zero. In May 2005, HKMA introduced the “Three Refinements” of the Hong Kong dollar Linked Exchange Rate System,<sup>29</sup> overseas hot money left Hong Kong quickly and the aggregate balance experienced a considerable reduction. HIBOR raised by 170 basis points (bps) to around 3% in two days. It is clear from Figure 2.12 that the average lending rate increased from 2005, along with the interest rates increase in the US. Since the subprime crisis broke in August 2007, an influx of hot money into Hong Kong has followed the Federal Reserve (Fed)’s quantitative easing policy. The lending rate then began to decline.

**Figure 2.14 Market shares measured by bank loans in 2012**



<sup>29</sup> The HKMA (2005) introduced the three refinements to the LERS on 18 May 2005: establishing a strong-side Convertibility Undertaking (CU) at HK\$7.75/US\$, shifting the week-side CU from HK\$7.80/US\$ to HK\$7.85/US\$, and creating a Convertibility Zone defined by CUs, with which the HKMA may conduct market operations consistent with Currency Board principles.



As can be seen from Figure 2.14, HSBC (Hong Kong) is the largest bank in the Hong Kong banking industry and it had the largest market share. The market share of HSBC (Hong Kong) has fluctuated over the years, it peaked at 32.69% in 1997 and bottomed out at 25.62% in 2009. HSBC (Hong Kong) has an extensive branch and ATM network across Hong Kong. For the year 2012, it operates more than 450 branches<sup>30</sup> in Hong Kong. Bank of China ( Hong Kong), Hang Seng, , Bank of East Asia, Standard Chartered Bank and Industrial and Commercial Bank of China (Asia) Limited all have a good market share, which captures 17.32%, 11.33% ,8.57% ,8.63% and 5.57%, respectively, in 2012. The other banks have a market share that is smaller than 5%, some are even smaller than 1%.

## **2.5 Conclusion**

This chapter has provided an overview of Hong Kong's banking sector, especially after 1997. Although the Hong Kong's economy and banking system have remained in good health, they have not been totally immune to the Asian financial crisis and the global financial crisis. Hong Kong's banking system is already well regulated and competitive. The Bank Reform Programme undertaken by the HKMA may not have led to revolutionary changes in Hong Kong's banking sector, but it has helped to improve market efficiency and competition. In addition, a large number of bank mergers and acquisitions activities have taken place in Hong Kong since 1997. Therefore, the research of bank competition issues, which include the

---

<sup>30</sup> Data Source: HSBC (Hong Kong) Annual Reports 2012.

crisis period, appear to be important in the development of Hong Kong's banking industry.

# Chapter 3

## Switching Costs in the Hong Kong

### Banking Industry

#### 3.1 Introduction

It is not uncommon to hear people complaining about their current service supplier. According to a report on banks' brand performance and "switching", which was undertaken by Industry (2013), a strategic brand consultancy, in 2013, 20% of bank customers in the UK are considering switching banks. These results are based on a survey of 2,017 bank customers from around the UK in 2013. Although many customers express a strong desire to switch, they have not put this desire into practice. The final report from Independent Banking Commission (IBC) in the UK, which was published in September 2011, reveals that in 2010 only 3.8% of bank customers changed bank accounts and, on average, personal account holders only switch banks every 26 years (Vickers, 2011). This is not the only evidence of low switching rates in the UK. Morgans (2010) finds that over 17% of current account consumers (equating to eight million people) in the UK have thought about switching bank accounts but only less than half (equating to 3.3 million people) have done so within the year 2009 and 2010. Why then did they not switch? Is it easy for them to switch?

One of the most important reasons for these persistently low switching rates is due to concerns about switching costs. These costs can be described as a barrier to a customer's changing of suppliers. These barriers include financial costs and nonfinancial costs, such as time and psychological costs. Take the switching costs of mobile users who switch from iPhone to Samsung, for example. In this case, the financial costs include the price of a new mobile phone and the applications that they will use, while the nonfinancial costs include the time and effort spent on learning new mobile system. In many cases, consumers are forced to suffer these costs when switching from one provider of goods or services to another. Normally, different customers of the same firm suffer different switching costs, even when they have same switching decision (Kim et al., 2003). The existence of switching costs gives firms a degree of market power. Therefore, each firm faces a trade-off between increasing market share by charging low prices to attract new customers who will become repeat-purchasers in the future while gaining super-normal profits by charging high prices from locked-in customers (Klemperer, 1995). Firms often like to create switching costs to encourage customer loyalty. Switching costs also have an impact on new entry and they then influence the market's competitiveness.

Like other industries, it has long been recognized that the existence of switching costs have a significant impact on the banking industry. For example, in the lending market switching costs weaken the substitutability of loans provided by different banks. The "lock-in" effect allows banks to price discriminate between

new and old customers (Klemperer, 1995). It also enables incumbent banks to gain superiority over their competitors in terms of information. It is interesting to note that the attitudes of banks towards the magnitude of switching costs are conflicted. They wish to offer lower switching costs because customers from their competitors can easily switch to them. Meanwhile, they also want higher switching costs because they wish to “lock-in” existing customers (Matthews, 2013). Therefore, it is meaningful to test the significance and estimate the magnitude of switching costs in order to help banks lock in customers.

Compared with the theoretical literature, the empirical literature on switching costs is sparse and more recent, mainly due to the lack of appropriate data. There are only a limited number of empirical studies on the measurement of switching costs. Kim et al. (2003) provides the only structural model available for econometric estimation concerns to the magnitude and significance of switching costs, which used an aggregated panel data that does not contain customer-specific information. However, there is no evidence of the significance or magnitude of switching costs in Hong Kong market.

In this chapter, in order to fill the gap in empirical work, a study of the switching costs in Hong Kong bank loan market is discussed. The database consists of an unbalanced panel of annual observations for the Hong Kong banking industry, spanning 16 years from 1997 to 2012<sup>31</sup>. The sample covers 18 licensed banks

---

<sup>31</sup> The sample of this thesis covers 18 licensed banks incorporated in Hong Kong for the period 1997 to 2012. Until June 2013, there were 21 licensed banks incorporated in Hong Kong. The main reason to choose these 18 banks and the period 1997 to 2012 was because the data availability is limited. In addition, the annual reports of banks incorporated outside Hong Kong are not released by HKMA. In the loan market, wholesale banks offer heterogeneous products for different people. In order to estimate the switching costs in the bank loan market, retail banks which offer

incorporated in Hong Kong in that period. In the bank loan markets, a borrower may face significant switching costs when switching between banks. In general, these switching costs are considered to be caused by asymmetric information between borrowers and lenders. The magnitude of switching costs is estimated based on a model presented by Kim et al. (2003), which is a structural model including a first order condition for maximization banks' present value, a market share equation and a trans-log cost system. My findings suggest that switching costs are significant in the Hong Kong bank loan market. The average point estimate of switching costs based on an entire sample is 0.1947. The estimates on the slope of the transition probability function for the entire sample are expected to be negative and significant at -4.7367. The existence of switching costs only increases the price-cost margin by 0.52% (52bps), which is approximately 8.26%<sup>32</sup> of the average interest rate on the loans' value. I also compare the magnitude of switching costs during good times and bad times, and find that the estimated switching costs are higher during the bad times due to the "Lemons Problem". On average, 2.54% of the customer's added value is attributed to the "lock-in" effect that is generated by switching costs. My empirical results also indicate that the

---

homogenous products are better choices. And the level of competition may also differ for the retail banking market and other banking market. Moreover, these 18 banks dominate the market. The statistics from HKMA show that the total assets of these 18 banks accounted for 78.62% of the whole market in 2012. Since these 18 banks dominate the loan market, if more financial institutions are included in the sample, the magnitude of switching costs and the level of competition in the loan market may have no significant impact. Based on Panzar-Rosse approach, Jiang et al. (2004) suggests that the market structure of the banking sector in Hong Kong can be characterized by perfect competition during 1992 to 2002. Therefore, if the sample is extended to cover the period 1989 to 1996, the results suggest that the Hong Kong bank market can be characterized as monopolistic competition may change.

<sup>32</sup> The average interest rate on loans is equal to 6.30%, the details of how to calculate interest rate on loans are discussed in section 2. The number 8.26% is obtained by using 0.52% divided by 6.30%.

Hong Kong banking industry is in the range of economies of scale. Furthermore, I show that all these results are robust using GMM approach.

This chapter is organised as follows. Section 3.1 is a brief introduction of whole chapter. Section 3.2 provides the relevant literature on switching costs. The theoretical framework and the empirical methodology are also described here. Section 3.3 discusses the data and variables used in estimation. Empirical results are discussed in Section 3.4. Section 3.5 concludes the chapter.

## **3.2 Literature review and methodology**

### **3.2.1 Introduction**

Although there are a large number of theoretical studies of the effects of switching costs on price competition, due to data limitations the empirical literature on switching costs is sparse and more recent. This section will discuss the previous literature of switching costs. In addition, a structural model of a firm's behaviour in the presence of switching cost that builds on the work of Kim et al. (2003) is introduced.

### **3.2.2 Definitions of switching costs**

Switching costs are broadly defined. Porter (1980) firstly gives an authoritative definition of switching costs as a "one time cost", as opposed to the ongoing costs when customers switch from one goods or service provider to another. Then, Jackson (1985) made this term popular and defined switching costs in many

aspects including economic, psychological and physical costs that arise when customers are willing to change supplier. Over the past 30 years, a growing number of scholars have paid attention to this subject and have given similar definitions, such as De Ruyter et al.(1998), Dick and Basu (1994), Thompson and Cats-Baril (2002), Jones et al.(2002), Whitten and Wakefield (2006), Farrell and Klemperer (2007). If a consumer purchases a product repeatedly, then the presence of switching costs will result in economies of scale (Farrell and Klemperer, 2007). Switching cost exists in many markets and they affect market competition, performance, and also firm behaviour. When the switching costs are large enough, such as when they exceed the difference between the prices of two suppliers, they may cause a “lock-in” effect where the rational consumer will repeat purchases from the same supplier and will be unwilling to switch to a supplier that is able to offer a lower price and better product quality. The famous “QWERTY” keyboard example (David, 1985) illustrates that the existence of a switching cost may cause consumers to stick to their choice in the future. Switching costs play a crucial role in winning customer loyalty. They reduce the customer’s sensitivity to price by reducing price elasticity. Klemperer (1987a) also explains the phenomenon that ex-ante homogenous products or services become heterogeneous after purchasing because of switching costs.

### **3.2.3 Types of switching costs**

Switching costs are important in different industries and consumer contexts (Klemperer, 1995). They have an impact on higher profits (Beggs and Klemperer,



1992), and market entry and exit (Farrell and Klemperer, 2007; Farrell and Shapiro, 1998; Wang and Wen, 1998). They are also associated with consumer behaviour to an inelastic response with price (Farrell and Shapiro, 1998). In order to manage switching cost efficiently, firms must understand the reasons behind switching costs. Klemperer (1987a) finds that there are at least three types of switching costs, which are: learning costs, transaction costs and artificial or contractual costs imposed by firms. In his later research, Klemperer (1995) further subdivided these three types, as follows

1. *Compatibility costs*, which arise when customers need to purchase matching auxiliary products after purchasing the original products. Such as having to buy camera lenses that must be compatible with the camera.
2. *Transaction costs*, which can be defined as the costs incurred by the customers when they change supplier. In a broad sense, except learning costs, the other costs described here are all kinds of transaction costs.
3. *Learning costs* are typically the costs of the consumer having to learn to use new brands, such as learning to use a new computer system.
4. *Costs that are due to uncertainty about the quality of interested brands*. If the quality of the product can only be known after consumption, then the consumer will be loath to switch to a new brand since there is a risk that they will not like the new brand.
5. *Contractual switching costs*, such as frequent flyer programs that encourage customers to travel on the same carrier, loyalty cards and so on (Klemperer and Png, 1986; Banerjee and Summers, 1987).

6. *Psychological costs of switching*, which appear when the consumer's change their preferences after using a product or service and then emotionally stick to it so that they find it difficult to switch supplier.

Fornell (1992) agrees with Klemperer's (1987a) ideas and concludes that "switching barriers can be caused by search costs, transaction costs, learning costs, loyal customer discounts, customer habit, emotional cost, and cognitive effort, coupled with financial, social, and psychological risks on the part of buyer" (p.10). Based on the previous literature, Burnham et al. (2003) also classified switching costs into three categories, which are: procedural costs, financial costs and relational costs<sup>33</sup>. The empirical work of Burnham et al. (2003) shows that these costs are highly negatively correlated with the consumers' intention to switch service providers.

Switching costs can be distinguished as exogenous and endogenous (Nilssen, 1992; Klemperer, 1995). The presence of exogenous switching costs has nothing to do with the firm's decisions (e.g. transaction costs and learning costs) but it does with endogenous switching costs induced by firm's actions directly (e.g. loyalty rewards). Therefore, firms can decide the size of endogenous switching costs but not exogenous ones. Firms can obtain higher prices and profits because of

---

<sup>33</sup> Procedural switching costs, which include learning (Alba and Hutchinson, 1987; Eliashberg and Robertson, 1988; Guiltinan, 1989; Wernerfelt, 1985), setup (Guiltinan, 1989; Klemperer, 1995), economic risk (Guiltinan, 1989; Klemperer, 1995; Samuelson and Zeckhauser, 1988) and evaluation costs (Samuelson and Zeckhauser, 1988; Shugan, 1980), primarily arise because of the expenditure of time and effort. Financial switching costs consist of benefits loss (Guiltinan, 1989) and monetary-loss costs (Heide and Weiss, 1995; Jackson, 1985; Klemperer, 1995; Weiss and Heide, 1993). In most cases, these costs can be summarized as a financially quantifiable resource loss. Personal relationship loss (Guiltinan, 1989; Klemperer, 1995) and brand relationship loss (Aaker, 1992) are major causes of relational switching costs. This type of switching cost refers to psychological or emotional discomfort due to the breaking of a relationship.

switching costs. This will reflect on firms extending the size of switching costs and “lock-in” their customers (Klemperer, 1995). Compared with the literature related to exogenous costs (see Klemperer, 1995), there is less literature on endogenous costs. For example, Shi (2013) developed a game theoretical model to study the relationship between endogenous and exogenous switching costs, and finds that in the equilibrium the endogenous switching costs cause profit losses to competing firms and the size of profit loss decreases with the size of exogenous switching costs. Banerjee and Summers (1987) considered the case of endogenous switching costs by using a two-period duopoly model with homogenous products where both firms issue coupons in the first period. They found that the prices in period 1, and the effective prices in period 2, are consistent with the monopoly price. These results are that same as Klemperer’s (1987a) two period model with exogenous switching costs. The only difference is that with endogenous switching costs the old customers will face lower prices than the new customers. The results of Caminal and Matutes (1990) are in agreement with those of Banerjee and Summers (1987). Marinoso (2001) studied whether the endogenous switching costs created by product incompatibility can be used as a strategic tool by the firm to lock-in consumers and reduce the competition in aftermarket for network industries. Haucap (2003) reviewed Marinoso’s (2001) work and comes to the same conclusions: producers are willing to achieve compatibility because switching costs are reduced by compatibility, which will allow the producers to charge higher prices on their products.

### **3.2.4 Theoretical literature**

The theoretical literature has largely demonstrated the impact of switching costs on pricing and industrial structure in a variety of markets. Klemperer (1995), National Economic Research Associates (2003) and Farrell and Klemperer (2007) present excellent literature reviews. Chen and Hitt (2006) survey prior literature on information technology and switching costs.

In many markets, switching costs give firms a degree of market power. This means that the current market share will decide the profits in the next period. Under the assumption that firms cannot set different prices to different groups (old and new customers), firms are faced with a trade-off. On the one hand, firms would like to set a higher price to exploit the lock-in customers but, on the other hand, the firms also want to reduce their prices to attract more new customers who will become repeat purchasers in the future. How then can we know which effects will prevail in equilibrium?

Villas-Boas (2014) presents a literature review of the effects of customers' switching costs on equilibrium prices and profits. Their paper focuses on the effects of several market forces, including firms' foresight, customers' foresight, the degree of stability of customer preferences and the market time horizon in the switching costs literature. Klemperer (1995) summarizes several basic economic models of competition with switching costs and answers the question of what price strategies firms will use when suffering from switching costs.

### 3.2.4.1 Models with switching cost

Based on the model of Von Weizsacker (1984), Klemperer (1987a) used a simple duopoly model (the numerical example of two airlines) to introduce the point that switching costs can lead to a non-cooperative equilibrium, which may be the same as the collusive solution in an otherwise same market without switching costs. Klemperer assumes that there are two firms (A and B) in the model, which produces homogenous products. The switching costs incurred by consumers changing firms are also homogenous and exogenous. Each of the firms has a sizeable customer base. The core assumption is that the firms must charge a single price to all customers. Klemperer (1987a) finds that, given all of the assumptions above, each firm serves only its old customers and acts as a monopolist against them. The reason for this is that neither firm can benefit by deviating from monopoly price to its old customers unless it sells to any of its rival's customers. Therefore, in this model, there is no switching in equilibrium. But in nature these assumptions are always not satisfied. For instance, when the switching costs are heterogenous, there may be some switching in equilibrium. The prices and profits will also be higher than in the case without switching.

The common model of the switching costs literature is the two-period model, which assumes that a firm cannot commit to future prices. There are two identical firms with different costs in the market. In the first period, both firms compete for customers. In the second period, the consumer faces a homogenous switching cost when changing supplier. There are no new customers. Farrell and Shapiro (1988) find that in the second period, firms with higher market shares charge higher prices than firms with lower market shares. The reason for this seems obvious: firms with

a higher market share can obtain a higher benefit from increasing prices to exploit their lock-in customers than the benefit it would obtain by reducing prices to attract uncommitted customers. Since the profits of the second period are appreciable, this leads to intense competition between the two firms in the first period. Therefore, firms are willing to price below cost in the first period to obtain customers and are able to price above marginal cost in the second period to get a higher profit. Klemperer (1987a and b), Klemperer (1995) and Padilla (1992) also conclude that, when compared with the case without switching costs, prices are lower in the first period and higher in the second period. This pattern of prices is presented as “bargains-then-ripoffs”. A lot of the literature related to the two-period model of switching costs including Klemperer (1987a, 1987b, 1995), Basu and Bell (2000), Ahtiala (2006), Lal and Matutes (1994), Gehrig and Stenbacka (2002), Ellison (2005), and Lee and Png (2004), who have focused on this “bargains-then-ripoffs” pattern.

In an ideal world, firms and customers can contract for the whole lifecycle of a product or service, and commit to future prices and qualities. Under such circumstances, customers will choose those firms that offer the lowest price throughout the whole lifecycle (Farrell and Klemperer, 2007). Since this is a whole lifecycle contract, there would be no switching during the whole life time. We can then find those firms who do not have market power. The existence of switching costs would not lead to any economic inefficiency, which is the same as the case without switching costs. The consumers and economic welfare will not be diminished by switching costs.

Such a whole lifecycle contract becomes unrealistic in real life circumstances. This raises the question about the extent that switching costs can have an impact on the consumers' welfare. This can be classified into two cases, where firms and customers sign a short-term contract and where they sign long-term contracts. Assuming that firms can set different prices to different customers (old and new), Farrell and Shapiro (1988) studied the behaviour of many identical firms who contend for customers in a market with switching costs. They illustrate that if switching costs are observable, then both short-term and long term contracts achieve the First Best, even when quality is not contractible. However, if switching costs are unobservable, then long-term contracts can outperform short-term contracts. However, these results can only hold within specific assumptions. In the situation of long-term contracts, incomplete long-term contracts can sometimes reduce the consumer's welfare. This was called the Principle of Negative Protection by Farrell and Shapiro (1988). In a mature market, new customers will enter into a second period. This will create a trade-off for the firms in the market, who can either set a higher price to exploit their existing customers or set a lower price to attract new customers. We can find that firms with a higher market share will prefer to set a high price. Padilla (1992) shows that because firms want to gain new customers, prices will become lower when compared to a static market with switching costs.

Klemperer (1987c) considers a two-period model with complete and perfect information, and suggests that the incumbents may raise their prices in order to deter entry. The idea is that switching costs hamper forms of entry, so that the firms must persuade their customers to pay these costs, which is particularly true

for a large-scale entry that seeks to attract other firms' customers (for instance to achieve a minimum variable scale if the market is not growing quickly). The difficulty for a new entry is that it may be broadly efficient given switching costs but nevertheless there is still a social cost of switching. Gayle and Wu (2013) agree with Klemperer (1987c) on this point by providing empirical evidence of the incumbents' response to the threat of entry using US domestic flight data for 2007.

By extending the two-period model into a multi-period it can be seen that the firms face a trade-off to exploit lock-in customers or to reduce its prices to obtain higher future profits. Farrell and Shapiro (1988) analyse an overlapping-generations model of duopolistic competition with infinitely many periods in the presence of consumer switching costs. With the assumption of a constant relative proportion of new and old customers in each period and homogenous switching costs, they found that firms without a customer base will be willing to price more aggressively than the "incumbent" in order to attract new customers. Firms with a higher market share will charge a higher price and concede new customers to their rival. Therefore, market leadership has tended to change over time since the market shares are transferred from a high price firm to a low price firm. In addition, average prices were higher than they were in the case without switching costs. In some markets, Switching costs encourage entry to serve new customers even when such entry is inefficient. Beggs and Klemperer (1992) and Padilla (1995) also found similar results by modelling a multi-period model in the presence of switching costs.



Klemperer (1995) concludes that there are three main reasons to explain why in equilibrium the prices are likely to be raised by the presence of switching costs. Firstly, because of the real interest rate, the same amount of money today is valued more highly than it will be tomorrow. This will induce firms to prefer harvesting today rather than investing in the future. Secondly, the pricing decision of firms today will influence how aggressive their rivals will be in future. If the number of locked-in customers of each firm is increased, then we will find in the next period that these firms will become less aggressive. Therefore, considering this effect, each firm will raise its price today to reduce the competitive power of its rivals in the next period. The last point is, if we take customers' expectations into account, we can find that the presence of switching costs make a rational customer to consider the expectations of future prices when making today's purchasing decision. If firms set a low price today, then customers will become less price-sensitive and the firms' elasticity of demand is also reduced. Many researchers have studied the impact of different customer expectations in markets with switching costs. Facing consumers who expect price reduction maintained in every periods, Von Weizsacker (1984) found that consumer demand is highly elastic in relation to price and the switching costs depress the prices when compared to a market without switching costs. However, this kind of consumer expectation is irrational. But, as Marinoso (2001) shows, if firms can set different price to locked-in and new customers, then the role of switching costs on prices is not related to the consumer's expectations. Cabral and Greenstein (1990), taking switching costs into account, compared two procurement regimes of US Federal Government and

found that when the consumers are able to influence the price they face then it is optimal for them to choose to partially or completely ignore the switching costs.

Most models of switching costs assume that firms cannot charge different prices to different customers. But Chen (1997) extends Klemperer's case to allow firms to price discriminate between existing customers and new customers. They constructed a two-period duopoly model which assumed that firms can price discriminate between locked-in and uncommitted customers by offering a discount to encourage new customers to switch from previous suppliers. If demand is very inelastic, then society and consumers will generally be worse off because the burden from switchers will be large but the level of output will be the same. In contrast, if market demand is elastic, then society and consumers will generally be better off due to the expansion of output. Shaffer and Zhang (2000) extended the results of Chen by considering a model where the firms are no longer able to provide homogenous products and different customers have different preferences. They showed that with the assumption of price discrimination, prices will be lower than in the case of price uniformity. If the new customers have same preferences as the old customers, then it is optimal to offer a discount to attract the new customers. In contrast, if they have different preferences for each customer's group, then it is better to offer a lower price to the locked-in customers to insure that they stay.

### **3.2.4.2 Aftermarkets**

The switching costs in an aftermarket are a special case of price discrimination between old and new customers. An aftermarket is a secondary market where consumers can buy follow-on products (such as a camera lens for a camera). Since the 1992 U.S. Supreme Court decision in the antitrust case of *Eastman Kodak Company v. Image Technical Services, Inc., et al.*, considerable attention has been given to the issue of aftermarket. In this case, Kodak was sued by Image, who alleged that they had monopolized the maintenance market for its copiers and micrographic equipment by refusing to sell spare parts to alternative maintenance suppliers. Kodak finally lost the trial. There are also many other court cases, such as *Cannon Kabushiki Kaisha v. Green Cartridge Company* in 1999 of Hong Kong (Elzinga and Mills, 2001). Morita and Waldman (2010) provide an explanation for the reason why a durable goods producer with little or no market power would monopolize the maintenance market for its own product based on consumer switching costs and consumer preferences. An interesting point is that this practice increases both social welfare and consumer welfare. The price of spare parts and maintenance services today will affect the behaviour of consumers tomorrow (Shapiro, 1995). Therefore, if the firms would like to exploit customers today, then they will hardly attract customers tomorrow. Mackie-Mason and Metzler (2002) describe a “Surprise” theory, whereby durable goods firms with some customer base would like to increase the price of spare parts to profit from their locked-in customers. But, as Shapiro (1995) notes, these firms may be prevented from fully exploiting their locked-in customers when these customers have heterogenous switching costs. In Shapiro’s (1995) paper, another two theories (i.e. “lack of

commitment” and “costly information”) are used to explain how consumers may be exploited in the aftermarket.

### **3.2.4.3 Market entry and exit**

As Farrell and Klemperer (2007) said, the most significant impact of switching costs is its effect on a firms’ entry. Aghion and Bolton (1987) analysed how an incumbent seller is able to deter entry to the market by new, same cost producers by signing long-term contracts. In many cases, under certain conditions, the existence of switching costs may encourage entry depend on the size of switching costs, the scale of entry, the market, and the existence of economies of scale. If the switching costs are very high in the markets, a new entrant has to price at a substantial discount to the incumbent’s price to attract customers, which would deter new entrants from entering the market. High switching costs will also reduce social welfare. Klemperer (1987c), and Farrell and Shapiro (1988) suggest that a moderate size of switching costs may make entry easier than lower or no switching costs. In fact, switching costs cause a surplus of entry. Wang and Wen (1998) even find that, although the new entrant has a higher marginal cost than an incumbent, it can still profit from entry if provided with sufficiently high switching costs. In general, switching costs encourage small scale entry but deter large scale entry (Gelman and Salop, 1983; Yoffie and Kwak, 2001). Market growth can also impact on entry opportunities in a market with switching costs. For example, a growing market may encourage entry since contending for locked-in customers lowers competitiveness. Although, in general, moderate switching costs are

conducive to small scale entry, they do not work when faced with strong economies of scale in the market.

### **3.2.5 Empirical literature**

Compared with the theoretical literature, the empirical literature on switching costs is sparse and more recent, mainly due to the lack of appropriate data. There are only a limited number of empirical analyses on the estimates of switching costs and their effects in different markets. For example, Bucklin et al. (1995), Che et al. (2007) and Dub   et al., (2009) study brand loyalty and state dependent effects for packaged goods, Stango (2002) and Barone et al. (2011) for credit market, Shy (2002) for bank deposits, Kim et al. (2003) for bank loan market, Kim et al. (2004) for mobile telecommunication industry, Viard (2007) for the telephone market, and Chen (2011) for network industry. Chen (2011) also presents a series of results that describe the effects of switching costs on market concentration and prices. This section summarises the existing literature on identifying and measuring switching costs according to the methods used.

#### **3.2.5.1 Direct methods**

Direct methods use information on individual consumer behaviour. For instance, using data on the online brokerage industry, Chen and Hitt (2002) developed and implemented an approach for measuring the magnitudes of switching costs and brand loyalty for online service providers that was based on the random utility modelling framework (MacFadden, 1973). They found significant variation in

measured switching costs across brokers. Although the customer's characteristics have little effect on switching, the system uses measures and system quality that are associated with reduced switching. In addition, firm characteristics reduce both switching and customer attrition. Epling (2002) studied competition in the long distance telephony market in the US after 1996. She found empirical evidence for heterogeneity in the subscriber switching costs and concluded that consumers with high switching costs end up paying higher prices. Shum (2004) estimated switching costs using panel data on household purchases of breakfast cereals. Greenstein (1993) analysed federal procurement of commercial mainframe computer systems during the 1970s, and found that an agency is likely to acquire a system from an incumbent vendor. The compatibility between a buyer's installed base and a potential system also influences the choice of vendor.

### **3.2.5.2 Indirect methods**

Actually, a direct measure of switching costs is difficult to obtain since switching costs are both consumer-specific and industry-specific, and they are not able to be directly observed by economists. Indirect methods use aggregate data to identify switching costs, usually by estimating reduced-form pricing equations. For example, Knittel (1997) analyzed the changes in prices for long distance telephone calls in the US after 1984, and found that the presence of search and switching costs causes price rigidity. Borenstein (1991) measured the magnitude of switching costs in the US retail petro market and found that gas stations discriminate against groups of customers who are less likely to switch to another station. This conclusion highlights the influence of shopping or search costs on

pricing decisions, even in a market that is thought to be quite competitive. In addition, Kim et al. (2003) provides the only structural model available for econometric estimation of the magnitude and significance of switching costs, which uses an aggregated panel data that does not contain customer-specific information. It estimates a first-order condition, a market share equation and a trans-log cost function jointly in a Bertrand oligopoly model, and finds that the point estimate of the average switching cost is 4.1%, which is about one-third of the market average interest rate on loans in value. The detail of Kim's model will be introduced in the methodology part. Based on the Kim's model, Yuan (2010) estimates the magnitude of borrowers' switching costs in the banking sector for 31 OECD and developing countries for the years 1996 to 2004. She finds that the switching costs are significant for all countries in the sample and the magnitude of switching costs are higher in developing countries than developed countries. Her results also show that indicators of informational asymmetries between borrowers and lenders, such as bank penetration and market concentration, have strong impacts on switching costs. In contrast to other empirical studies, Shy (2002) develops a quick and easy way to estimate the magnitude of switching costs using observed data on market shares and prices under a set of assumptions. This method is based on the undercut-proof of property concept (Morgan and Shy, 1996). He applies this method for both the Israeli cellular phone market and the Finnish bank deposits market. Although this method has been widely cited, Shcherbakov (2008) points out that the assumptions include homogenous products and static behaviour on both demand and supply side that are very strong, which is likely to be violated regardless of the product type. Zhu et al. (2011) argues that Shy's (2002) model

only considers the behaviour of firms rather than the behaviour of consumers and, therefore, the calculated results of switching costs are inaccurate. In addition, they do not agree with Shy's (2002) argument that even in the duopoly model a Nash-Bertrand equilibrium in pure prices does not exist. Using the undercut-proof equilibrium method presented by Shy (2002), Carlström (2010) estimates the size of switching costs in the Finnish retail bank market and finds that switching costs amount to about 50% of the interest rate for both cooperative and saving banks in the lending market.

## **3.2.6 Methodology**

### **3.2.6.1 Introduction**

This chapter describes an empirical model of firm behaviour in the presence of switching cost for loans across time. The model builds on Kim et al. (2003), who provide the only structural model available for econometric estimation concerns to the magnitude and significance of switching costs that uses highly aggregated data lacking information on customer-specific transition history. In Kim et al.'s (2003) paper, the model is applied to a panel data of Norwegian banking industry to estimate the switching costs in the market for bank loans. The novelty of this model is that, by introducing the definition of "transition probabilities", the customer specific switching behaviour can be implied from the changes in each bank's market share. Therefore, without observing individual switching decision, switching costs can still be found based on the change of bank's market shares.



Another attractive property of Kim's model is that it allows customers to switch between banks at any period.

### **3.2.6.2 The model's framework**

The empirical model is based on the research of market conduct with the existence of customer switching costs (Klemperer, 1987c). Following Kim et al. (2003), I consider an oligopoly lending market with  $n$  banks competing in interest rate on loans.<sup>34</sup> Here, the customers (i.e. borrowers) are assumed to have an inelastic demand for loans in order to focus on the customers' decisions on the choice of bank.<sup>35</sup> The demand quantity of each customer is fixed in each of the infinite discrete periods.<sup>36</sup> The customers maximize their utility by deciding from which bank to borrow, and take the interest rates charged by all banks in the market as given. Although the customers are allowed to switch at any period, the switching between banks is costly and the magnitude of the switching cost is common knowledge to both the banks and customers. The customer behaviour that generates probabilities of switching between banks (i.e. transition probabilities) are functions of the interest rate on loans and switching costs. The demand faced by each bank can be obtained by aggregating the transition probabilities over all customers. Therefore, although the customer switching behaviour is not

---

<sup>34</sup> This is a multiple-stage price (Bertrand) competition model in which the firms are allowed to set the prices.

<sup>35</sup> Because the demand of loans are not significantly altered by the change of interest rate on loans, the assumption is that a given bank and its rivals have the same sensitivity of the transition probability of randomly selected borrowers to changes in the interest rate on loans.

<sup>36</sup> This assumption is not held subsequently and the quantity of customer demand is changing at an exogenously determined rate.

observable, we still can find the magnitude of switching costs by using the market share of each bank.

### 3.2.6.3 Demand side

The customers compare the interest rates on loans charged by different banks in order to choose from which bank to borrow. I model the customer's borrowing decision in terms of the probability of borrowing from different banks. Different customers have different borrowing decisions. The probability of borrowing from a specific bank represents the proportion of customers who decide to borrow from that bank in aggregation.<sup>37</sup> If the customer wants to switch, then the switching cost is added to the interest rate of loans charged by the bank. Following Kim et al (2003),  $Pr_{i \rightarrow i,t}$  denotes the probability that a customer who borrowed in period  $t-1$  from bank  $i$  will continue to borrow from the same bank in the subsequent period. We can also define  $Pr_{j \rightarrow i,t}$  to be the probability that a customer who previously borrow from bank  $j$  will switch to borrow from bank  $i$  in the subsequent period. Since the transition probabilities are functions of interest rate on loans and switching costs, I use  $p_{i,t}$  to denote the interest rate charged by bank  $i$  in period  $t$ . Similarly, the  $(n-1)$  vector  $\mathbf{p}_{i R,t}$  is used to denote the alternative interest rate charged by bank  $i$ 's rivals.<sup>38</sup> Customers suffer switching costs when they change the banks. In fact, switching costs are likely to differ among customers. Here the switching costs are assumed to be constant over time and over customers.

---

<sup>37</sup> Since the presence of switching costs, transition probabilities are assumed to be Markovian, as long as the transition probabilities are between 0 to 1, the switch exists.

<sup>38</sup> I use bold letters to denoted vectors.

Therefore, the mean switching costs are denoted here by  $s$ . The probability of continuing to borrow from the same bank  $i$  is:

$$Pr_{i \rightarrow i, t} = f\{p_{i, t}, \mathbf{p}_{i R, t} + \mathbf{s}\} \quad (3.1)$$

where  $\mathbf{s} \equiv s \cdot I$ , here  $I$  is an  $(n-1)$  unity vector.

The (conditional) probability of switching to bank  $i$  from bank  $j$  is formulated as follows:

$$Pr_{j \rightarrow i, t} = f\{p_{i, t} + s, \mathbf{p}_{i R, t} + \mathbf{s}_j\} \quad (3.2)$$

where  $\mathbf{s}_j$  is an  $(n-1)$  vector in which each of the elements equals  $s$ , except for the  $j^{th}$  element, which is zero. In aggregate data, the individual decisions from which bank to borrow are unobserved. So we need to formulate the probability of switching to borrow from bank  $i$  unconditional of the rival's identity. Therefore, the probability that the borrower who borrowed from one of bank  $i$ 's rivals in the previous period switches to borrow from bank  $i$  in current period is:

$$Pr_{i R \rightarrow i, t} = \sum_{j \neq i} (f\{p_{i, t} + s, \mathbf{p}_{i R, t} + \mathbf{s}_j\} * \frac{y_{1, j, t-1}}{\sum_{k \neq i} y_{1, k, t-1}}) \quad (3.3)$$

where  $Pr_{i R \rightarrow i, t}$  is the probability that a customer who borrowed from the bank  $i$ 's rivals will switch to borrow from bank  $i$  in current period.  $y_{1, j, t-1}$  is denoted as bank  $j$ 's total loans in period  $t-1$ .  $\frac{y_{1, j, t-1}}{\sum_{k \neq i} y_{1, k, t-1}}$  denotes the probability that a randomly selected rival's borrower is one who borrows from bank  $j$  in the previous period.

Since a higher relative interest rate on loans charged by bank  $i$  will lower the probability that any customer will borrow from it, the partial derivative of Equation (3.1) and Equation (3.3) should have the following properties:

$$\frac{\partial Pr_{i \rightarrow i,t}}{\partial p_{i,t}} < 0, \frac{\partial Pr_{i \rightarrow i,t}}{\partial p_{iR,t}} > 0. \quad (3.4)$$

and

$$\frac{\partial Pr_{iR \rightarrow i,t}}{\partial p_{i,t}} < 0, \frac{\partial Pr_{iR \rightarrow i,t}}{\partial p_{iR,t}} > 0. \quad (3.5)$$

Then, the total demand of bank  $i$  at time  $t$  is formulated as follows,

$$y_{1,i,t} = y_{1,i,t-1}Pr_{i \rightarrow i,t} + y_{1,iR,t-1}Pr_{iR \rightarrow i,t} \quad (3.6)$$

where  $y_{1,i,t}$  is the bank  $i$ 's total demand of loans at period  $t$ .

By applying the law of large numbers, the first term on the right hand side of equation (3.6) shows the number of the bank  $i$ 's "loyal" customers who continue to borrow from it. The second term on the right hand side of equation (3.6) approximates the number of the rivals' customers who choose to switch to borrow from bank  $i$ .<sup>39</sup>

Taking into account the market growth rate,  $g_t = \frac{\sum y_{1,i,t}}{\sum y_{1,i,t-1}}$ , the function of total demand of loans becomes:

$$y_{1,i,t} = (y_{1,i,t-1}Pr_{i \rightarrow i,t} + y_{1,iR,t-1}Pr_{iR \rightarrow i,t})g_t \quad (3.7)$$

By taking a first-order (linear) approximation on the transition probabilities, the transition probabilities becomes the functions of the interest rate on loans charged

---

<sup>39</sup> We assume the number of customers is fixed.

by bank  $i$ , the average interest rate on loans charged by bank  $i$ 's rivals and the switching cost.

$$Pr_{i \rightarrow i,t} = \alpha_0^i + \alpha_1 p_{i,t} + \alpha_2 (\bar{p}_{i,R,t} + s) \quad (3.8)$$

where  $p_{i,t}$  is the interest rate charged by the bank  $i$ ,  $\bar{p}_{i,R,t}$  is the average interest rate charged by the rival banks and  $s$  is the switching cost.

$$Pr_{j \rightarrow i,t} = \alpha_0^i + \alpha_1 (p_{i,t} + s) + \alpha_2^* I'(\mathbf{p}_{i,R,t} + \mathbf{s}_j) \quad (3.9)$$

where  $\mathbf{s}_j$  is an  $(n-1)$  vector of switching costs, in which each of the elements equal  $s$ , except  $j$ th element, which is zero. Equation (3.9) can be written as:

$$Pr_{j \rightarrow i,t} = \alpha_0^i + \alpha_1 (p_{i,t} + s) + \alpha_2^* (\sum_{j \neq i} p_{j,t} + (n-2)s) \quad (3.10)$$

For  $\alpha_2^* = \frac{\alpha_2}{n-1}$

$$Pr_{j \rightarrow i,t} = \alpha_0^i + \alpha_1 (p_{i,t} + s) + \alpha_2 \left( \bar{p}_{i,R,t} + \frac{n-2}{n-1} s \right) \quad (3.11)$$

This equation is not a function of bank  $j$ , thus it is also the transition probability of a randomly selected rivals' customer:

$$Pr_{i,R \rightarrow i,t} = \alpha_0^i + \alpha_1 (p_{i,t} + s) + \alpha_2 \left( \bar{p}_{i,R,t} + \frac{n-2}{n-1} s \right) \quad (3.12)$$

where  $\alpha_0^i$ ,  $\alpha_1$  and  $\alpha_2$  from equation (3.8) and (3.12) are coefficients.  $\alpha_0^i$  represents the bank-specific heterogeneity.  $\alpha_1$  measures the sensitivity of the transition probability to the bank's own interest rate. It is assumed that  $\alpha_1 < 0$  since the higher probability of borrowing from bank  $i$ , the lower interest rate on loans charged by the bank.  $\alpha_2$  is the cross-price sensitivity.

We know the transition probability that the borrower borrows from bank  $i$  should be decreasing in the interest rate charged by bank  $i$  and increasing in the average interest rate of its rivals. Then, the partial derivatives of equation (3.8) and (3.12) should have the following signs:

$$\frac{\partial Pr_{i \rightarrow i,t}}{\partial p_{i,t}} = \frac{\partial Pr_{i R \rightarrow i,t}}{\partial p_{i,t}} = \alpha_1 < 0 \quad (3.13)$$

and

$$\frac{\partial Pr_{i \rightarrow i,t}}{\partial \bar{p}_{i R,t}} = \frac{\partial Pr_{i R \rightarrow i,t}}{\partial \bar{p}_{i R,t}} = \alpha_2 > 0 \quad (3.14)$$

Because the borrowers are assumed to have an inelastic demand for loans, a small increase of  $p_{i,t}$  should have the same effect on the transition probabilities as the same size decrease of  $\bar{p}_{i R,t}$ . This implies  $\alpha_2 = -\alpha_1$ . Hence, we can rewrite the function of transition probabilities:

$$Pr_{i \rightarrow i,t} = \alpha_0^i + \alpha_1(p_{i,t} - \bar{p}_{i R,t} - s) \quad (3.15)$$

and

$$Pr_{i R \rightarrow i,t} = \alpha_0^i + \alpha_1(p_{i,t} - \bar{p}_{i R,t} - \frac{s}{n-1}) \quad (3.16)$$

From equations (3.15) and (3.16), we take the partial derivatives with respect to switching cost  $s$ , we know  $\frac{\partial Pr_{i \rightarrow i,t}}{\partial s} = -\alpha_1 > 0$  and  $\frac{\partial Pr_{i R \rightarrow i,t}}{\partial s} = \frac{\alpha_1}{n-1} < 0$ . Hence, the higher the switching cost, the higher the proportion of the bank's customer will stay, but the lower the proportion of its rivals' customers will choose to switch to the bank  $i$ .

Then, by substituting (3.15) and (3.16) into the total demand equation (3.7), and dividing by the market demand in the period  $t$ , the market share of bank  $i$  in period  $t$   $\sigma_{i,t}$  is :

$$\sigma_{i,t} = -\sigma_{i,t-1} \frac{n}{n-1} s \alpha_1 + \alpha_0^i + \alpha_1 (p_{i,t} - \bar{p}_{iR,t} + \frac{s}{n-1}) \quad (3.17)$$

Since  $\alpha_1$  is negative, the lock-in effect can be represented as

$$\frac{\partial \sigma_{i,t}}{\partial \sigma_{i,t-1}} = -\frac{n}{n-1} s \alpha_1 > 0 \quad (3.18)$$

The positive lock-in effect shows that the more that a customer bases the bank lock-in during the last period, the more customers this bank has in the current period. It can be also known that the lock-in effect is increasing by the magnitude of switching costs because of,

$$\frac{\partial (\frac{\partial \sigma_{i,t}}{\partial \sigma_{i,t-1}})}{\partial s} = -\frac{n}{n-1} \alpha_1 > 0 \quad (3.19)$$

The switching-cost effect can then be shown as:

$$\frac{\partial \sigma_{i,t}}{\partial s} = \left( \frac{1}{n} - \sigma_{i,t-1} \right) \frac{n}{n-1} \alpha_1 \begin{cases} < 0 & \text{if } \sigma_{i,t-1} < 1/n \\ > 0 & \text{if } \sigma_{i,t-1} > 1/n \end{cases} \quad (3.20)$$

The switching-cost effect is the effect of switching costs on market shares. This effect favours larger-than-average banks relative to smaller-than-average banks. This intuition is that the larger the bank's market share is, the more the customers will be "locked-in" with it.

### 3.2.6.4 Supply Side

Bank  $i$  maximizes the present value of its profits in every period  $\tau$ :

$$V_{i,\tau} = \sum_{t=\tau}^{\infty} \delta^{t-\tau} \pi_{i,t} \quad (3.21)$$

where  $\delta$  is the one-period discount factor and  $\pi_{i,t}$  is the bank's profit in period  $t$ .

The profit is

$$\pi_{i,t} \equiv y_{i,t} * p_{i,t} - C_{i,t} \quad (3.22)$$

where  $C_{i,t} = C\{\mathbf{w}_{i,t}, y_{i,t}\}$  is the total costs of loans, which is a function of its output supplied and a vector of input prices. Taking first order condition with respect to  $p_{i,\tau}$  will get the optimal interest rate charged by bank  $i$  at period  $\tau$ :

$$\frac{\partial V_{i,\tau}}{\partial p_{i,\tau}} = \sum_{t=\tau}^{\infty} \delta^{t-\tau} \frac{\partial \pi_{i,t}}{\partial p_{i,\tau}} = 0 \quad (3.23)$$

As shown in Kim et al. (2003), the above optimal interest rate strategy can be expressed as follows (for the derivation of equation 3.24 refer to Appendix A.1):

$$pcm_{i,t} = -\delta \cdot \sigma_{i,t+1} \frac{n}{n-1} s g_{t+1} - \frac{\sigma_{i,t}}{\alpha_1} \quad (3.24)$$

where  $pcm_{i,t} = p_{i,t} - mc_{i,t}$  is the price-cost margin in period  $t$ .

Equation 3.24 shows the relation between the price-cost margin of loans ( $pcm$ ), the market shares ( $\sigma$ ), and the switching costs ( $s$ ). The price-cost margin is usually taken as an indicator of market power because the larger the margin, the larger the difference between the price and the competitive price will be. The first term on the RHS represents the benefits to the bank from capturing customers in period  $t$  who will be "locked-in" in future periods. The larger this benefit is (a higher  $s$  or



$g_{t+1}$ ), the lower will be the optimal period  $t$  price-cost margin, in an attempt to capture these customers. The second term on the RHS of this equation represents the current period oligopoly power of the bank. The larger the current market share is, the larger will be the price-cost margin. When switching costs exist, the bank charges a lower interest rate on loans than indicated by the pure oligopoly power ( $-\delta \cdot \sigma_{i,t+1} \frac{n}{n-1} < 0$  then  $pcm_{i,t} < -\frac{\sigma_{i,t}}{\alpha_1}$ ) which they use as “investments” to lock in customers. Therefore, the market share ( $\sigma_{i,t}$ ) is larger than it would be without “the investment” (Yuan, 2010).

### 3.2.7 Empirical methodology

Kim et al. (2003) provide two equations to estimate

$$pcm_{i,t} = -\delta \cdot \sigma_{i,t+1} \frac{n}{n-1} s g_{t+1} - \frac{\sigma_{i,t}}{\alpha_1} + u_{i,t} \quad (3.25)$$

where  $u_{i,t}$  is an error term.

and

$$\sigma_{i,t} = -\sigma_{i,t-1} \frac{n}{n-1} s \alpha_1 + \alpha_0^i + \alpha_1 \left( p_{i,t} - \bar{p}_{i,R,t} + \frac{s}{n-1} \right) + \epsilon_{i,t} \quad (3.26)$$

where  $\epsilon_{i,t}$  is an error term.

To eliminate the numerous fixed effects ( $\alpha_0^i$ ), the market share equation (3.26) is first- order differenced:

$$\Delta \sigma_{i,t} = -\Delta \sigma_{i,t-1} \frac{n}{n-1} s \alpha_1 + \alpha_1 (\Delta p_{i,t} - \Delta \bar{p}_{i,R,t}) + \epsilon_{i,t}' \quad (3.27)$$

where  $\Delta$  denotes first-order difference.  $\epsilon_{i,t}'$  is an error term.

To obtain the price-cost margin in equation (3.25), we estimate the margin costs implied by the trans-log cost function and its associated input cost share equations.

Using the second-order Taylor-series approximation, bank  $i$ 's time-variant trans-log cost function (one output, three inputs) is as follows:

$$\begin{aligned} \ln C_{i,t} = & \beta_0 + \delta_1 \ln y_{1,i,t} + \sum_k \beta_k \ln w_{k,i,t} + \frac{1}{2} \left( \sum_k \sum_l \beta_{kl} \ln w_{k,i,t} \ln w_{l,i,t} \right. \\ & \left. + \delta_{11} (\ln y_{1,i,t})^2 \right) + \sum_k \gamma_{1k} \ln y_{1,i,t} \ln w_{k,i,t} + \omega_{i,t} \end{aligned} \quad (3.28)$$

where  $\omega_{i,t}$  is an error term,  $k=1,2,3$  and  $l=1,2,3$

From Shephard's lemma, the input cost share equations can be written in deterministic form as

$$Sh_{k,i} = \frac{\partial \ln TC_{i,t}}{\partial \ln w_{k,i,t}} = \frac{w_{k,i,t} x_{k,i,t}}{TC_{i,t}} = \beta_k + \sum_l \beta_{kl} \ln w_{l,i,t} + \gamma_{1k} \ln y_{1,i,t} \quad (3.29)$$

where  $Sh_{k,i}$  is the share of the  $k$ th factor in bank  $i$ 's period  $t$  production cost.  $C_{i,t}$  is the total cost of bank  $i$  in period  $t$ , and  $y_{1,i,t}$  is bank  $i$ 's loans in period  $t$ .  $w_{l,i,t}$  are exogenous input prices of bank  $i$  in period  $t$ .

The following restrictions for symmetry and linear homogeneity in prices are imposed on the trans-log cost system:

$$\beta_{kl} = \beta_{lk}, \forall k, l; \sum_k \beta_k = 1; \sum_k \gamma_{1k} = 0; \sum_l \beta_{kl} = 0, \forall k. \quad (3.30)$$

Then, the marginal cost can be written as

$$mc_{i,t} = \frac{\partial C_{i,t}}{\partial y_{1,i,t}} = \frac{C_{i,t}}{y_{1,i,t}} (\delta_1 + \delta_{11} \ln y_{1,i,t} + \sum_k \gamma_{1k} \ln w_{k,i,t}) \quad (3.31)$$

The first order condition (equation 3.25), the market share equation (equation 3.27), and the trans- log cost system including inputs share equations<sup>40</sup> (equation 3.28 and 3.29) are jointly estimated using the non-linear 3SLS approach<sup>41</sup>. A GMM approach<sup>42</sup> is used as a robustness test. A positive  $s$  is our basic indication for the existence of customer switching costs in the market for bank loans. Since demand should be downward sloping, then  $\alpha_1$  must be a negative sign to ensure the validity of this model.

### 3.2.8 Summary

This section has reviewed the theoretical and empirical literature of switching costs. In order to estimate the magnitude and significance of switching costs, a structural model that builds on Kim et al. (2003) is applied. In this structural model, the first order condition equation (equation 3.25), a market share equation (equation 3.27), and the trans- log cost system including inputs share equations (equation 3.28 and 3.29) are jointly estimated using the non-linear (3SLS) approach. A GMM approach is used as a robustness test.

---

<sup>40</sup> Since the sum of three input shares is equal to unity, one share equation is deleted from the system to avoid singularity problem.

<sup>41</sup> 3SLS is the combination of 2SLS and SUR. It can be used in a system of equations which contains endogenous variables and the residuals in each equation are also correlated.

<sup>42</sup> The estimation procedure of GMM is as follows: Let  $z = (z_1, z_2, \dots, z_n)$  be a set of instrumental variables used in each equation, for example,  $z_1$  are the instruments for Equation 3.43 (the first order condition equation).  $z$  is exogenous and not correlated with error terms. Utilizing the conditions  $E(z_i \varepsilon_i) = 0$ , where  $\varepsilon$  is the error term in each equation and  $i=1, 2, \dots, n$ , the moment

equations are  $m = \begin{bmatrix} z_1' \varepsilon_1 \\ \vdots \\ z_n' \varepsilon_n \end{bmatrix}$ . Then the general method of moment (GMM) estimator  $\theta$  is defined as

$\min_{\theta} m'(z' \Omega z)m$ , where  $\Omega$  is the optimal weighting matrix.

## **3.3 Data and variables**

### **3.3.1 Introduction**

My empirical strategy makes an inference about the magnitude and significance of switching costs based on observations on bank-level data from 18 licensed banks incorporated in Hong Kong during 1997 to 2012. In this section, the data and summary statistics are discussed in Section 3.3.2. Section 3.3.3 presents the key characteristics of Hong Kong banking industry. Section 3.3.4 introduces the data cleaning rules in detail. In addition. And Section 3.3.5 concludes the whole section 3.3.

### **3.3.2 Data**

The Asian financial crisis was in many ways a nightmare for many Asian countries. It induced a particularly destructive affect in many Asian countries' banking systems. By coincidence, it happened at the same time as the handover of Hong Kong back to Chinese control. Under the Basic Law, a "one country, two systems" policy was formulated, which meant that Hong Kong retained its own political and economic systems. Although the banks in Hong Kong escaped disaster, the Hong Kong banking industry passed through a difficult period during and after the Asian financial crisis (Chiu, 2003). Hong Kong's financial sector was hit again by the global financial crisis of 2007 to 2008. In order to study the switching costs for this interesting period, I have collected an unbalanced panel of Hong Kong bank level data for the period of 1997-2012 from Bankscope and the banks' own Annual

Reports.<sup>43</sup> The data are annual and cover 18 licensed banks in Hong Kong<sup>44</sup>. A sample of the banks is given in Appendix A.2. According to the statistics reported in the Hong Kong banking survey by KPMG (2013), these 18 banks have the largest market share in the Hong Kong banking industry. For the year 2012, the total assets of these 18 banks was HKD 11,681,441 million (which at that time was equal to USD 1,506,699 million)<sup>45</sup> which accounted for 78.62% of the whole market. The gross loans and advances of these banks was HKD 5,268,304 million (is equal to USD 679,518 million), which accounted for 94.6% of the total loans. Meanwhile, the ratio was 96.03% for the case of deposits<sup>46</sup>. All of the nominal data used for estimating the switching costs are deflated by the CPI (2009M10-2010M9=100) collected from DataStream.<sup>47</sup> Macro data (including real GDP, inflation, three- month Hong Kong Interbank Offered Rate (HKBOR) and wage

---

<sup>43</sup> The panel data is unbalanced because data for some banks are missing for some years. The data for 1997 is missing for the banks including ICBC (Asia), DBS Bank (Hong Kong ) Limited, Nanyang Commercial Bank Ltd, Wing Hang Bank Ltd, Wing Lung Bank Ltd, Chong Hing Bank Limited and Fubon Bank (Hong Kong) Limited. The data of 1997 to 1999 is missing for the Bank of China (Hong Kong) Limited and Standard Chartered Bank (Hong Kong) Limited. The unavailability of these observations is mainly because these banks are required to comply with the listing rules on disclosure set forth by the Hong Kong Stock Exchange. Therefore, these financial data are not released to public.

<sup>44</sup> Until June 2013, there were 21 licensed banks incorporated in Hong Kong, they are: Bank of China (Hong Kong) Limited, Bank of East Asia Limited, China Citic Bank International Limited, China Construction Bank (Asia) Corporation Limited, Chiyu Banking Corporation Limited, Chong Hing Bank Limited, Citibank (Hong Kong) Limited, Dah Sing Bank Limited, DBS Bank (Hong Kong) Limited, Fubon Bank (Hong Kong) Limited, Hang Seng Bank Limited, Hong Kong & Shanghai Banking Corporation Limited (HSBC), Industrial and Commercial Bank of China (Asia) Limited, Nanyang Commercial Bank Limited, Public Bank (Hong Kong) Limited, Shanghai Commercial Bank Limited, Standard Chartered Bank (Hong Kong) Limited, Tai Sang Bank Limited, Tai Yau Bank Limited, Wing Hang Bank Limited and Wing Lung Bank Limited. I exclude CitiBank (Hong Kong) Limited, Tai Sang Bank Limited and Tai Yau Bank Limited mainly because of the low availability of the data in the Banks' Annual Reports. In addition, the available data in Bankscope for these banks is inaccurate which inconsistent with the Banks' Annual Reports.

<sup>45</sup> 1 HKD= 0.1290 USD. Data source: Bloomberg. Date: 4<sup>th</sup> June 2014. This exchange rate is used throughout this thesis.

<sup>46</sup> According to the HKMA Annual Report (2012), in 2012, the total assets of all authorized banks in Hong Kong is HKD 14,859 billion, the total loans to customer is HKD 5,569 billion and the total deposits from customers is HKD 8,297 billion.

<sup>47</sup> Data Source: Census and Statistics Department, Hong Kong.

rate) were also collected from DataStream.<sup>48</sup> Financial data (including 3-month Treasury bill rates and 91-day exchange fund bill rates) are drawn from the International Financial Statistics (IMF) and Hong Kong Monetary Authority<sup>49</sup>. The definition and measurement of the variables used for estimating switching costs are presented in Table 3.1. In order to solve the endogeneity problem, the endogenous variables in the models, the time differences of the market shares ( $\sigma_{i,t-1}$ ,  $\sigma_{i,t}$ ,  $\sigma_{i,t+1}$ ), the interest rate on loans, and the bank loans are instrumented by various lags of the market shares up to 3 years,<sup>50</sup> one time period lag of the interest rate on loans, real GDP, inflation rate, Hong Kong Interbank Offered Rate (HIBOR) rate and the wage index of Hong Kong<sup>51</sup>. A Sargan test of over-identifying restrictions is applied to check the validity of instrumental variables and the results suggest that all of the instrumental variables are valid. Table 3.2 provides the definition and measurement of instrumental variables, which are not presented in Table 3.1. A summary of all the variables is given in Table 3.3 and Table 3.4.

---

<sup>48</sup> Inflation Rate and Wage Rate is calculated based on annually CPI and wage index.

Data Source of real GDP: Oxford Economics. Data Source of inflation rate: IMF. Data Source of wage index: Census and Statistics Department, Hong Kong.

Data Source of HKBOR: Hong Kong Monetary Authority.

<sup>49</sup> T-bill rates are weekly data and Exchange fund bill rates are daily data. I transfer all the data into annually by taking the average of the observations each year.

<sup>50</sup> Kim et al. (2003) also use various lags of the market shares as instrumental variables.

<sup>51</sup> Ho (2010) also uses a set of instrumental variables includes HIBOR and wage index when estimating marginal costs using trans-log cost function for Hong Kong banking industry.

**Table 3.1 The definition and measurement of variables**

Variable name	Definition of each variables
$C_{i,t}$	The total cost of bank $i$ at time $t$ . Where $C_{i,t}$ = Total operating expenses+ interest expenses.
$y_{1,i,t}$	The loans of bank $i$ at time $t$ . <sup>52</sup>
$L_{i,t}$	The number of labour of bank $i$ at time $t$ .
$FA_{i,t}$	The fix assets of bank $i$ at time $t$ .
$D_{i,t}$	The deposits of bank $i$ at time $t$ .
$w_{1,i,t}$	The exogenous input prices on labour. where $w_{1,i,t}$ = personal expenses/ numbers of labour
$w_{2,i,t}$	The exogenous input price on capital. where $w_{2,i,t}$ = non personal expenses/fix assets =(total operating expenses-personal expenses)/fix assets
$w_{3,i,t}$	The exogenous input price on deposits. where $w_{3,i,t}$ =Interest expenses/total deposits
$Sh_{1,i}$	The labour costs share in bank $i$ 's time $t$ . Where $Sh_{1,i,t} = w_{1,i,t}L_{i,t}/TC_{i,t}$
$Sh_{2,i}$	The capital costs share in bank $i$ 's time $t$ . Where $Sh_{2,i,t} = w_{2,i,t}FA_{i,t}/TC_{i,t}$
$Sh_{3,i}$	The deposits costs share in bank $i$ 's time $t$ . Where $Sh_{3,i,t} = w_{3,i,t}D_{i,t}/TC_{i,t}$
$\delta$	3-month Treasury bill rates.
$g_t$	The market growth rate on loans at time $t$ . where $g_t = \sum y_{i,t} / \sum y_{i,t-1}$ .
$n$	The number of banks at time $t$
$\sigma_{i,t}$	The market share measured by value of loans of bank $i$ at time $t$ .
$p_{i,t}$	The interest rate on loans of bank $i$ at time $t$ .
$\bar{p}_{iR,t}$	The average interest rate on loans of bank $i$ 's rivals at time $t$ .

<sup>52</sup> Due to data limitations, the types of loan cannot be distinguished. For instance, consumer and corporate loans.

**Table 3.2 The definition and measurement of instrumental variables (apart from presented variables in Table 3.1)**

Variable name	Definition of each variables
$rgdp_t$	Real GDP in Hong Kong
$infl_t$	Inflation rate in Hong Kong
$HIBOR_t$	Hong Kong Interbank Offered Rate
$wage_t$	Wage rate in Hong Kong

**Table 3.3 Summary statistics (HKD million)**

Variable	Obs.	Mean	S.D.	Min	Max
$C_{i,t}$	275	8,240.21	13,597.22	339.53	87,402.99
$y_{1,i,t}$	275	136,791.70	196,141.00	6,390.81	1,162,937.00
$L_{i,t}$	278	3,656.57	4,660.13	257.00	24,038.00
$FA_{i,t}$	275	4,908.95	8,434.44	48.08	48,800.94
$D_{i,t}$	275	253,646.40	422,455.90	9,098.66	2,414,710.00
$w_{1,i,t}$	274	0.38	0.14	0.16	1.33
$w_{2,i,t}$	274	0.56	0.78	0.08	5.36
$w_{3,i,t}$	275	0.03	0.02	0.00	0.15
$S_{1,i}$	274	0.22	0.10	0.06	0.44
$S_{2,i}$	274	0.19	0.11	0.04	0.62
$S_{3,i}$	275	0.60	0.19	0.15	0.87
$\delta$	288	0.03	0.02	0.00	0.07
$g_t$	270	1.07	0.08	0.93	1.27
$n$	288	18	0	18	18
$\sigma_{i,t}$	275	0.05	0.07	0.00	0.33
$p_{i,t}$	275	0.06	0.02	0.02	0.16
$\bar{p}_{iR,t}$	288	0.06	0.02	0.03	0.11
$rgdp_t$	288	1,504,833.00	287,515.70	1,122,294.00	1,965,153.00
$infl_t$	288	0.01	0.03	-0.04	0.06
$HIBOR_t$	288	0.03	0.03	0.00	0.08
$wage_t$	288	0.01	0.02	-0.02	0.06

*Note: all the nominal data in the table are deflated by CPI.*



**Table 3.4 Summary statistics- year 1999, 2007 and 2012 (HKD million)**

Variable	1999		2007		2012	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
$C_{i,t}$	7,769.42	15,101.08	13,841.15	20,864.78	8,380.26	10,169.25
$y_{1,i,t}$	63,966.86	109,921.84	153,173.66	197,682.07	238,266.61	301,058.95
$L_{i,t}$	2,704.41	3,866.18	3,937.00	4,805.67	4,127.11	5,021.21
$FA_{i,t}$	3,361.18	5,705.74	4,247.71	7,016.24	9,144.47	14,815.51
$D_{i,t}$	118,241.80	222,064.99	308,428.93	493,118.32	410,427.92	600,138.89
$w_{1,i,t}$	0.29	0.05	0.42	0.09	0.53	0.25
$w_{2,i,t}$	0.28	0.31	0.69	0.63	0.89	1.49
$w_{3,i,t}$	0.05	0.01	0.04	0.01	0.01	0.01
$Sh_{1,i}$	0.11	0.02	0.14	0.03	0.27	0.06
$Sh_{2,i}$	0.09	0.03	0.12	0.05	0.24	0.11
$Sh_{3,i}$	0.80	0.03	0.74	0.06	0.49	0.14
$\delta$	0.05	0.00	0.03	0.00	0.0012	0.00
$g_t$	0.99	0.00	1.14	0.00	1.04	0.00
n	18	0.00	18	0.00	18	0.00
$\sigma_{i,t}$	0.04	0.08	0.06	0.07	0.06	0.07
$p_{i,t}$	0.10	0.01	0.07	0.01	0.05	0.01
$\bar{p}_{iR,t}$	0.10	0.00	0.07	0.00	0.05	0.00
$rgdp_t$	1,150,426.00	0.00	1,735,703.00	0.00	1,965,153.00	0.00
$infl_t$	-0.04	0.00	0.02	0.00	0.04	0.00
$HIBOR_t$	0.06	0.00	0.04	0.00	0.00	0.00
$wage_t$	0.03	0.00	0.02	0.00	0.01	0.00

*Note: all the nominal data in the table are deflated by CPI.*

In order to find out the variation of all of the variables over time, I will break the whole period year by year. Table 3.4 shows the summary of all the variables for the years 1999, 2007 and 2012, which represent the early, middle and late parts of the sample, respectively. From the table, it seems that Hong Kong banking industry has grown steadily. In the year 1999, the average bank loans were HKD 63,966.86 million (USD 8,251.72 million), the average fix assets was HKD 3,361.18 million (USD 433.59 million), the average customer deposits was HKD 118,241.80 million (USD 15,253.19 million). After thirteen years of development, these numbers have grown about three times by the year 2012. In 2012, the average bank loans sharply went up to HKD 238,266.61million (USD 30,736.39 million), the average fix assets were HKD 9,144.47 million (USD 1,179.59 million) and the average customer deposits increased to HKD 410,427.92 million (USD 52,945.20 million). It is worth noting that average total costs peaked at HKD 13,841.15 million (USD 1,785.51 million) in 2007, and the numbers in 2012 were only slightly larger than that in 1999. This is mainly due to the increase of interest expenses, which come from the high average lending rate in Hong Kong in 2007. Since the subprime crisis broke in August 2007, an influx of hot money into Hong Kong followed the Fed's quantitative easing policy, and then the lending rate began to decline. In addition, both the average price of labour and the average price of capital increased steadily while the price of deposits decreased gradually.

### 3.3.3 Data cleaning rules

The bank level data were collected from Bankscope and banks' Annual Reports. Bankscope is a widely used database that provides comprehensive account statements and financial information of banks. Thus, the sample spans 16 years from 1997 to 2012. In some cases, data from the consolidated statement may contain redundant information. Therefore, when an unconsolidated statement and a consolidated statement are both available, the unconsolidated statement is selected. However, for most banks in the Hong Kong market I will keep the consolidated data because there are large numbers of unconsolidated data that are missing. All of the data collect from Bankscope are checked with the banks' Annual Reports.<sup>53</sup> I have replaced incoherent data which differs from the Annual Reports. I also have eliminated observations that have negative and missing values for the needed variables.<sup>54</sup>

#### 3.3.3.1 Interest rate on loans

Since the interest rate on loans are not reported in bank statements and other databases, I calculate the interest rate on loans by using following equation (Matthews and Zhang, 2010)<sup>55</sup>.

---

<sup>53</sup> All the data of Hong Kong & Shanghai Banking Corporation Limited (HSBC) is collected from Annual Reports because the data in Bankscope is consolidated statements of the bank and its subsidiary and associated companies of Asia-Pacific region. The personal expenses in Hong Kong region are unavailable and can be calculated using personal expenses in Asia-Pacific region times the ratio of employees in Hong Kong by the total employees in Asia-Pacific region.

<sup>54</sup> For instance, the observation of 2001 personal expenses for Chiyu Bank (Hong Kong) is missing.

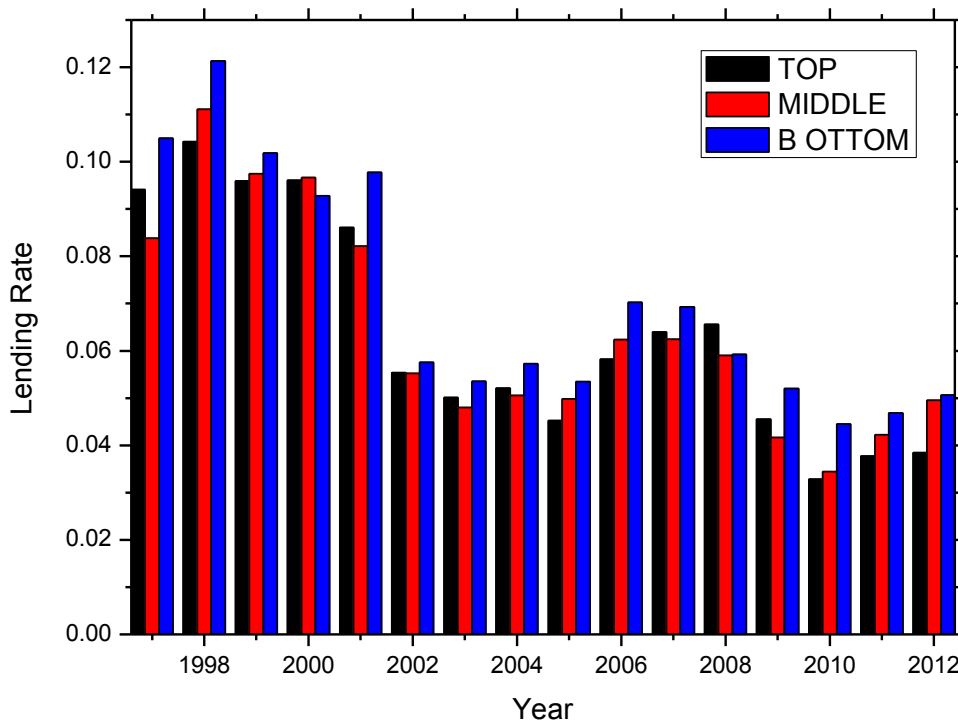
<sup>55</sup> The derivation of equation (3.32) is as follows.  $r_E = \frac{IE}{TE} = \frac{IL+IO}{TE} = \frac{IL}{TE} + \frac{IO}{TE} = \frac{IL}{y_1} * \frac{y_1}{TE} + \frac{IO}{O} * \frac{O}{TE} = p * \left(\frac{y_1}{TE}\right) + r_O * \left(\frac{O}{TE}\right)$  where  $r_E$  is interest rate on earning assets, IE is interest earning, TE is total

$$p = \left[ \left( r_E - r_O * \frac{O}{TE} \right) * \frac{TE}{y_1} \right] \quad (3.32)$$

where  $p$  is the interest rate on loans,  $r_E$  is the interest rate on earning assets,  $r_O$  is the interest rate on other earning assets (in calculation, 91-day exchange fund bill rates are treated as interest rate on other earning assets),  $O$  is the other earning assets,  $TE$  is the total earning assets, and  $y_1$  is the loans.  $O$ ,  $TE$  and  $y_1$  can be obtained from the bank balance sheet.

Figure 3.5 below plots the interest rate on loans for 3 bank groups.

**Figure 3.5 Interest rate on loans for 3 banks groups**




---

earning assets,  $IL$  is interest earnings on loans,  $IO$  is interest earnings on other earning assets,  $y_1$  is loans,  $O$  is other earning assets,  $p$  is the interest rate on loans and  $r_O$  is the interest rate on other earning assets.

I have classified all of the banks into three groups according to their market share, as measured by bank loans in 2012. I use average the interest rate on loans of the top three banks (i.e. HSBC, Bank of China and Hang Seng) to represent the lending rate of large banks, the average interest rate on loans from three banks in the middle group (i.e. Nanyang Commercial Bank, Wing Hang and CITIC) to represent the lending rate of middle banks, and the average interest rate on loans from three banks in the bottom group (i.e. Fubon, Chiyu and Public) to present the lending rate of small banks. Figure 3.5 illustrates the changes of interest rate over the period from 1997 to 2012. In general, there is no great difference in interest rate on loans between these three groups. The only exceptions are for some particular years, such as 2000 and 2008, when the interest rates on the loans from small banks were slightly lower than those of large and middle banks.

### **3.3.3.2 The number of employees**

Due to the lack of data on the number of employees, I have calculated the number of employees using following methods (Matthews et al., 2007).

For bank  $i$ , if the observations are only unavailable for certain years, then I have calculated the growth rate of prices of labour for other years. I have then taken an average and forecast the price of labour for the missing data years. After which, the unknown observations can be calculated using forecasted price labour divided by the personal expenses<sup>56</sup>. If data is unavailable for bank  $i$  over the whole period,

---

<sup>56</sup> For example, the number of labor of SCB (Hong Kong) is missing from 2008 to 2012. In order to calculate the 2008 staff number, I firstly calculate the growth rate of price of labor for each year

then I assume that in a competitive market, bank  $i$  and  $j$ , which are the same size,<sup>57</sup> should have a similar price for labour. Then, the following equation should hold:

$$p_{l,i,t} = \frac{PE_{i,t}}{L_{i,t}} = \frac{PE_{j,t}}{L_{j,t}} = p_{l,j,t} \quad (3.33)$$

where  $p_{l,i,t}$  is the labour price of bank  $i$  at time  $t$ ,  $p_{l,j,t}$  is the labor price of bank  $j$  at time  $t$ ,  $PE_{i,t}$  is the personal expenses of bank  $i$  at time  $t$ ,  $PE_{j,t}$  is the personal expenses of bank  $j$  at time  $t$ ,  $L_{i,t}$  is the number for labour of bank  $i$  at time  $t$ ,  $L_{j,t}$  is the number for labour bank  $j$  at time  $t$ .

Therefore, the number for labour of bank  $i$ ,  $L_{i,t}$ , is<sup>58</sup>

$$L_{i,t} = \frac{PE_{i,t} * L_{j,t}}{PE_{j,t}} \quad (3.34)$$

### 3.3.4 Summary

My database consists of an unbalanced panel of annual observations for the Hong Kong banking industry, spanning the 16 years from 1997 to 2012. The sample covers 18 licensed banks incorporated in Hong Kong in that period. These 18 banks occupy a large proportion of the market share of the Hong Kong banking

---

by using the following formula,  $g_t = \frac{\frac{PE_{t+1}}{L_{t+1}}}{\frac{PE_t}{L_t}} - 1$ , where  $g_t$  is the growth rate of prices of labor, PE is personal expenses, L is the number of labor. Then I take average of each year to obtain the average growth rate which is 0.15878. Since the price of labor for 2007 is 0.63939, the price of labor for 2008 is equal to  $0.63939 * (1 + 0.15878) = 0.7408$ . After that, the number of labor for 2008 can be calculate as Personal expenses of 2008 divided by the price of labor 2008 which is about 5466.

<sup>57</sup> Total assets or net loans are used for comparison.

<sup>58</sup> The numbers of labor for the following banks are calculated using Equation (3.34): Chiyu Banking Corporation Limited, Chong Hing Bank Limited, DBS Bank (Hong Kong) Limited, Fubon Bank (Hong Kong) Limited, Nanyang Commercial Bank Limited and Public Bank (Hong Kong) Limited.

industry. Among these banks, HSBC (Hong Kong) is the largest and it has the largest market share. The main characteristics of the Hong Kong banking industry during the sample periods have also been introduced. It has been shown that the shock wave from the Asian financial crisis still has an effect on the Hong Kong banking industry, which can be seen in the major indicators of bank performance, such as the amount of banks loans and deposits. Data cleaning rules have also been introduced in detail in this section.

## **3.4 Empirical study and results**

### **3.4.1 Introduction**

In this section, the unbalanced panel of Hong Kong bank level data for the period 1997 to 2012 is used to estimate the magnitude and significance of switching costs. The results from the joint estimation of a first-order condition (equation 3.25), market share equation (equation 3.27), and cost system (equation 3.28 and 3.29) using non-linear 3SLS are presented. The results of a robustness test using a GMM approach is also shown in this section.

### **3.4.2 Empirical results**

The first order condition (equation 3.25), the market share equation (equation 3.27), and the trans-log cost system including inputs share equations (equation 3.28 and 3.29) are jointly estimated using the non-linear 3SLS approach. In contrast to Kim (1985), bank loans  $y_1$  (output) are treated as an endogenous variable since they are

correlated with the shock  $u_{i,t}$  in equation 3.25. The reason for this is that the unobserved supply shocks are captured by the error term and the bank loans depend on this unobserved supply shock. In order to solve the endogeneity problem, the endogenous variables in these models use the time differences of the market shares ( $\sigma_{i,t-1}$ ,  $\sigma_{i,t}$ ,  $\sigma_{i,t+1}$ ), the interest rate on loans, and the bank loans, which are instrumented by various lags of the market shares up to 3 years,<sup>59</sup> one time period lag of the interest rate on loans, real GDP, inflation rate, Hong Kong Interbank Offered Rate (HIBOR) rate and the wage rate of Hong Kong<sup>60</sup>.

Table 3.7 shows the estimated results of trans-log cost system and switching costs equations from 1997 to 2012 using non-linear 3SLS. The first, second, and last column of this table describe the variables in the model, the parameters and the coefficients of estimation, respectively. In a trans-log cost system, all of the variables are in logarithmic form. All of the explanatory variables are normalized by their sample means. According to the results, the coefficient of bank loans  $\delta_1$  is positive and significant at 0.8942. This refers to the elasticity of total cost w.r.t. bank loans, at the means of the data (the derivation can be seen in Appendix A.3). By looking into the influence of bank inputs prices on total costs, it can be found that all of the coefficients of exogenous input prices are positive and significant. The coefficient of input prices on labour is 0.1581. The coefficient of the input prices on capital is 0.1591 and the coefficient of the input prices on deposits, which is higher than the other two, is equal to 0.6828.

---

<sup>59</sup> Kim et al. (2003) also use various lags of the market shares as instrumental variables.

<sup>60</sup> Ho (2010) also uses a set of instrumental variables includes HIBOR and wage index when estimating marginal costs using translog cost function for Hong Kong banking industry.



**Table 3.7 System estimation of trans-log cost system and switching costs equations using non-linear 3SLS. Included observation=275. Standard errors are in parenthesis <sup>61</sup>**

Variable	Parameter	Coefficient
Equation (3.28): Dependent Variable $\ln C$		
Constant	$\beta_0$	9.1098*** (0.0496)
$\ln y_{1,i,t}$	$\delta_1$	0.8942*** (0.0581)
$\frac{1}{2} \ln y_{1,i,t}^2$	$\delta_{11}$	0.0109 (0.0103)
$\ln y_{1,i,t} \ln w_{1,i,t}$	$\gamma_{11}$	-0.0447** (0.0211)
$\ln y_{1,i,t} \ln w_{2,i,t}$	$\gamma_{12}$	-0.0426*** (0.0187)
$\ln y_{1,i,t} \ln w_{3,i,t}$	$\gamma_{13}$	0.0873*** (0.0329)
$\ln w_{1,i,t}$	$\beta_1$	0.1581*** (0.0170)
$\ln w_{2,i,t}$	$\beta_2$	0.1591*** (0.0140)
$\ln w_{3,i,t}$	$\beta_3$	0.6828*** (0.0270)
$\frac{1}{2} \ln w_{1,i,t}^2$	$\beta_{11}$	0.0869*** (0.0180)
$\frac{1}{2} \ln w_{2,i,t}^2$	$\beta_{22}$	0.0760*** (0.0191)
$\frac{1}{2} \ln w_{3,i,t}^2$	$\beta_{33}$	0.2037*** (0.0167)
$\ln w_{1,i,t} \ln w_{2,i,t}$	$\beta_{12}$	0.0204 (0.0181)
$\ln w_{1,i,t} \ln w_{3,i,t}$	$\beta_{13}$	-0.1073*** (0.0102)
$\ln w_{2,i,t} \ln w_{3,i,t}$	$\beta_{23}$	-0.0964*** (0.0084)
Equation (3.25) and (3.27): Dependent Variable $pcm$ and $\Delta\sigma$		
<b>Parameter</b>		<b>Coefficient</b>
$s$		0.1947*** (0.0675)
$\alpha_I$		-4.7367*** (0.6638)

<sup>61</sup> Note: 1: \* indicates 10% significance level, \*\* indicates 5% significance level, \*\*\* indicates 1% significance level. Note 2: The restrictions for symmetry and linear homogeneity in prices  $\sum_k \beta_k = 1$ ;  $\sum_k \gamma_{1k} = 0$ ;  $\sum_l \beta_{kl} = 0$  are imposed. Note 3: Since the above restrictions are imposed directly into the Eviews files, therefore the standard errors of  $\ln y_{1,i,t} \ln w_{1,i,t}$ ,  $\ln w_{3,i,t} \cdot \frac{1}{2} \ln w_{1,i,t}^2$ ,  $\frac{1}{2} \ln w_{2,i,t}^2$  and  $\frac{1}{2} \ln w_{3,i,t}^2$  are calculated by hand. In the Eviews, the standard errors of the reported coefficients are the square roots of the diagonal elements of the coefficient covariance matrix. The formula of calculating standard error for sum of two variables is  $se_{1+2} = \sqrt{se_1^2 + se_2^2 + 2covariance_{1,2}}$ . The covariance matrix is shown in Appendix A.4.

The point estimate of the switching costs  $s$ , based on the entire sample, is 0.1947, which is statistically significant at the 1% significant level. The positive  $s$  indicates the existence of switching costs in the bank loans market in Hong Kong. This model prices all kinds of switching barriers into switching costs. There are two major switching patterns in the market. One is that a borrower may terminate the loan agreement when sufficiently better loan contract are provided by a rival bank. Another is that a borrower may consider switching to other banks after maturity of the loan. The switching costs may be underestimated because the model assumes that all of the changes in the market shares are driven by switching behaviour. This assumption overestimates the number of switchers and then, therefore, underestimates switching costs. These results are consistent with Yuan's (2010) study of 32 OECD and developing countries, which presents the maximize value of switching costs in Hong Kong is significant at 0.15. Compared with the results of Kim et al. (2003) in their study of the Norwegian banking industry, in which the average point estimate of switching costs is about 4.1% in Norway, the result of switching costs in Hong Kong bank loans market are higher.

The parameter estimates on the slope of the transition probability function for the entire sample,  $\alpha_I$ , is negative and significant at the 1% significant level, which is -4.7367. Since the loan demand function should be downward sloping, it is known that the lending rates and the demand of bank loans have a negative relationship. Then, it would seem that  $\alpha_I$  needs to be negative to ensure a downward sloping demand curve. Since  $\alpha_I$  measures the sensitivity of the transition probability to the bank's own interest rate, the estimated value of  $\alpha_I$  indicates if bank's own interest rate increases by one unit, while the probability

that a customer will continue to borrow from the same bank will decrease by 4.7367 units.

### 3.4.3 The effect of existence of switching costs on price-cost margin

In the absence of switching costs, the first order condition (equation 3.25) can be simplified as

$$pcm_{i,t} = -\frac{\sigma_{i,t}}{\alpha_1} \quad (3.35)$$

Then, by using the point estimates of  $\alpha_1$  and the average market share  $\overline{\sigma_{i,t}}$ , which is equal to 0.0545, the average price-cost margin when switching costs have been eliminated can be calculated equal to 0.0115. The average price-cost margin when switching costs exist is 0.0167. The difference between them is only 0.0052. Therefore, the existence of switching costs only raise the price-cost margin by 0.52% (52bps), which is approximately 8.26%<sup>62</sup> of the average interest rate on the loans' value. This is mainly due to the competitive banking environment in Hong Kong. Furthermore, banks are also cross selling, which may increase the price of the other financial products to lock in customers. This low value of price-cost margin just satisfies the Bertrand behaviour of the market. Although the loan

---

<sup>62</sup> The average interest rate on loans is equal to 6.30%, the details of how to calculate interest rate on loans are discussed in section 2. The number 8.26% is obtained by using 0.52% divided by 6.30%.

market has a certain level of market power, the price-cost margins are still very low, due to competition.

### **3.4.4 Switching costs during good times and bad times**

In order to compare the magnitude of switching costs during the good times and bad times, two time periods have been picked up. One is year 2002 to year 2007, the other is year 2007 to year 2012. In 2002, Hong Kong economy entered a recovery phase after the Asian financial crisis, when the economy rebounded sharply from 2003. The average real GDP growth rate was around 6%<sup>63</sup> during this period. Thus, this period can be considered as a good time. Then, for the period 2007 to 2012, as a result of global financial crisis, economic activities notably slowed. Unemployment in Hong Kong rose and the growth rate of real GDP declined. Therefore, this period can be considered as a bad time. It can be seen from the Table 3.8 that the estimated switching costs based on period 2002-2007 is 0.1771 and the number of period 2007-2012 is 0.1988. Both coefficients are positive and significant, but the magnitude of estimated switching costs during the bad time is slightly larger than that of in good time. During the bad times, the issue of the “Lemons Problem” is more serious. Banks will be more willing to lend money to creditable customers. For the new borrowers, banks will charge a much higher risk premium or even reject their application. It is most likely that a higher estimated switching cost exists during the bad times.

---

<sup>63</sup> Data source: HKMA Annual Reports.

**Table 3.8 A contrastive analysis of switching costs during good times and bad times<sup>64</sup>**

<b>Periods</b>	<b>2002-2007</b>	<b>2007-2012</b>
$\alpha_1$ (transition probability slope)	-7.7564 *** (1.6216)	-4.1670*** (0.7682)
$s$ (switching costs)	0.1771** (0.0883)	0.1988* (0.1067)

### **3.4.5 The contribution of customer's added value to the lock-in phenomenon generated by switching costs**

The value of customer lock in can be clarified by the firm's optimization. Define the marginal value of a locked-in customer,  $mv_{i,t}$ , which is the increase of firm's present value due to an addition locked-in customer beyond the increase in profits generated by the current sales to that customer, then

$$\frac{\partial PV_{i,t}}{\partial y_{i,t}} = \frac{\partial \pi_{i,t}}{\partial y_{1,i,t}} + mv_{i,t} \quad (3.36)$$

In a steady state, the market size remains constant, and then the contribution of lock-in customer as a proportion of the added value is

$$\frac{mv_{i,t}}{\partial PV_{i,t}/\partial y_{1,i,t}} = -\delta \frac{n}{n-1} s \alpha_1 \quad (3.37)$$

(Appendix A.5 shows the derivation).

<sup>64</sup> Note: \* indicates 10% significant level, \*\* indicates 5% significant level and \*\*\* indicates 1% significant level.

Based on the estimated switching costs  $s$  and  $\alpha_1$ , the value of  $\frac{mvl_{i,t}}{\partial PV_{i,t}/\partial y_{1,t}}$  is around 2.54%.<sup>65</sup> This reveals that 2.54% of the customer's added value is attributed to the lock in effect generated by switching costs.

### 3.4.6 Multi-outputs trans-log cost functions

The bank loans are treated as output in trans-log cost function. There are several reasons to give up the other outputs such as bank other earning assets and bank net fees and commissions. The main reason is due to the multicollinearity problems between the regressors. Fee and commission income in the cost function requires a measure of the off-balance sheet output. Fee income is price times output. And the price is difficult to measure. Recent studies find that fee income is procyclical and positively correlated with interest earning assets and complementary and therefore will results problem of multicollinearity. As is shown in the Table 3.9, the correlation between  $\ln y_1$  and  $\ln y_2$  is highly reached to 0.9324, and the correlation between  $\ln y_2$  and  $\ln y_3$  is extremely high to 0.9525. This suggests the presence of a muticollinearity problem. Under this situation, OLS estimators may be imprecise because of large standard errors. The large standard error will generate low t-statistics and it may affect coefficients fail to attain statistical significance. A reversal sign of coefficients might exist and addition or deletion of few observations may result in substantial changes in the estimated coefficients. Furthermore, Kim (1986) provides evidence that a composite measure of output

---

<sup>65</sup> Average 3 month Treasury Bill Rate of Hong Kong for period 1997 to 2012 is used as discount rate.

fails to provide a proper explanation of banking technology and he suggests a single output to be used in banking research. In addition, Hou and Dickinson (2007) shows other earning assets are the complementary for loans. Therefore include the other earning assets and fees and commissions into the trans-log cost system will not have significant impact on the marginal costs of loans. Hence, the magnitude of switching costs estimated by the Kim et al. (2003)'s model will have no significant change if multi-outputs trans-log cost function is applied.

**Table 3.9 Correlation between bank loans ( $lny_1$ ), other earning assets ( $lny_2$ ) and net fees and commissions ( $lny_3$ )**

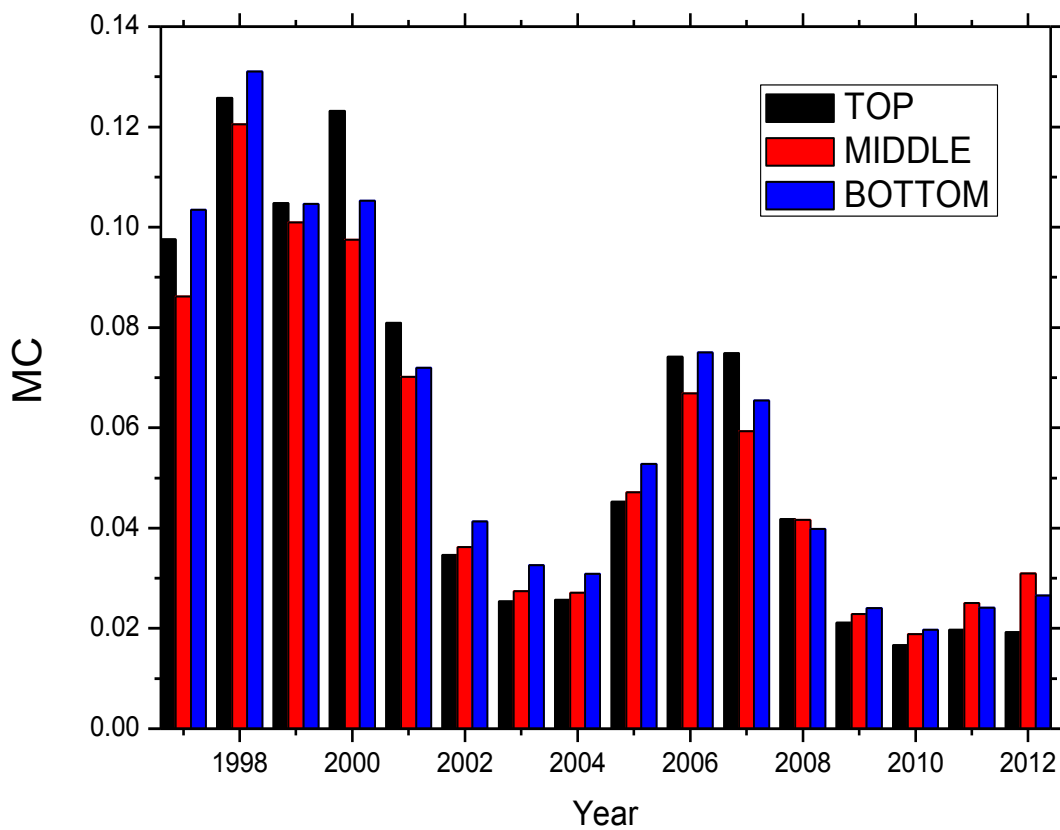
	$lny_1$	$lny_2$	$lny_3$
$lny_1$	1	0.932448	0.958728
$lny_2$	0.932448	1	0.952576
$lny_3$	0.958728	0.952576	1

### 3.4.7 Marginal costs

Figure 3.6 presents the general trend in marginal costs of three bank groups from year 1997 to year 2012. There are not many differences in the overall pattern of marginal costs between groups. However, great changes have taken place in marginal costs over the years. Before 2001, the marginal costs remained at a relevant high level, for instance the marginal cost of HSBC reached a high point at 16.94% in 2000. It appears that big banks with large market shares have slightly higher marginal costs than small banks. In 2002, the numbers sharply went down and then hit a bottom in 2003. From the year 2004 to 2007, the marginal costs

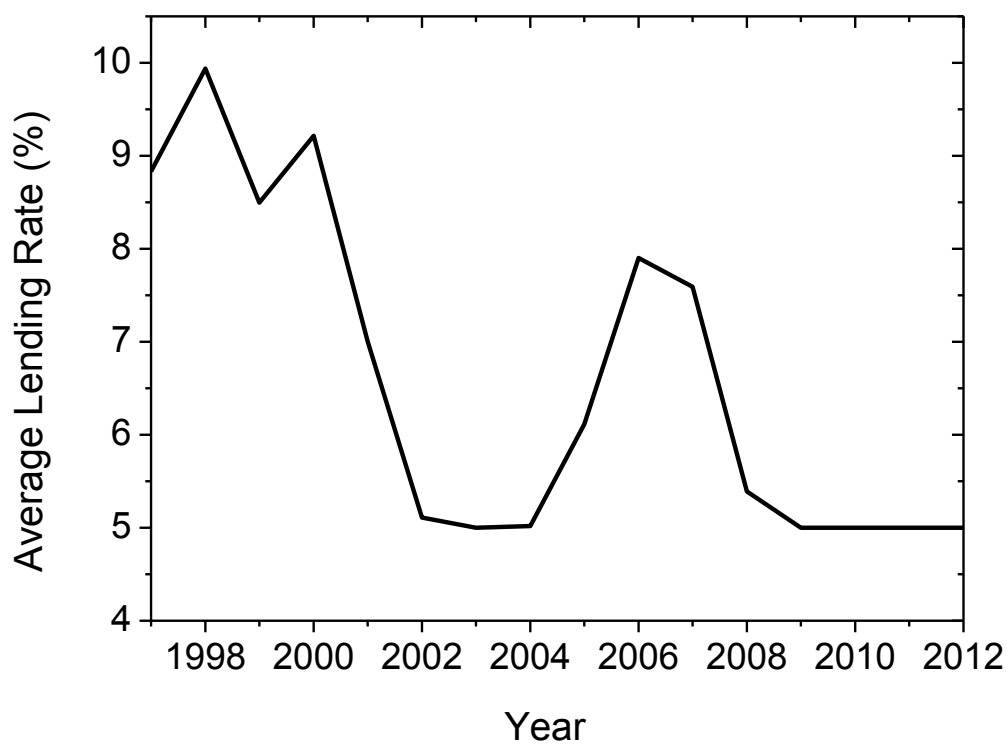
steadily increased year by year, but it started to drop down in 2008. Until 2011, the marginal costs rose again. It would seem that the marginal costs are higher when a financial crisis happens. The main reason for this is that high interest payments increase marginal costs. The average lending rate in Hong Kong is shown in Figure 3.7. This figure provides some interesting phenomenon that the marginal costs and average lending rate has a similar trend. Therefore, it can be concluded that the fluctuation of interest rate will lead to changes of marginal costs.

**Figure 3.6 Marginal costs of three banks groups using non-linear 3SLS approach**





**Figure 3.7 Average lending rate in Hong Kong from 1997 to 2012**



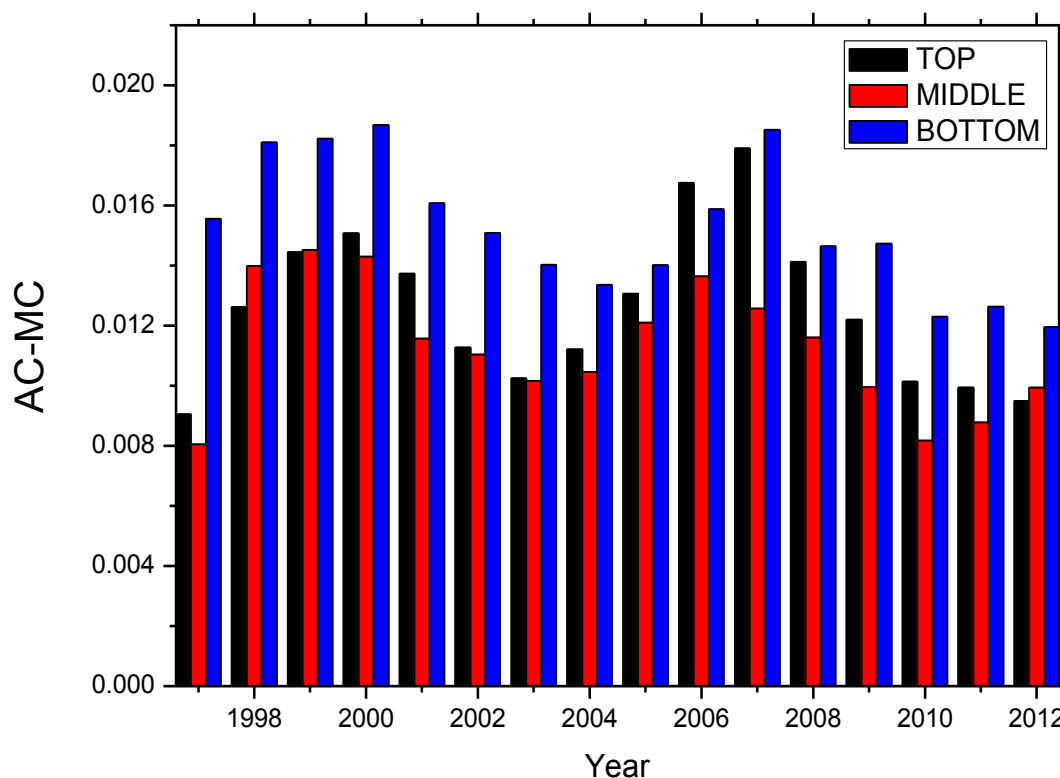
*Data Source: Hong Kong Monetary Authority*

### **3.4.8 Economies of scale**

According to the results of 3SLS, the coefficient of  $\ln y_{1,t}$  is positive and significant at 0.8942, which is less than 1. This implies that there are overall economies of scale. In order to evaluate the economies of scale, AC-MC is calculated. Figure 3.8 shows the difference between average costs and marginal costs for different bank groups. It seems that, although the difference is not big, banks are operating where average costs are higher than marginal costs. This states that banks are in the range of economies of scale and means that the banks can reduce the average cost of lending by expanding the amount of loans, especially

for the small banks. This finding is consistent with Ho (2014), who examines the economies of scale in Hong Kong's banking industry using a panel data of 23 banks for the period 2004 to 2010. His findings reveal that scale economies exist, especially in smaller categories of banks.

**Figure 3.8 AC-MC (unit: million HKD)**



### 3.4.9 Robustness test using GMM approach

As a robustness check, I estimate the models using a GMM approach. The results are shown in Table 3.10. Similar results are obtained using the GMM method. All of the estimated coefficients have the same signs as the non-linear 3SLS and the parameters are even more significant when using GMM. The coefficient of bank

loans is 0.8360, which is smaller than the number using non-linear 3SLS. Using GMM, the coefficients of input prices on labour and capital are smaller but the coefficient of input prices on deposits is larger. The switching cost is positive and significant at 0.1980, which is slightly larger than using the non-linear 3SLS method. The parameter estimates on the slope of the transition probability function for the entire sample,  $\alpha_I$ , is negative and significant at -6.2626.

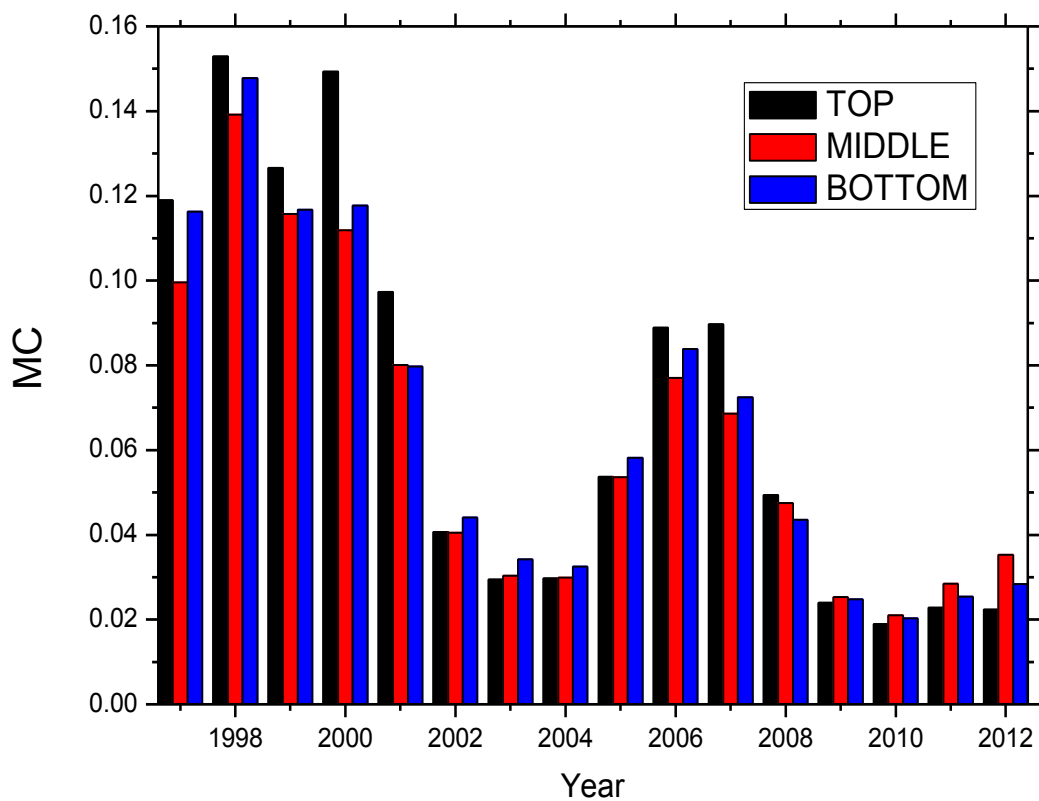
**Table 3.10 System estimation of trans-log cost system and switching costs equations using GMM. Included observation=275. Standard errors are in parenthesis<sup>66</sup>**

Variable	Parameter	Coefficient
Equation (3.28): Dependent Variable $\ln C$		
Constant	$\beta_0$	9.0278*** (0.0472)
$\ln y_{1,i,t}$	$\delta_1$	0.8360*** (0.0427)
$\frac{1}{2} \ln y_{1,i,t}^2$	$\delta_{11}$	0.0362*** (0.0096)
$\ln y_{1,i,t} \ln w_{1,i,t}$	$\gamma_{11}$	-0.0640*** (0.0191)
$\ln y_{1,i,t} \ln w_{2,i,t}$	$\gamma_{12}$	-0.0578*** (0.0174)
$\ln y_{1,i,t} \ln w_{3,i,t}$	$\gamma_{13}$	0.1218*** (0.0298)
$\ln w_{1,i,t}$	$\beta_1$	0.1413*** (0.0158)
$\ln w_{2,i,t}$	$\beta_2$	0.1374*** (0.0134)
$\ln w_{3,i,t}$	$\beta_3$	0.7213*** (0.0259)
$\frac{1}{2} \ln w_{1,i,t}^2$	$\beta_{11}$	0.0866*** (0.0166)
$\frac{1}{2} \ln w_{2,i,t}^2$	$\beta_{22}$	0.0714* (0.0393)
$\frac{1}{2} \ln w_{3,i,t}^2$	$\beta_{33}$	0.2136*** (0.0376)
$\ln w_{1,i,t} \ln w_{2,i,t}$	$\beta_{12}$	0.0278 (0.0169)
$\ln w_{1,i,t} \ln w_{3,i,t}$	$\beta_{13}$	-0.1144*** (0.0092)
$\ln w_{2,i,t} \ln w_{3,i,t}$	$\beta_{23}$	-0.0992*** (0.0353)
Equation (3.25) and (3.27): Dependent Variable $pcm$ and $\Delta\sigma$		
<b>Parameter</b>		<b>Coefficient</b>
$s$		0.1980*** (0.0353)
$\alpha_l$		-6.2626*** (1.2369)

<sup>66</sup> Note: 1: \* indicates 10% significance level, \*\* indicates 5% significance level, \*\*\* indicates 1% significance level. Note 2: The restrictions for symmetry and linear homogeneity in prices  $\sum_k \beta_k = 1$ ;  $\sum_k \gamma_{1k} = 0$ ;  $\sum_l \beta_{kl} = 0$  are imposed. Note 3: Since the above restrictions are imposed directly into the Eviews files, therefore the standard errors of  $\ln y_{1,i,t} \ln w_{1,i,t}$ ,  $\ln w_{3,i,t}$ ,  $\frac{1}{2} \ln w_{1,i,t}^2$ ,  $\frac{1}{2} \ln w_{2,i,t}^2$  and  $\frac{1}{2} \ln w_{3,i,t}^2$  are calculated by hand. In the Eviews, the standard errors of the reported coefficients are the square roots of the diagonal elements of the coefficient covariance matrix. The formula of calculating standard error for sum of two variables is  $se_{1+2} = \sqrt{se_1^2 + se_2^2 + 2covariance_{1,2}}$ . The covariance matrix is shown in Appendix A.4.

Figure 3.9 describes the trend of marginal costs of three bank groups using GMM estimation. Although some of the values are higher than non-linear 3SLS estimation, the overall trend of marginal costs remain the same.

**Figure 3.9 Marginal costs using GMM approach**



The results of GMM estimation confirms the existence of switching costs in the loan market of the Hong Kong banking industry, therefore the findings from the non-linear 3SLS estimation are robust.

### 3.4.10 Summary

This section estimated an empirical model which is based on Kim et al.'s (2003) study. It examines the banking behaviour in the presence of switching cost in Hong Kong bank loan market during 1997 to 2012. I find that, when using the non-linear 3SLS approach, the point estimates of the switching costs,  $s$ , based on the entire sample is significant at 0.1947. This indicates the existence of switching costs in the bank loans market in Hong Kong. The estimates that the slope of the transition probability function for the entire sample,  $\alpha_1$ , is negative and significant at -4.7367. The effect of the existence of switching costs only raises the price-cost margin by 0.52% (52bps), about 8.26% of the average interest rate on the loans' value. Compared with the results of Kim et al. (2003) for the Norwegian banking industry, switching costs are higher in the Hong Kong bank loans market. I also compare the magnitude of switching costs between good times and bad times for the Hong Kong market. The empirical results suggest that the magnitude of estimated switching costs during the bad time is slightly larger than that of in good time. Moreover, on average, 2.54% of the customer's added value is attributed to the lock in effect generated by switching costs. Based on the results of marginal costs, the Hong Kong banking industry is in the range of economies of scale. All of the results are robust since the GMM approach has also been applied into the empirical model and similar results have been obtained.

### **3.5 Conclusion**

In this chapter, I have applied an empirical model of banking behaviour to estimate the significance and magnitude of switching costs in Hong Kong bank loans market using a non-linear 3SLS approach. The sample contains an unbalanced panel of annual data collected from 18 licensed banks in Hong Kong, spanning 16 years from 1997 to 2012. I have obtained evidence which suggests the existence of switching costs in Hong Kong banking industry. The average point estimate of switching cost based on entire sample is 0.1947. The existence of switching costs only increase the price-cost margin by 0.52% (52bps), which amounts to about 8.26% of the average interest rate on the loans' value. This is mainly due to the competitive banking environment in Hong Kong. In such a banking environment, there is no distinct difference regarding the lending prices between banks. In order to obtain more profits, the banks need to provide cross selling which may increase the price of the other financial products to lock in customers. Therefore, it seems that the switching costs are also priced into the other financial products prices.

Moreover, I have also compared the magnitude of switching costs during the good times and bad times. It is most likely that a higher estimated switching cost exist during the bad times. It seems that during the bad times, the issue of the "Lemons Problem" is more serious. Banks will be more willing to lend money to creditable customers. For the new borrowers, banks will charge a much higher risk premium or even reject the application from them. On average, 2.54% of the customer's added value is attributed to the lock in effect generated by switching costs. Estimated marginal costs are obtained from estimation, and I find that the

Hong Kong bank loans market is in the range of economies of scale. It means that banks can reduce the average cost of lending by expanding the amount of loans. Finally, a robustness check using the same models but GMM approach has also been estimated. Similar results have been obtained, which indicates that the findings from non-linear 3SLS approach are robust.

Since switching costs offer banks a degree of market power, the possible implications of switching costs on competition mean that switching costs are also an important issue for regulators. Klemperer (1995) suggests that in general the existence of switching costs raise prices, increase deadweight loss, and discourage market entry. So should government make policies that encouraging lower switching costs and reduce entry barriers? Although significant switching costs have been found in Hong Kong's bank loans market, they may not necessarily be anti-competitive or welfare reducing because this is a partial analysis. The empirical model based on Kim et al.'s (2003) study only take the loan market into account. As a result, government policies should try to figure out the size of welfare losses in Hong Kong due to the switching costs before encouraging activities that reduce switching costs.



# **Chapter 4**

## **Testing for Collusion and**

## **Competition in Hong Kong's Banking**

## **Sector: Conjectural Variation**

### **Approach**

#### **4.1 Introduction**

As the wave of global economic integration has risen, almost every nation has tried their best to enhance the degree of openness and improve their national welfare. In order to adapt to the requirements of economic openness, financial regulation is increasingly becoming relaxed and competition in the banking industry has gradually been intensified. However, competition in the banking industry of both developed countries and emerging market countries has not always been smooth, and they have suffered financial crises as well as growth. In particular, since August 2007, the US sub-prime crisis has triggered a new round of global financial turmoil and a number of large-scale integrated banking institutions (such as Citigroup, UBS and HSBC Group) have suffered serious losses. With the further evolution of the sub-prime crisis during the global financial turmoil, market pessimism has been increasingly intense and the world's banking industry has

plunged into panic and turmoil, which has caused serious losses for the development of the entire global economy. Therefore, the question of how to achieve workable competition in the banking industry is becoming an urgent focus of study.

The main reasons for choosing the Hong Kong banking industry for the present study are three-fold. First, Hong Kong has one of the highest concentrations<sup>67</sup> of banking institutions in the world. The banking industry dominates the financial system in Hong Kong. However, the Hong Kong banking industry has gone through many hardships during its development; for instance, the Asian financial crisis and the sub-prime financial crisis. Researchers are interested in the competitive condition for Hong Kong banking industry in order to obtain a stable monetary and financial environment. Second, Hong Kong is the world's premier offshore RMB business centre. The increasing economic integration between Hong Kong and mainland China reflects the importance of Hong Kong in providing funding for investment in China. Third, only a limited number of empirical studies have investigated the degree of collusion and competitive condition in Hong Kong banking market. In order to fill the gap in the empirical work, I aim to study the degree of collusion and the level of market competition in Hong Kong bank loans market using a conjectural variation approach. Consistent with the database used in Chapter 3, the empirical estimation is based on an unbalanced panel of annual observations from 18 banks incorporated in Hong Kong during 1997 to 2012.

---

<sup>67</sup> As discussed in Chapter 2 (p.27), the 3-bank concentration ratio of Hong Kong is at 72.15% in 2011 and the 5-bank concentration ratio is 81.39% in 2011 (Data source: World Bank).

This chapter measures the degree of collusion and the nature of competitive condition among the 18 Hong Kong banks during 1997 to 2012 using conjectural variation approach. This approach was introduced by Iwata (1974), Bresnhan (1982) and Lau (1982), which was established on the belief that rival banks may react if a bank varies its own output or price. The conjectural parameter is often defined as the bank's expectation about its rivals' prices responses to changes in its own price. The theoretical model used to estimate the conjectural variation parameter is based on Coccorese (2005). The system contains a log demand function, a pricing equation and a trans-log cost system, which is jointly estimated using non-linear 3SLS and GMM approach. The estimated conjectural variation parameter  $\lambda$  is insignificant at 0.3452 using non-linear 3SLS approach. And the parameter is equal to 0.6001 using GMM approach which is also insignificant. The empirical results suggest that banks in Hong Kong operated in a competitive fashion in the loan market and the behaviour is coherent with a Nash- Bertrand equilibrium in prices with no significant evidence of collusion on pricing. These findings are consistent with Wong et al. (2007) and Ho (2010). The trend of marginal costs and price-cost margins of banks presented in this section are consistent with the results in Chapter 3.

The rest of this chapter is organized as follows: Section 4.2 provides the literature reviews on bank competition especially focus on conjectural variation approach. The theoretical and empirical methodologies are also presented here. Section 4.3 discusses the data and variables. Section 4.4 shows the empirical results. Section 4.5 concludes the chapter.

## **4.2 Literature reviews and methodology**

### **4.2.1 Introduction**

Market power and competition is an important field of study in the banking industry. This section will discuss the previous literature of measuring banking competition, especially that using the conjectural variation approach. In addition, an empirical model using a conjectural variation approach that builds on Coccoresse (2005) is introduced. In this chapter, the conjectural parameter is defined as the bank's expectation about its rivals' prices responses to changes in its own price.

### **4.2.2 Literature reviews**

#### **4.2.2.1 Measures of competition**

##### **4.2.2.1.1 Structural approach**

In order to measure the degree of competition in the banking market, the literature can be usually divided into structural and non-structural approaches. Bikker and Haaf (2002b), Degryse et al. (2009) and Arrawatia and Misra (2012) present excellent reviews on the methodological approaches and empirical research related to competition, especially in the banking industry. The structural approach (or the traditional industrial organization (IO) approach) measures banking competition from market structure, which is based on the Structure-Conduct-Performance (SCP) paradigm and the efficiency hypothesis (Demsetz, 1973; Peltzman, 1977), as well as some other formal approaches that originated from industrial organisation theory. The SCP model was developed by Bain (1956) and it links

market concentration with competition. It was quite popular until the beginning of the 1990s. The SCP model assumes a stable causal relationship among structure, conduct and performance. It explains how an exogenous market structure that influences a bank's conduct can affect their market performance. According to the SCP paradigm, market structures influence the conduct of banks in the industry. It assumes that a more concentrated market will stimulate collusion among the banks and then reduce the degree of competition (increase market power) in that market. It then assumes that the conduct of the banks' influences their market performance. Although the less competitive behaviour of the banks leads to higher profitability, it lowers the social efficiency. A number of indicators have been used as a proxy for market concentration; for instance, n-bank concentration ratio<sup>68</sup> or Herfindahl-Hirschman Index (HHI).<sup>69</sup> Assuming that the market structure is exogenous, researchers often regress a measure of bank performance; for example, bank profitability on market concentration indicators and some other control variables that may affect the bank's profits.<sup>70</sup> The SCP hypothesis implies a positive relationship between market concentration and bank profitability. Furthermore, the SCP hypothesis also assumes that greater barriers to entry will increase the exercise of market power. There is a vast body of literature that has used the SCP

---

<sup>68</sup> The n-bank concentration ratio can be calculated as the sum of the market shares of n largest firms in the industry.

<sup>69</sup> HHI can be measured as the sum of the squares of market shares for all firms in the industry. It ranges from  $1/N$  to 1. The higher HHI, the more concentrated in the industry. The industry is monopoly when HHI equal to 1.

<sup>70</sup> It should be noted that most studies using SCP approach to the banking industry do not put a measure of bank conduct into the model, the only exception is Calem and Carlino (1991) (Bikker and Haaf, 2002b).

approach to study the relationship between market concentration and market performance.

Some earlier researchers have summarised the literature that has used an SCP approach, for instance, Gilbert (1984), Molyneux et al. (1996) and Weiss (1974). Weiss (1974) reviewed 46 published studies that used the SCP model to address the relationship between concentration and profits before the early 1970s. Most of these studies found a positive relationship between market concentration and market power or profitability (Church and Ware, 2000). Berger and Hannan (1989) studied the relationship between deposit rate and concentration for the US retail deposit market using quarterly data from 1983Q3 to 1985Q4, which can be considered as a representative paper using the SCP approach. They verify the SCP hypothesis and finds that higher market concentration means that higher market power will lead to lower deposit rates.

The SCP paradigm has been criticized by many researchers due to its theoretical and empirical problems. For an overview, see Berger et al. (2004) and Degryse et al. (2009) and Church and Ware (2000). For example, the assumption of the traditional SCP paradigm that the market structural is exogenous is questionable. The efficiency hypothesis (Demsetz, 1973; Peltzman, 1977) suggests that the market structure is endogenous, which can be influenced by conduct and performance. In addition, concentration is due to the higher degree of efficiency of banks. In an oligopoly framework, the market shares and the exercise of market power are endogenous, which is determined by the firm's conduct and some other

factors. Finally, an endogenous concentration can be seen as a reason for the barriers to entry (Baumol et al., 1983).

#### **4.2.2.1.2 Non-structural approach**

In order to solve the problems with the structural measures of competition, the non-structural approach was developed in the 1980s. This approach is also called the new empirical industrial organisation (NEIO) approach. The aim of the non-structural approach is to obtain the firms' conduct directly without taking market structure or market shares into account. The innovation of new empirical industrial organisation can be summarized by the following three points. Firstly, the traditional industrial organisation approach only pays attention to market structure analysis framework, while the NEIO approach turns away from market structure to market behaviour. Secondly, the traditional IO approach follows a static paradigm, but the NEIO establishes a bi-directional and dynamic research framework. Finally, it breakthroughs the neo-classical theoretical assumptions of the IO approach and establishes a research approach under the condition of incomplete information. Several models and indicators are popularly used in bank competition literature; for example, the Panzar-Rosse (1987) model, Lerner Index Lerner (1934), the Boone (2008) Competition Indicator, structural demand models (Dick, 2008) and Conjectural Variation approach (Iwata, 1974; Bresnhan, 1982; Lau, 1982).

#### ***4.2.2.1.2.1 Literature of the Panzar-Rosse model***

The Panzar and Rosse (1987) model has been widely used in the empirical literature related to bank competition. This approach estimates a reduced form price function or revenue equation using cross-section data to assess the competitive behaviour of banks. An H-statistic, which is a measure of bank competition, can be obtained as the sum of the elasticities of a bank's revenue with respect to its input prices. Rosse and Panzar (1977), Panzar and Rosse (1982, 1987) show that when the H-statistic is negative or zero, the structure of the market can be considered as monopolistic. This case includes collusive oligopoly and may include conjectural variation short run oligopoly (Shaffer 1982, 1983). An increase of input prices which shifts average cost curve and marginal cost curve upward will result in no change or a decrease in revenue. When the H-statistic is equal to one, the market is under perfect competition. In this case, an increase in both average cost and marginal cost due to an increase in input prices will lead to a one-to-one increase in revenues without altering the optimal output of individual firms. Finally, when the H-statistic is between zero to one, the market is characterized by monopolistic competition. An important condition to get accurate results is that the market should be in long-term equilibrium. The Panzar-Rosse approach has both limitations and advantages. For instance, it only requires firm-level data, such as revenues and input prices, which can be easily obtained. In addition, the Panzar-Rosse approach is robust in a small sample. Further details of the literature related to the Panzar-Rosse approach will present in Chapter 5.



#### ***4.2.2.1.2 Literature of the Lerner Index***

The Lerner index was proposed by Lerner (1934) to measure a firm's market power. It can be calculated as the difference between price and marginal costs, divided by price. This index ranges from 0 to 1. A higher Lerner Index implies a higher market power. When the Lerner Index is equal to 0, where price is equal to marginal costs, the firm is considered as a perfectly competitive. The Lerner Index is equivalent to the negative inverse of price elasticity demand facing the firm. Demirguc-Kunt and Peria (2010) show that the advantage of Lerner index compared with Panzar-Rosse H statistic is that it is not a long-run equilibrium measure of competition. Therefore, it can be calculated at each point of time. However, the main limitation of this measure is that marginal costs are difficult to get. Hence, by focusing on this problem, Baker and Bresnahan (1988) present a method that used the residual demand elasticity to measure the size of market power, which simplifies the actual measurement of market power. Goldberg and Rai (1996) used the stochastic cost frontier regression, which was proposed by Aigner et al. (1977) to measure bank efficiency, and put it directly into Berger and Hannan's (1997) testing model. They use the ratio of net interest income (the difference between deposits and loans) to total asset as one of the indicators to measure the bank performance. They then applied the method to the banking market using the data of 11 European countries for the period 1988-1991. Their findings suggest that concentration and profit margins are not significantly positively correlated, which does not support the SCP hypothesis. However, in those countries which have a low concentration in banking market, the efficient structure hypothesis is valid.

#### ***4.2.2.1.2.4 Literature of the Boone competition Indicator***

Although price cost margin is widely used as a measure of competition, there are some papers, such as Amir (2000), Bulow and Klemperer (2002), Rosenthal (1980) and Stiglitz (1989), that doubt the robustness of this measure. They find that more intense competition leads to higher price cost margin instead of lower. Boone (2008) introduces a new way to measure competition based on a firm's Relative Profit Differences (RPD), which is theoretically robust as a measure of competition while the data requirements are simply as the price cost margin measure. This approach is based on the notion that in a more competitive market inefficiently firms are punished more harshly than more efficient ones. Therefore, efficiency can be defined as the possibility to produce the same output with lower costs. Then, comparing the relative profits between some random efficient firm and a firm with greater efficiency, it is found that a more competitive the market leads to a greater difference between efficiency and performance. Van Leuvensteijn et al. (2011) apply the Boone indicator to the bank loans market of five major countries in the Euro area in comparison to the UK, the US and Japan for the period 1994 to 2004. The innovation of their paper is to apply this method not only on entire banking market but also on separate product markets, such as the loan market, and for single types of banks. They also employ a trans-log cost function to estimate the marginal cost instead of average variable costs as a proxy (Boone et al., 2007). They find that different countries have different competition in the bank loans market. The Euro area is less competitive than the US market but more competitive than the UK and Japan. Van Leuvensteijn (2008) used the same dataset as Genesove and Mullin (1998) to show that the Boone competitive

indicator is better able to measure competition empirically. They use the data of the US sugar industry for the period 1890 to 1914. However, some researchers have queried its validity. Using a rich newly built data set for German manufacturing enterprises, Schiersch and Schmidt-Ehmcke (2010) test the empirical applicability and robustness of Boone competitive indicator. Based on their findings, they argue that the Boone competitive indicator is not an empirically robust indicator to measure competition.

#### ***4.2.2.1.2.5 Literature of structural demand models***

Some other papers have used a characteristics-based demand system, such as Dick (2008). Following the discrete choice literature, Dick (2008) estimates a structural demand model for commercial bank deposit services using US data for the period 1993-1999. Her results indicate that consumers are sensitive to both account fees and deposit interest rates. But when compared with deposit rates it was found that the consumers respond a lesser extent to changes in account fees. Furthermore, she also showed evidence that staffing, geographic density, age, size and geographic diversification of banks have a positive relationship with consumer demand.

#### ***4.2.2.1.2.6 Literature of the conjectural variation approach***

Iwata (1974), Bresnhan (1982) and Lau (1982) introduced a way to measure the degree of competition based on structural equations. This methodology is often called the conjectural-variations method, which is based on the belief that rival banks may react if a bank varies its own output or price. Therefore, a bank will take into account the variation in other banks' price when choosing its own price.

This methodology often estimates a simultaneous-equation model, including a demand equation, a supply equation, which is derived from the first order condition of profit maximization, and a cost function, where a conjectural parameter expressing the degree of coordination of banks is included. The conjectural parameter is often defined as the bank's expectation about its rivals' prices responses to changes in its own price. In this chapter, I focus on the literature of measuring bank competition using a conjectural variation approach.

Shaffer (1989) applies this method to a time series of aggregate data for the US banking industry from 1941 onwards, and rejects the collusive conduct hypothesis and finds that the US banking industry is consistent with perfect competition. He also uses this method to test the degree of competition in the Canadian banking industry and finds that conduct in the industry has resembled perfect competition for the period 1965 to 1989 (Shaffer, 1993). The attractive feature of this paper is that he extended the model to allow for heterogeneity with and between different sectors and countries, and included bank heterogeneity. Similar with Shaffer (1993), Berg and Kim (1998) estimates the conjectural variation parameter for different output sectors including retail and wholesale sectors of the loan market for Norwegian banking industry. They also found that the retail loan market has strong market power whereas the wholesale loan market is characterized by a competitive structure.

Ruiz-Moreno et al. (2010) suggests that the main problem of conjectural variation approach is that the high number of firms in some industries may affect the availability of degrees of freedom that lead to extremely difficult or impossible estimation of conjectural variation models. Because of this problem, most of the

empirical literature using the conjectural variation approach does not analyse the competitive interactions between every firm in the industry. It often estimates a single parameter for all the banks in the market (e.g., Carbó et al., 2009 for Spain) or a single parameter for the group of the largest banks (e.g., Coccoresse, 2005 for Italy). Most studies that apply the conjectural variation approach find little evidence of market power in European banking system (Liu et al., 2010). Coccoresse (2005) studied the market conduct of the eight largest banks for the period 1998 to 2000 for the Italian banking industry. The results show there is no conflict between competition and concentration in the banking industry and these eight banks are consistent with a more competitive conduct than the Bertrand-Nash outcome. Based on Coccoresse's (2005) model, Aydemir (2013) examined the market conduct of the largest banks in the Turkish banking sector for the period 1988 to 2009. These results show collusive conduct in the loan market. Furthermore, the evidence verifies the view that high market concentration will lead to less competition, which is consistent with the SCP paradigm.

#### ***4.2.2.1.2.7 The case of Hong Kong***

As one of the most important international financial centres in the world, the banking industry dominates the financial system in Hong Kong. In addition, Hong Kong has one of the highest market concentrations of banks in the market. According to the statistics from HKMA Annual Reports, from year 1997 to year 2012, the number of authorized institutions in Hong Kong declined from 361 to 200. The major reason for this was bank consolidation through mergers and acquisitions. The Herfindahl-Hirschman Index (HHI) of Hong Kong banking

sector is higher than most developed countries (Jiang et al., 2004), which also indicates that Hong Kong has a high degree of concentration with enough potential room for market power by large banks. Such market behaviour may be considered as oligopolistic coordination, in which large banks may obtain a strong market power on prices.

In order to maintain monetary and financial stability, a study of collusion behaviour and competitive conditions in the Hong Kong banking industry becomes meaningful. There has recently been a vast literature on measuring bank competition using a conjectural variation approach for different countries, such as Sjöberg (2004) for Swedish banks, Chaffai and Sellami (2014) for Tunisian commercial banks, Florian (2012) and León (2014) for west African banks, and Misra and Arrawatia (2013) for Indian commercial banks. However, only a limited number of empirical studies have investigated that competitive condition of, and concentration in, the Hong Kong banking market. Some empirical studies have been based on the Panzar-Rosse (1987) approach, such as Jiang et al. (2004), Wong et al. (2006) and Chu et al. (2013). These papers will be discussed in further detail in Chapter 5. Some other papers that have inferred the degree of market competition are based on the conjectural variation approach. For example, Wong et al. (2007) apply the model of Coccoresz (2005) and show that the Hong Kong bank loans market can neither be classified as monopoly nor perfect competition during the period 1991 to 2002, with no significant signs of collusion on pricing. Ho (2010) uses the data of 23 commercial banks in Hong Kong during 1997 to 2004 and finds that the Hong Kong bank loans market is characterized by non-

cooperative competitive behaviour in that period and the industry becomes more competitive after deregulation.

### 4.2.3 Methodology

The specification and estimation of the demand system follows Coccorese (2005) which use a price-setting model. The products are heterogeneous between firms and price competition. It then assumes that at any period  $t$ , the demand of loans for each bank depends on its own price, the price of rivals, and other exogenous factors (e.g., national income), as follows:

$$y_{it} = y_{it}(p_{it}, p_{jt}, \mathbf{DM}_{it}), i = 1, \dots, n \quad (4.1)$$

where  $y_{it}$  is the quantity demanded,  $p_{it}$  is the interest rate on loans charged by bank  $i$  in period  $t$ ,  $p_{jt}$  is an index of the alternative interest rate charged by bank  $i$ 's rivals in period  $t$ ,  $\mathbf{DM}_{it}$  is a vector of exogenous factors affect quantity demand, and  $n$  is the number of banks in the market.

The market is defined as the loan market of Hong Kong. There are 18 banks in the sample, therefore  $n$  is equal to 18. The market is treated as a duopolistic market, where each bank faces a single competitor, which is formed by the 17 remaining banks. The index of the rival banks' interest rate on loans is calculated as the average interest rate on loans of the other 17 banks.

The cost function is affected by quantity of output and the exogenous input prices:

$$C_{it} = C_{it}(y_{it}(\cdot), \mathbf{w}_{it}) \quad (4.2)$$

where  $C_{it}$  is the total costs of bank  $i$  in period  $t$ , and  $\mathbf{w}_{it}$  is a vector of exogenous input prices of bank  $i$  in period  $t$ .

The profit function of banks can be specified as

$$\pi_{it} = y_{it}(p_{it}, p_{jt}, \mathbf{DM}_{it})p_{it} - C_{it}(y_{it}(\cdot), \mathbf{w}_{it}) \quad (4.3)$$

where  $\pi_{it}$  is the profit of bank  $i$  in period  $t$ .

Then, maximising profit w.r.t. the  $p_{it}$

$$\frac{\partial \pi_{it}}{\partial p_{it}} = y_{it} + (p_{it} - mc_{it}(\cdot)) \left( \frac{\partial y_{it}}{\partial p_{it}} + \frac{\partial y_{it}}{\partial p_{jt}} \frac{\partial p_{jt}}{\partial p_{it}} \right) = 0 \quad (4.4)$$

where  $mc_{it}(\cdot) = \frac{\partial C_{it}}{\partial y_{it}}$  is the marginal cost of bank  $i$  in period  $t$ . After rearranging the above equation, the banks must satisfy the following first-order condition<sup>71</sup>:

$$p_i = mc_i - \frac{1}{\frac{\varepsilon_{ii} + \lambda \varepsilon_{ij}}{p_i} + \frac{\varepsilon_{ij}}{p_j}} \quad (4.5)$$

By rearranging equation (4.5), the conjectural variation parameter is as follows:

$$\lambda = -\frac{p_j}{\varepsilon_{ij}} \left( \frac{1}{p_i - mc_i} + \frac{\varepsilon_{ii}}{p_i} \right) \quad (4.6)$$

where  $\varepsilon_{ii} = \frac{\partial y_i}{\partial p_i} \frac{p_i}{y_i} = \frac{\partial \ln y_i}{\partial \ln p_i}$  is the own-price elasticity of demand,  $\varepsilon_{ij} = \frac{\partial y_i}{\partial p_j} \frac{p_j}{y_i} =$

$\frac{\partial \ln y_i}{\partial \ln p_j}$  is the cross-price elasticity of demand, and  $\lambda = \frac{\partial p_j}{\partial p_i} \in [-\infty, 1]$  is the

conjectural variation parameter of bank  $i$ . When  $\lambda = 1$ , the behaviours of the banks is considered as perfectly collusive behaviour. When  $\lambda = -\infty$ , the market

---

<sup>71</sup> The time subscript is omitted for notational convenience.



corresponds to the perfect competition. The intermediate value of  $\lambda$  corresponds to oligopolistic competition. In particular, when  $\lambda = 0$ , the behaviour is regarded as a Nash- Bertrand equilibrium in prices (Ho, 2010). The details of the explanation are discussed below.

Since demand should be downward sloping, then  $\varepsilon_{ii}$  is expected a negative sign. And since loans between banks are substitute products, then  $\varepsilon_{ij}$  is expected a positive sign. The conjectural variation parameter  $\lambda$  measures the degree of coordination of banks, which can be defined as the bank  $i$ 's expectation about its rivals' price change responses to a change in its own price.

A positive  $\lambda$  indicates that collusive pricing behaviour exists in the market, which means that a bank expects its rivals to match its own price. For instance, if a bank raises its own interest rate on loans, it seems that the quantity of loan will be reduced. If  $\lambda$  is positive, then the rival banks will also be expected to increase their interest rate on loan. Then, the equilibrium output will be reduced because the outputs of all of the banks are declining and the interest rates in the market will be increased. If the banks collude with each other, as in this case, then the banks' joint profits will increase. The banks' joint profits is maximised when  $\lambda = 1$  (perfect coordination), where banks are act as joint monopoly. They are perfectly matched in prices and the substitution effect in the market become not significant. A bank expects that all of the other banks act exactly same after it changes its own price.

When  $\lambda = 0$ , the bank behaviour is coherent with a Nash equilibrium in price, where banks independently choose prices in order to maximize profits. A bank

expects its rivals to not response to any changes in its price. A negative  $\lambda$  implies that a bank expects its increase in price to be followed by a reduction in its rivals' prices. Therefore, the extreme case when  $\lambda = -\infty$ , corresponds to the perfect competition, in this case the first order condition (equation 4.5) can be written as  $P=MC$ .

As shown in equation (4.6), the sign of the conjectural variation parameter  $\lambda$  is determined by the observed price-cost margin and its own price elasticity. If  $\frac{p_i - mc_i}{p_i} > \frac{1}{|\varepsilon_{ii}|}$ , in this case,  $\lambda > 0$ , then the observed price cost margin is higher than that obtained from the Nash-Bertrand equilibrium. This shows greater market power in the industry compared with that in the Nash-Bertrand equilibrium.

#### 4.2.4 Empirical model

A system of demand function (equation 4.1), cost function (equation 4.2) and the first order condition (equation 4.5) is estimated simultaneously in order to obtain the conjectural variation parameter  $\lambda$ . A log-linear equation is applied to the demand function (equation 4.1)<sup>72</sup>:

$$\ln y_{1,i,t} = \varphi_0 + \varphi_1 \ln p_{i,t} + \varphi_2 \ln \overline{p_{i,Rt}} + \varphi_3 \ln r g d p_t + \varphi_4 \ln F A_{i,t} + \vartheta_{i,t} \quad (4.7)$$

where  $\ln r g d p_t$  and  $\ln F A_t$  are two exogenous factors affect the demand of loans.  $\ln r g d p_t$  is the natural logarithm of real GDP.  $\ln F A_t$  is the natural logarithm of the fix assets. This variable is a proxy of network size effect of the bank on its own

---

<sup>72</sup> The log linear demand function is widely used in banking research. For instance, Coccoresse(2005) uses log linear demand function to assess the market conduct for largest banks in Italy, Wong et al. (2007) investigates the degree of collusion in Hong Kong banking sector based on the model of Coccoresse (2005), and Aydemir (2013) applies the same model for the Turkish banking sector.

demand.<sup>73</sup>  $\vartheta_{i,t}$  is a random error term representing demand shocks in period  $t$ . The estimated coefficient of  $\ln p_{it}$ ,  $\varphi_1$ , is the own price elasticity and the estimated coefficient of  $\ln \overline{p_{i,Rt}}$ ,  $\varphi_2$ , can be interpreted as the cross-price elasticity.

Regarding the cost function, the same trans-log cost system (one output, three inputs) which Chapter 3 used is applied in this chapter. The trans-log cost function has previously been used in the literature of Hong Kong. For example, Kwan and Lui (2000), and Kwan (2006) used the stochastic frontier approach to analyse the cost efficiency of commercial banks in Hong Kong. Wong et al. (2007) used a two output, two inputs trans-log cost function to test collusion in the Hong Kong banking sector. Ho (2010) examines competition among commercial banks in Hong Kong following deregulation in a small open economy.

Then, bank  $i$ 's time-variant trans-log cost function (one output, three inputs) is as follows:

$$\begin{aligned} \ln C_{i,t} = & \beta_0 + \delta_1 \ln y_{1,i,t} + \sum_k \beta_k \ln w_{k,i,t} + \frac{1}{2} (\sum_k \sum_l \beta_{kl} \ln w_{k,i,t} \ln w_{l,i,t} + \delta_{11} (\ln y_{1,i,t})^2) \\ & + \sum_k \gamma_{1k} \ln y_{1,i,t} \ln w_{k,i,t} + \kappa_{i,t} \end{aligned} \quad (4.8)$$

where  $C_{i,t}$  is total cost of bank  $i$  in period  $t$  and  $y_{1,i,t}$  is bank  $i$ 's outputs in period  $t$ . Loans are treated as bank output.  $w_{1,i,t}$ ,  $w_{2,i,t}$  and  $w_{3,i,t}$  are three exogenous input prices on labor, capital and deposits, respectively.  $k, l=1,2,3$ .  $\kappa_{i,t}$  is an error term.

---

<sup>73</sup> Some papers, such as Coccoresse (2005), use the number of branches of each bank as a proxy of network size effect. Since the data of the number of branches is missing for the Hong Kong banking industry, I will instead use fix assets.

From Shephard's lemma, the input cost share equations can be written in deterministic form as

$$Sh_{k,i} = \frac{\partial \ln c_{i,t}}{\partial \ln w_{k,i,t}} = \frac{w_{k,i,t} x_{k,i,t}}{c_{i,t}} = \beta_k + \sum_l \beta_{kl} \ln w_{l,i,t} + \gamma_{1k} \ln y_{1,i,t} \quad (4.9)$$

where  $Sh_{k,i}$  is the share of the  $k$ th factor in bank  $i$ 's period  $t$  production cost.

The following restrictions for symmetry and linear homogeneity in prices are imposed on the trans-log cost system:

$$\beta_{kl} = \beta_{lk}, \forall k, l; \sum_k \beta_k = 1; \sum_k \gamma_{1k} = 0; \sum_l \beta_{kl} = 0, \forall k. \quad (4.10)$$

Then, the marginal cost can be written as

$$mc_{1,i,t} = \frac{\partial c_{i,t}}{\partial y_{1,i,t}} = \frac{c_{i,t}}{y_{1,i,t}} (\delta_1 + \delta_{11} \ln y_{1,i,t} + \sum_k \gamma_{1k} \ln w_{k,i,t}) \quad (4.11)$$

Then, by substituting equation (4.11) into (4.5), equation (4.5) becomes

$$p_{i,t} = \frac{c_{i,t}}{y_{1,i,t}} (\delta_1 + \delta_{11} \ln y_{1,i,t} + \sum_k \gamma_{1k} \ln w_{k,i,t}) - \frac{1}{\frac{\varphi_1 + \lambda \varphi_2}{p_{i,t} p_{j,t}}} + \mu_{i,t} \quad (4.12)$$

where  $\mu_i$  is a random shock to bank  $i$  in year  $t$ .

Hence, the structural model contains the log demand function (equation 4.7), trans-log system including the share equations<sup>74</sup> (equation 4.8 and 4.9), and the pricing equation (equation 4.12) are jointly estimated using non-linear 3SLS and GMM approach.

---

<sup>74</sup> Since the sum of three input shares is equal to unity, one share equation is deleted from the system to avoid singularity problem.

## 4.2.5 The linkage between own price elasticity, $\varphi_1$ , and sensitivity of the transition probability to the bank's own interest rate, $\alpha_1$

The function of total demand in Chapter 3 is given by equation 3.7 (p.79) as

$$y_{1,i,t} = (y_{1,i,t-1}Pr_{i \rightarrow i,t} + y_{1,iR,t-1}Pr_{iR \rightarrow i,t})g_t$$

Because the borrowers are assumed to have an inelastic demand for loans, a small increase of  $p_{i,t}$  should have the same effect on the transition probabilities as the same size decrease of  $\bar{p}_{iR,t}$ . This implies  $\alpha_2 = -\alpha_1$ . Hence, the function of transition probabilities is shown in equation 3.15 (p.81) in Chapter 3 as:

$$Pr_{i \rightarrow i,t} = \alpha_0^i + \alpha_1(p_{i,t} - \bar{p}_{iR,t} - s)$$

And the transition probability of a randomly selected rivals' customer is (equation 3.16 (p.81)):

$$Pr_{iR \rightarrow i,t} = \alpha_0^i + \alpha_1(p_{i,t} - \bar{p}_{iR,t} - \frac{s}{n-1})$$

By substituting both equation (3.15) and equation (3.16) into equation (3.7), equation (3.7) can be written as:

$$y_{1,i,t} = [y_{1,i,t-1}(\alpha_0^i + \alpha_1(p_{i,t} - \bar{p}_{iR,t} - s)) + y_{1,iR,t-1}(\alpha_0^i + \alpha_1(p_{i,t} - \bar{p}_{iR,t} - \frac{s}{n-1}))]g_t \quad (4.13)$$

Then, the price elasticity of demand  $\varphi_1$  can be obtained as:

$$\varphi_1 = \frac{dy_{1,i,t}}{dp_{i,t}} \frac{p_{i,t}}{y_{1,i,t}} = (y_{1,i,t-1}\alpha_1 + y_{1,iR,t-1}\alpha_1) \frac{p_{i,t}}{y_{1,i,t}} g_t \quad (4.14)$$

Equation (4.14) shows the relationship between the price elasticity of demand  $\varphi_1$  and sensitivity of the transition probability to the bank's own interest rate  $\alpha_1$ .

## **4.2.6 Summary**

This section has reviewed the theoretical and empirical developments of the studies related to measure bank competition, especially those using the conjectural variation approach. A conjectural variation approach is applied in order to measure the degree of collusion and competition for the Hong Kong bank loan market. A structural model including a demand function (equation 4.7), a trans-log system (equation 4.8 and 4.9), and the pricing equation (equation 4.12) are jointly estimated to obtain the conjectural variation parameter  $\lambda$ . In this section, the linkage between own price elasticity and the sensitivity of the transition probability to the bank's own interest rate in Chapter 3 is also presented.

## **4.3 Data and variables**

### **4.3.1 Introduction**

In order to assess the reliability of the previous results in Chapter 3, the same dataset is used to examine the degree of competition in the banking sector of Hong Kong based on the conjectural variation approach. In this section, the data and summary statistics which are not presented in Chapter 3 are discussed. The details of the other data and variables can be found in Chapter 3.

### 4.3.2 Data

Consistent with the dataset used in Chapter 3, the Hong Kong banking data are extracted from Bankscope and the Annual Reports of individual banks for the years from 1997 to 2012. The sample consists of balance sheet and income statement information of 18 licensed banks that are incorporated in Hong Kong. The panel data are annually and unbalanced. The sample of banks is listed in Appendix A.2, which also shows data availability of each bank. The bank-level data used in the estimation contains bank loans, bank total costs,<sup>75</sup> number of labour, fix assets, customer deposits, and interest rate on loans. Table 3.1 in Chapter 3 provides the definition and measurement of these variables in detail. The data cleaning rules including the way to calculate the number of labour and interest rate on loans are also discussed in Chapter 3. All the nominal data are deflated by the CPI (2009M10-2010M9=100) collected from the DataStream.<sup>76</sup> Macro data used for estimating the demand function, such as real GDP, is also collected from DataStream.<sup>77</sup>

In the model, the regressors  $P_{i,t}$  and  $y_{1,i,t}$  are positively correlated with the unobserved product characteristics that are captured by the error term  $\omega_{i,t}$  in equation 4.7. Therefore, the OLS estimator becomes biased. In order to solve the endogeneity problem, the endogenous variables in the model bank loans ( $y_{1,i,t}$ ), the interest rate on loans ( $P_{i,t}$  and  $\bar{p}_{iR,t}$ ) are instrumented by real GDP, inflation

---

<sup>75</sup> Measured as the sum of total operating expenses and interest expenses.

<sup>76</sup> Data Source: Census and Statistics Department, Hong Kong.

<sup>77</sup> Data Source of real GDP and property price index: Oxford Economics.

rate, Hong Kong Interbank Offered Rate (HIBOR) rate, wage rate of Hong Kong, one lag of interest rate on loans, one lag of log interest rate on loans and average costs.<sup>78</sup> . The Sargan test of over identifying restrictions has been applied to test the validity of the instrumental variables. The results suggest that all set of instrumental variables are validity. Table 4.1 shows the definition and measurement of variables including instrumental variables, which are not presented in Table 3.1 of Chapter 3. The summary of these variables is shown in Table 4.2.

**Table 4.1 The definition and measurement of variables (apart from presented variables in Table 3.1 of Chapter 3)**

<b>Variable name (Instrumental Variables)</b>	<b>Definition of each variable</b>
$AC_{i,t}$	Average cost of bank $i$ at time $t$ . where $AC_{i,t} = TC_{i,t}/y_{1,i,t}$

**Table 4.2 Summary statistics (HKD million)**

<b>Variable</b>	<b>Obs.</b>	<b>Mean</b>	<b>S.D.</b>	<b>Min</b>	<b>Max</b>
$AC_{i,t}$	275	0.0672	0.0354	0.0184	0.1719

*Note: all the nominal data in the table is deflated by CPI.*

<sup>78</sup> To estimate the trans-log cost system, the same set of instrumental variables in Chapter 3 are applied. I use real GDP, inflation rate, Hong Kong Interbank Offered Rate (HIBOR) and wage index of Hong Kong as instrumental variables. To estimate demand function, I use average costs, one lag of log interest rate on loans as instrumental variables. I use one lag of interest rate on loans, real GDP, inflation, HIBOR and wage index of Hong Kong as instrumental variations in the pricing equation.



### 4.3.3 Summary

Consistent with the database used in Chapter 3, this database consists of an unbalanced panel of annual observations for the Hong Kong banking industry for the period 1997 to 2012. The sample covers 18 licensed banks in Hong Kong in that period. The measurement and summary statistics of data that are not presented in Chapter 3 are discussed in this section.

## 4.4 Empirical results

### 4.4.1 Introduction

Using the conjectural variation approach, this chapter tests the degree of collusion and competition in the Hong Kong bank loan market. This section presents the empirical results from the joint estimation of a log demand function (equation 4.7), a trans-log cost system (equation 4.8 and 4.9), and a pricing equation (equation 4.12) using non-linear 3SLS and GMM approaches.

### 4.4.2 Empirical results

The log demand function (equation 4.7), trans-log cost system, including the share equations (equation 4.8 and 4.9) and the pricing equation (equation 4.12), are jointly estimated using the non-linear 3SLS and GMM approach. In order to solve the endogeneity problem, the endogenous variables in the model bank loans ( $y_{i,t}$ ), the interest rate on loans ( $p_{i,t}$  and  $\bar{p}_{iR,t}$ ) are instrumented by real GDP, inflation

rate, Hong Kong Interbank Offered Rate (HIBOR) rate, wage index of Hong Kong, one lag of interest rate on loans, one lag of log interest rate on loans, and average costs. Empirical results using the non-linear 3SLS approach are presented in Table 4.3.

**Table 4.3 Empirical results of estimating conjectural variation parameter using non-linear 3SLS. Included observation=275. Standard errors are in parenthesis<sup>79</sup>**

Variable	Parameter	Coefficient	Variable	Parameter	Coefficient
Demand equation (equation 4.7): Dependent Variable $\ln y_{1,i,t}$			$\ln y_{1,i,t} \ln w_{3,i,t}$	$\gamma_{13}$	0.1103*** (0.0372)
<i>Constant</i>	$\varphi_0$	-20.4057** (9.5679)	$\ln w_{1,i,t}$	$\beta_1$	0.1498*** (0.0160)
$\ln p_{i,t}$	$\varphi_1$	-1.0778*** (0.3246)	$\ln w_{2,i,t}$	$\beta_2$	0.1507*** (0.0172)
$\ln \bar{p}_{l,Rt}$	$\varphi_2$	0.8243 (0.5901)	$\ln w_{3,i,t}$	$\beta_3$	0.6995*** (0.0143)
$\ln r g d p_t$	$\varphi_3$	1.7298** (0.7495)	$\frac{1}{2} \ln w_{1,i,t}^2$	$\beta_{11}$	0.0934*** (0.0203)
$\ln F A_{i,t}$	$\varphi_4$	0.8249*** (0.0401)	$\frac{1}{2} \ln w_{2,i,t}^2$	$\beta_{22}$	0.0830*** (0.0185)
Trans-log cost system (equation 4.8 and 4.9): Dependent Variable $\ln C_{i,t}$			$\frac{1}{2} \ln w_{3,i,t}^2$	$\beta_{33}$	0.2002*** (0.0071)
<i>Constant</i>	$\beta_0$	9.0595*** (0.0603)	$\ln w_{1,i,t} \ln w_{2,i,t}$	$\beta_{12}$	0.0119 (0.0157)
$\ln y_{1,i,t}$	$\delta_1$	0.7111*** (0.0742)	$\ln w_{1,i,t} \ln w_{3,i,t}$	$\beta_{13}$	-0.1053*** (0.0089)
$\frac{1}{2} \ln y_{1,i,t}^2$	$\delta_{11}$	-0.0692*** (0.0175)	$\ln w_{2,i,t} \ln w_{3,i,t}$	$\beta_{23}$	-0.0949*** (0.0087)
$\ln y_{1,i,t} \ln w_{1,i,t}$	$\gamma_{11}$	-0.0523*** (0.0004)	Pricing equation (equation 4.12): Dependent variable $p_{i,t}$		
$\ln y_{1,i,t} \ln w_{2,i,t}$	$\gamma_{12}$	-0.0580*** (0.0225)	Conjectural variation parameter	$\lambda$	0.3452 (0.2291)

<sup>79</sup> Note: 1: \* indicates 10% significance level, \*\* indicates 5% significance level, \*\*\* indicates 1% significance level. Note 2: The restrictions for symmetry and linear homogeneity in prices  $\sum_k \beta_k = 1$ ;  $\sum_k \gamma_{1k} = 0$ ;  $\sum_l \beta_{kl} = 0$  are imposed. Note 3: Since the above restrictions are imposed directly into the Eviews files, therefore the standard errors of coefficients of  $\ln y_{1,i,t} \ln w_{1,i,t}$ ,  $\ln w_{3,i,t}$ ,  $\frac{1}{2} \ln w_{1,i,t}^2$ ,  $\frac{1}{2} \ln w_{2,i,t}^2$ ,  $\frac{1}{2} \ln w_{3,i,t}^2$  are calculated by hand. In the Eviews, the standard errors of the reported coefficients are the square roots of the diagonal elements of the coefficient covariance matrix. The formula of calculating standard error for sum of two variables is  $se_{1+2} = \sqrt{se_1^2 + se_2^2 + 2covariance_{1,2}}$ . The covariance matrix is shown in Appendix B.1.

In the demand equation, the coefficients of  $\ln p_{i,t}$  and  $\ln \overline{p_{l,Rt}}$  have the expected sign. The own-price elasticity,  $\varphi_1$ , is negative and significant at -1.0778.<sup>80</sup> It confirms a downward sloping demand curve for the Hong Kong bank loans market. The cross-price elasticity,  $\varphi_2$ , is positive and significant at 0.8243, which implies that loans offered by different banks are substitutes. Since the elasticity of demand is larger than 1, the demand for loans seems to be elastic. Similar to the results of Wong et al. (2007) and Coccorese (2005), the absolute value of own-price elasticity is larger than the absolute cross-price elasticity, which indicates that the loan demand is more sensitive to the variation in the price offered by the bank in which the customers currently bank with,  $\ln p_{i,t}$ . However, the difference between the two values of elasticity is small. The coefficient of real GDP is positive and significant at 1.7298, as expected, which shows a positive relationship between real GDP and loan demand. Then, looking into the bank characteristics, the coefficient of  $\ln FA_{i,t}$ ,  $\varphi_4$ , is positive and significant at 0.8249. This shows that customers prefer to borrow from large banks than small banks. Therefore, it presents a good proxy of the banks' network size effect over the loan demand.

In the trans-log cost system, similar results are obtained as in Chapter 3. All the coefficients have the same sign as before, except for the coefficient of  $\frac{1}{2} \ln y_{1,i,t}^2$ . According to the results from Table 4.3, the coefficient of bank loans  $\delta_1$  is positive

---

<sup>80</sup> As a robustness check, I substitute the estimated sensitivity of the transition probability to the bank's own interest rate  $\alpha_1$  in Chapter 3, which is equal to -4.7367 in equation 4.14. The average own-price elasticity can be calculated equal to -1.3953, which is negative, as expected. It is not far away from the own-price elasticity estimated in this chapter.

and significant at 0.7111, which indicates the existence of economic of scale. All of the coefficients of exogenous input prices are positive and significant.

According to the results, the value of the conjectural variation parameter  $\lambda$  is 0.3452 but insignificant. This suggests that there is no evidence of oligopolistic coordination between banks in Hong Kong bank loans market during 1997 to 2012. The market behaviour is coherent with a Nash-Bertrand equilibrium in prices. These findings are consistent with Wong et al. (2006, 2007), who shows that the market can neither be classified as a monopoly nor be considered as perfect competition. Ho (2010) also indicates that the Hong Kong bank loans market is regarded as a Nash-Bertrand equilibrium. Compared with the findings of Coccoresse (2005) for the Italy banking industry, the Hong Kong bank loans market is less competitive than Italy. The value of the average conjectural variation parameter is always negative and significant for the case of Italy. This is mainly due to the banking industry being well regulated in Hong Kong, hence the interest rate regulations and entry restrictions are stronger. The market size in Hong Kong is relative small therefore not all banks can fully exercise economics of scale. This is the reason Hong Kong banking industry is considered more concentrated and less competitive.

Both retail and wholesale banking market in Hong Kong are already well developed and dominated by several large banks like HSBC, Bank of China, Standard Chartered and Bank of East Asia. HSBC accounts for the largest market share, as measured by bank loans in the Hong Kong market which reached to 27% in 2012. The Asian Financial Crisis of 1997 has put more pressure on banks in

Hong Kong to find new ways to enhance revenue and reduce cost. In a competitive banking market like Hong Kong, it is difficult for banks to increase market share or margins, therefore it is becoming more likely that banks will seek to expand and cut costs by mergers and acquisitions. In addition, environmental factors such as market liberalization, technological development, globalisation and the pressure from shareholder also boosted the merger and acquisitions activities in Hong Kong (BIS, 2001; Jiang et al. 2004). The major reason for the decline of the number of authorized institutions in Hong Kong from 1997 to 2012 was bank consolidation through mergers and acquisitions. Table 2.2 in Chapter 2 summarises the major mergers and acquisitions activities taken place in Hong Kong after 1997. One of the representative deals is the consolidation of the ten banks in Hong Kong that originally belonged to the Bank of China Group into the Bank of China (Hong Kong) in 2001. Figure 2.2 in Chapter 2 describes the trend of 3-bank concentration ratio and 5-bank concentration ratio of Hong Kong. It can be seen from the figure that these two ratio sharply increased from 2001, largely reflecting merger and acquisition activity. According to the theory, interest spread is wider through merger and acquisition activities which will result in the decrease of interest elasticity demand for loans, may lead to collusive and non-competitive behaviour (Freixas and Rochet, 1997). But according to the results from Chapter 4, the estimated conjectural variation parameter is insignificant, which suggests there is no significant evidence of collusion on pricing in the market during the period 1997 to 2012. It can be argued that the merger and acquisition activity of banks in Hong Kong has had little effect on the collusive behaviour of Hong Kong banks.

**Table 4.4 Empirical results of the conjectural variation parameter using GMM. Included observation=274. Standard errors are in parenthesis** <sup>81</sup>

Variable	Parameter	Coefficient	Variable	Parameter	Coefficient
Demand equation (equation 4.7): Dependent Variable $\ln y_{1,i,t}$			$\ln y_{1,i,t} \ln w_{3,i,t}$	$\gamma_{13}$	0.1252*** (0.0376)
<i>Constant</i>	$\varphi_0$	-16.9352* (8.8185)	$\ln w_{1,i,t}$	$\beta_1$	0.1462*** (0.0148)
$\ln p_{i,t}$	$\varphi_1$	-0.8263*** (0.2567)	$\ln w_{2,i,t}$	$\beta_2$	0.1478*** (0.0181)
$\ln \bar{p}_{l,Rt}$	$\varphi_2$	0.3753 (0.4032)	$\ln w_{3,i,t}$	$\beta_3$	0.7060*** (0.0137)
$\ln r g d p_t$	$\varphi_3$	1.4485** (0.6861)	$\frac{1}{2} \ln w_{1,i,t}^2$	$\beta_{11}$	0.0905*** (0.0202)
$\ln F A_{i,t}$	$\varphi_4$	0.8170*** (0.0365)	$\frac{1}{2} \ln w_{2,i,t}^2$	$\beta_{22}$	0.0804*** (0.0178)
Trans-log cost system (equation 4.8 and 4.9): Dependent Variable $\ln C_{i,t}$			$\frac{1}{2} \ln w_{3,i,t}^2$	$\beta_{33}$	0.2089*** (0.0073)
<i>Constant</i>	$\beta_0$	9.0937*** (0.0640)	$\ln w_{1,i,t} \ln w_{2,i,t}$	$\beta_{12}$	0.0190 (0.0159)
$\ln y_{1,i,t}$	$\delta_1$	0.7075*** (0.0653)	$\ln w_{1,i,t} \ln w_{3,i,t}$	$\beta_{13}$	-0.1095*** (0.0085)
$\frac{1}{2} \ln y_{1,i,t}^2$	$\delta_{11}$	-0.0931* (0.0188)	$\ln w_{2,i,t} \ln w_{3,i,t}$	$\beta_{23}$	-0.0994*** (0.0086)
$\ln y_{1,i,t} \ln w_{1,i,t}$	$\gamma_{11}$	-0.0623 (0.0598)	Pricing equation (equation 4.12): Dependent variable $p_{i,t}$		
$\ln y_{1,i,t} \ln w_{2,i,t}$	$\gamma_{12}$	-0.0629*** (0.0236)	Conjectural variation parameter	$\lambda$	0.6001 (0.5895)

<sup>81</sup> Note: 1: \* indicates 10% significance level, \*\* indicates 5% significance level, \*\*\* indicates 1% significance level. Note 2: The restrictions for symmetry and linear homogeneity in prices  $\sum_k \beta_k = 1$ ;  $\sum_k \gamma_{1k} = 0$ ;  $\sum_l \beta_{kl} = 0$  are imposed. Note 3: Since the above restrictions are imposed directly into the Eviews files, therefore the standard errors of coefficients of  $\ln y_{1,i,t} \ln w_{1,i,t}$ ,  $\ln w_{3,i,t}$ ,  $\frac{1}{2} \ln w_{1,i,t}^2$ ,  $\frac{1}{2} \ln w_{2,i,t}^2$  and  $\frac{1}{2} \ln w_{3,i,t}^2$  are calculated by hand. In the Eviews, the standard errors of the reported coefficients are the square roots of the diagonal elements of the coefficient covariance matrix. The formula of calculating standard error for sum of two variables is  $se_{1+2} = \sqrt{se_1^2 + se_2^2 + 2covarince_{1,2}}$ . The covariance matrix is shown in Appendix B.1.

Moreover, this model is estimated using the GMM approach as a robustness check. The results are shown in Table 4.4. According to Table 4.4, although some parameters are not significant using the GMM approach, all of the estimated coefficients have the same signs as the non-linear 3SLS results. The conjectural variation parameter is positive and not significant at 0.6001, which is larger than using the non-linear 3SLS approach. These results are mainly due to the relative low cross-price elasticity obtained using GMM approach, although this coefficient is not significant using the GMM approach. Banks tend to rely more on market power to make profit. These estimation results confirm that there is no evidence of oligopolistic coordination between banks in the Hong Kong bank loans market. The market can be considered as a Nash-Bertrand equilibrium for the period 1997 to 2012. The market structure of the Hong Kong banking industry can be considered as oligopolistic competition. These results are consistent with the findings of Ho (2010), in which the conduct parameter is positive but insignificant at 0.7. In addition, these findings are also consistent with Wong et al. (2007), in that the conjectural variation parameter is -0.0023 and is not significant.

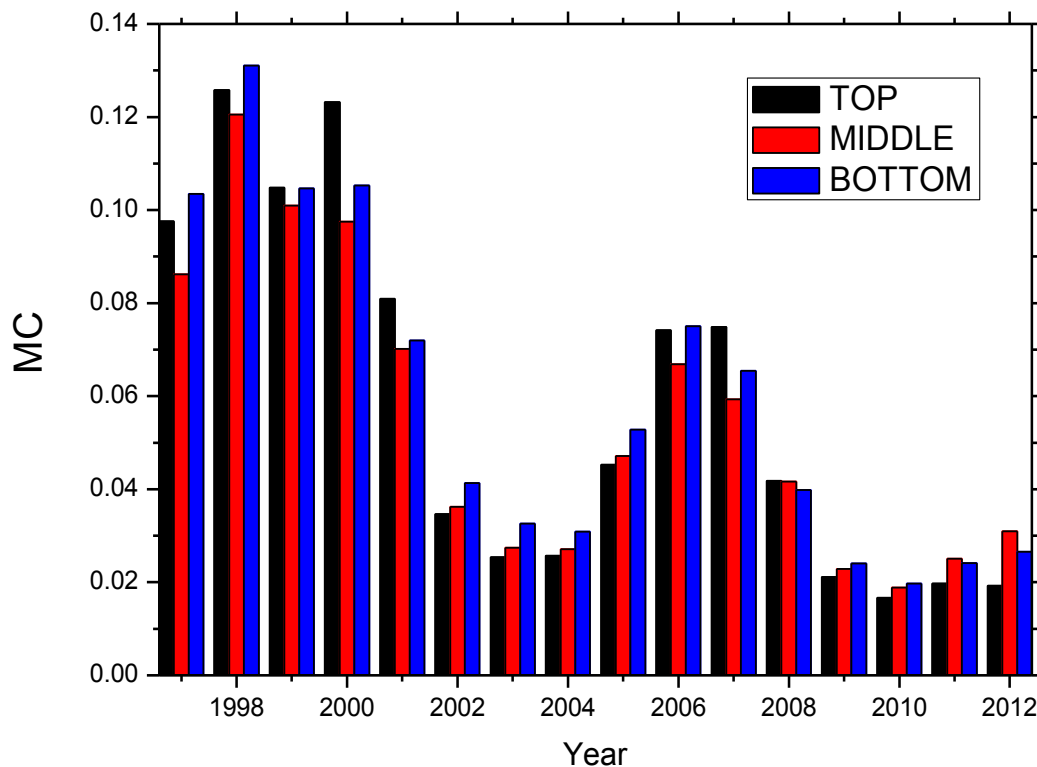
### **4.4.3 Marginal costs: A comparison between Chapter 3 and 4**

Figures 4.1 and 4.2 depict the general trend in marginal costs of three bank groups from year 1997 to year 2012 based on the model of Chapter 3 and the model of this chapter, respectively. The classification of these three groups is the same as that used in Chapter 3, as follows. According to the market shares, as measured by



banks loans in 2012, all of the banks are divided into three groups. I then use the top three banks (i.e. HSBC, Bank of China and Hang Seng) to represent large banks, three middle banks (i.e. Nanyang Commercial Bank, Wing Hang and CITIC) to express the middle banks, and three bottom banks (i.e. Fubon, Chiyu and Public) to represent the small banks. Although in general the marginal costs obtained using conjectural variation approach are relatively smaller than that using the model to estimate switching costs, there is not much difference in the overall pattern between the two models. Therefore, the results obtained in this chapter are robust.

**Figure 4.1 Marginal costs of three bank groups in Chapter 3 using non-linear 3SLS**



**Figure 4.2 Marginal costs of three bank groups using non-linear 3SLS approach**

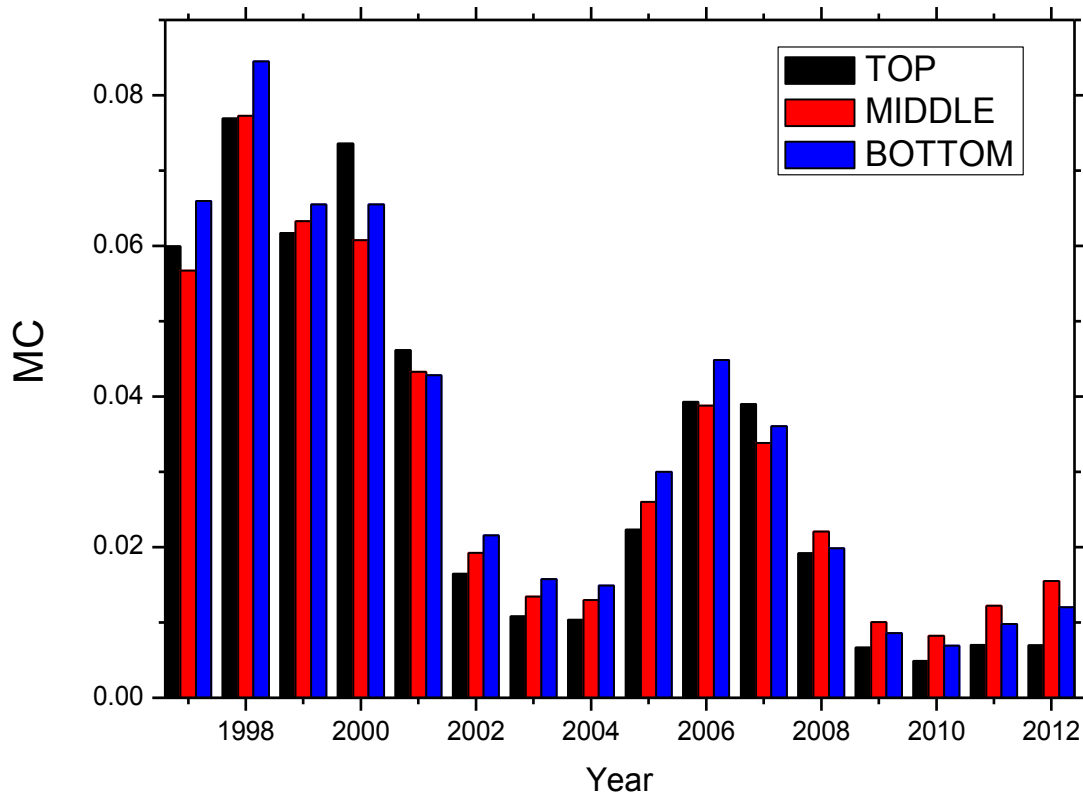
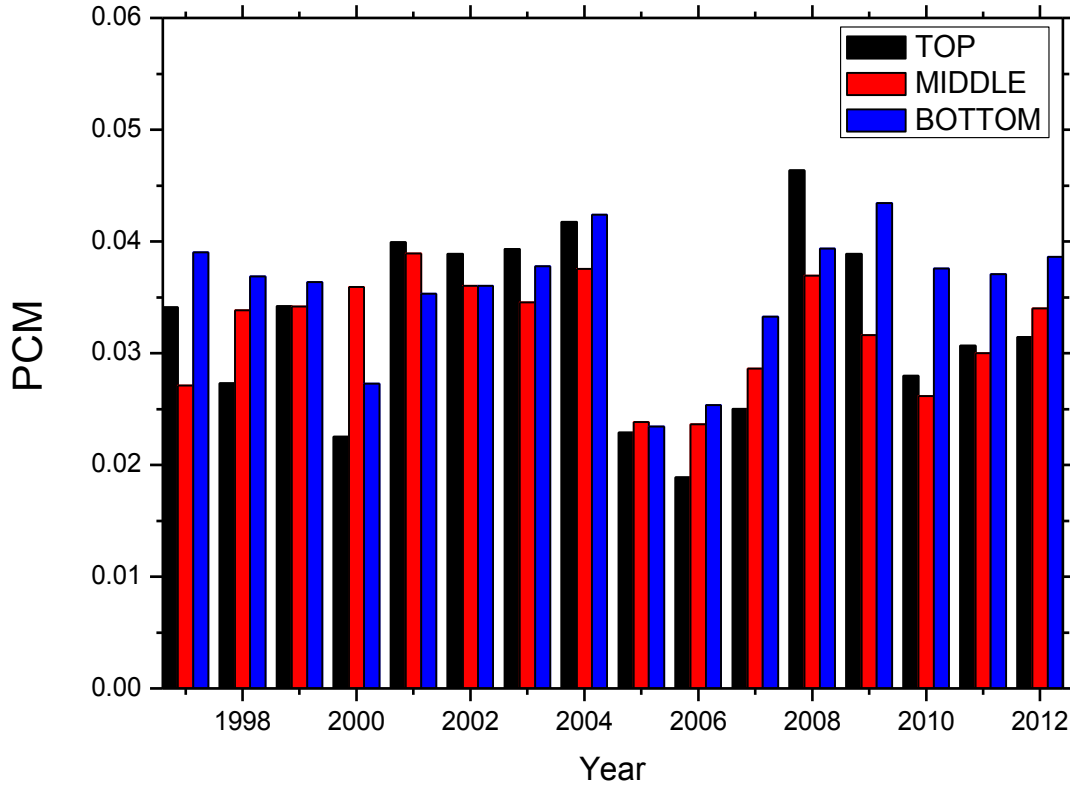


Figure 4.3 provides the price cost margin of three bank groups for the period 1997 to 2012. For the entire sample, the values of price cost margin range from 0.68% to 6.50%. The average price cost margin based on the entire sample is 3.27%. Compare with the case of Italy (Coccoresse, 2005) and Turkish (Aydemir, 2013), the price cost margin in Hong Kong is much smaller.

Figure 4.3 Price cost margin



#### 4.4.4 Summary

This chapter measures the degree of collusion and the nature of competitive condition among the 18 Hong Kong banks during 1997 to 2012 using a conjectural variation approach. The empirical results suggest that the bank behaviour is coherent with a Nash- Bertrand equilibrium in the Hong Kong bank loans market in which the conjectural variation parameter  $\lambda$  is insignificant at 0.3452 using a non-linear 3SLS approach. In addition, there is no significant evidence of collusion on pricing in Hong Kong bank loans market. As a robustness test, using the GMM approach the conjectural variation parameter is positive and

insignificant at 0.6001, which is relatively larger than using non-linear 3SLS approach. These findings are consistent with Wong et al. (2007) and Ho (2010). The trend of marginal costs and price-cost margins of banks presented in this section is consistent with the results in Chapter 3.

## **4.5 Conclusion**

By using the conjectural variation approach, this chapter measured the degree of collusion and competitive condition among the 18 banks incorporated in Hong Kong during 1997 to 2012. The evidence from the empirical results suggests that Hong Kong banking is characterized by oligopolistic competition and the bank behaviour is coherent with a Nash- Bertrand equilibrium in which the conjectural variation parameter is insignificant at 0.3452 using a non-linear 3SLS approach while the number is 0.6001 using a GMM approach. In addition, the pattern of marginal costs and price cost margins is consistent with that of Chapter 3. Therefore, the empirical results are robust.

Hong Kong banks face fierce competition. The Hong Kong government is committed to promote competition in order to enhance economic efficiency and free trade, and thereby also improve consumer welfare. Before 1997, there was no competition policy in Hong Kong. After the Competition Policy Advisory Group (COMPAG), which was supervised by the Financial Secretary, was established in December 1997, the first Statement on Competition Policy was promulgated in May 1998 to provide a policy framework to guide the market and to promote

competition. From the view of the consumer, the experience of competition policy in the Hong Kong banking industry is that it leads to lower prices, product innovation, more choices and improved services. But from the view of the banks, this policy also increases the competition in the banking market. Many strategies have been adopted by banks to beat the increasing level of competition. For example, they may increase their share in the mortgage market while some banks offer cash rebates to mortgage borrowers up to 8%. Since the interest-earning business is becoming more difficult, banks are increasingly relying on non-interest earning business, such as insurance, stock transactions, bonds sale.

Shanghai's new free-trade zone (FTZ), which launched on September 2013, may also bring competitive pressure to bear on the Hong Kong banking industry. Although there is no immediate competition from the FTZ, Hong Kong banks should not relax. Over the past few decades, Hong Kong has enjoyed considerable benefits as a gateway for foreign investors wanting to invest in mainland China. Following the launch of the Hong Kong-like free trade area in Shanghai, Hong Kong will no longer be able to maintain the same status as a gateway to the Mainland and, therefore, Hong Kong banks should introduce new services and products to compete in this rapidly evolving environment.

# Chapter 5

## Competitive Condition in the Hong

## Kong Banking Sector:

## The Panzar-Rosse Approach

### 5.1 Introduction

As one of the most important international financial centres, Hong Kong has one of the most concentrated<sup>82</sup> and competitive banking industries in the world. In the past two decades, the operating environment in Hong Kong's banking sector has experienced great changes, such as regulatory liberalisation. Since 1999, a Bank Sector Reform Programme has been undertaken by the HKMA, The HKMA has gradually removed several barriers to competition, including regulated interest rates, branching restrictions for foreign banks, and limited access of restricted licence banks to the Real Time Gross Settlement (RTGS) system<sup>83</sup>. The relaxation of economic policy can increase market competition, and consequently improve economic efficiency in Hong Kong. However, it may also reduce the market power

---

<sup>82</sup> Reflecting this, as discussed in chapters 1 and 2, the 3-bank concentration ratio and the 5-bank concentration ratio of Hong Kong calculated by World Bank are high at 72.15 and 81.39 respectively in 2011. According to the half-year monetary and financial stability report from HKMA 2006, the Herfindahl-Hirschman Index (HHI) of the banking sector in Hong Kong is around 0.14 in 2005. In addition, I have also calculated the HHI of 18 licensed banks in Hong Kong during 1997 to 2012, and found that the HHI of this sample ranges from 0.19 to 0.22.

<sup>83</sup> The detail of policies responses after the Asian financial crisis can be found in Chapter 2 (p.35).

and profitability of Hong Kong's banks. Therefore, it is important for policymakers to understand the competition in banking sector and how it has evolved over time.

In the previous chapter, in order to assess the market conduct of Hong Kong banks for the period 1997 to 2012, a structural model formed by a log demand equation (equation 4.7), a trans-log cost system (equation 4.8 and 4.9), and a pricing equation (equation 4.12) was estimated using a conjectural variation approach. The results suggest that banks behaviour in Hong Kong bank loans market is consist with a Nash-Bertrand equilibrium. Banks in Hong Kong operated in a competitive fashion in the loan market during the period 1997 to 2012, with no significant evidence of collusion on pricing. As pointed by Shaffer (2004a, b), the conjectural variation approach has a number of disadvantages: firstly, it is sensitive to market definition; secondly, it requires non-linear system estimation; thirdly, it can be subject to multicollinearity; fourthly, the requirements of data are higher; and lastly, it can be fooled by expense preference behaviour. Using simulation experiments, Hyde and Perloff (1995) conclude that the structural model requires more data and more explicit assumptions than the other two methods. If the specification is correct, then it is the most accurate approach, although there is no way to know whether or not it is correctly specified.

In this chapter, I aim to examine the competitive conditions in Hong Kong's banking sector using the Panzar-Rosse (P-R) approach. To do this estimation, I have estimated two equations jointly that use the SUR approach: the first is a reduced form revenue equation and the second is an equilibrium condition

equation<sup>84</sup>. The findings show that banks in Hong Kong can be characterised as monopolistically competitive, the H- statistic is equal to 0.5069 using total revenue as dependent variable. Moreover, I use interest income and non-interest income as dependent variables of the reduced form revenue equations and compare the degree of competition between interest earnings part and non-interest earnings part of the bank's revenue stream. The results suggest that the degree of market competition of interest earnings area is slightly higher than that of non-interest area. In addition, in order to consider the time evolution of competition for interest and non-interest streams, I estimate the P-R model for a six years rolling sample. The results show that in the interest stream there is a gradual declining trend in the values of the H-statistics. Compared with the bad times, the Hong Kong bank interest earnings stream is more competitive during the good times. For the non-interest case, the values of the H-statistic have fluctuated sharply over the period.

This chapter contributes to the extant literature in banking competition in Hong Kong in several ways. First, I extend the period to 2012 using a P-R approach. Second, due to the system residuals, I estimate the model as a system using the SUR approach. This has not been previously done in the P-R literature. Third, by estimating the model for a six year rolling sample, the results show the evolvement of competition for both interest and non-interest markets.

The rest of this chapter is organised as follows: Section 5.2 discusses the related literature using P-R approach and outlines the P-R empirical model; Section 5.3

---

<sup>84</sup> When interest income and non-interest income are used as dependent variables of the reduced form revenue equations, there are two revenue equations in the system. Therefore, in total, three equations are jointly estimated using SUR approach.



shows the data and variables used in empirical estimation; Section 5.4 details the econometric methods and presents the empirical results using total revenue, interest income or non-interest income as dependent variable of reduced form revenue equation; and finally, Section 5.5 summarizes the findings and concludes the chapter.

## **5.2 Literature reviews and methodology**

### **5.2.1 Introduction**

As discussed in Chapter 4, many methods have been developed to measure market competition. These methods can be divided into two main streams: structural and non-structural approaches. The Panzar-Rosse (P-R) approach is a non-structural method that is widely used in empirical banking studies. In this section I focus on the literature using a P-R approach, I will also present P-R's empirical model for testing market competition.

### **5.2.2 Literature reviews**

#### **5.2.2.1 The Panzar and Rosse approach**

The P-R model, which was developed by Rosse and Panzar (1977), and Panzar and Rosse (1982, 1987), is regarded as a key method of measuring the degree of competition in the new empirical industrial organization literature. This approach, which can be formally derived from profit-maximizing equilibrium conditions,

estimates a reduced form revenue equation. The H-statistic, which is a measure of bank competition, can be obtained as the sum of the elasticities of a bank's revenue with respect to input prices. This statistic ranges from minus infinity to unity. Panzar and Rosse (1977, 1987) show that banks are in a pure monopoly market when this statistic is negative or zero. This situation includes collusive oligopoly and may also include conjectural variation short run oligopoly (Shaffer 1982, 1983). An increase of input prices, which shifts average cost curve and marginal cost curve upward, will result in no change or decrease in revenue. One unit increase in input prices will result in more than one unit fall in output sold. When the H-statistic equal to one, the market is under perfect competition. In this case, an increase in both average cost and marginal cost due to an increase in input prices will lead to a one-to one increase in revenues without altering the optimal output of individual firms. For intermediate cases where the H-statistic is between zero and one, the market is characterized by monopolistic competition. An increase of input prices increases the average and marginal costs. This leads to the exit of loss-making banks and a subsequent increase in revenue.

It is worth noting that an important condition to get accurate results, especially for perfect competition and monopolistic competition conclusion based on the H-statistic, is that the market should be in a long-run equilibrium (Panzar and Rosse, 1987). This means that the number of banks needs to be endogenous to the model. Shaffer (1982) regressed Return on Asset (ROA)<sup>85</sup> on input prices and some control variables, and indicates that in the long-run equilibrium the dependent

---

<sup>85</sup> The case is same if using Return on Equity (ROE) as dependent variable.

variable should not be correlated with input prices. In addition, the extension of the P-R method to banking requires some further assumptions about the banks' production activity. De Bandt and Davis (2000) point out that the banks need to be assumed to be a single product firm. Under this assumption, the banks are viewed mainly as financial intermediaries that produce intermediation services by using elements such as labour, capital and deposits as inputs. Molyneux et al. (1996) show that one assumes that there is no causal relationship with input prices and services quality because such a correlation may bias the H-statistic. Moreover, the model assumes that the banks are profit maximizing firms while the performance of banks needs to be influenced by the actions of other market participants. The price elasticity of demand need to be greater than one, and the cost structures of banks are homogenous (Bikker, 2004).

### **5.2.2.2 Some earlier studies using P-R approach**

Shaffer (1982) observes a monopolistic competitive banking behaviour of New York banks for 1979. This was a pioneering study on bank competition using the P-R method. Some earlier studies, such as Nathan and Neave (1989), applied the P-R model to the Canadian financial system and found that Canada's banking market is characterized by monopolistic competition for the period 1983 and 1984, but is characterized by perfect competition in 1982. In addition, Molyneux et al. (1994) suggested that major European Community banking markets in Germany, the UK, France, and Spain operated under conditions of monopolistic competition between 1986 and 1989. But for Italy, the H-statistic is negative and significant,

hence it seems to operate under monopoly or conjectural variations short-run oligopoly conditions. Moreover, Vesala (1995) tested the competitive condition in the Finnish banking industry over the period 1985 to 1993, and found monopolistic competitive behaviour, except for 1989 and 1990, where the banking market is characterized by perfect competition. In addition, Molyneux et al. (1996) tested the P-R statistic on a sample from Japan and indicate that these banks behaved as monopoly or conjectural variation short-run oligopoly in 1986 but as under monopolistic competition in 1988. Some other researchers have used the P-R method for a single country, such as Coccorese (1998, 2004) for Italy, Shaffer (2004b) for United States, Matthews et al. (2007) for the UK. There have also been some cross-country studies, including: Bikker and Groeneveld (2000) for 15 EU countries; De Bandt and Davis (2000) for France, Germany and Italy; Bikker and Haaf (2002a) for 23 OECD countries; Clasessens and Leaven (2004) for 50 countries; Goddard and Wilson (2009) for Canada, France, Germany, Italy, Japan, UK, and US; Schaeck et al. (2009) for 45 countries; and, Carbo et al. (2009) for 14 EU countries. Bikker et al. (2012) summarizes most of the published studies that have used the P-R method to the banking industry up to 2009.

### **5.2.2.3 Recent studies using P-R approach**

It is noted that many of the earlier applications of the P-R model were conducted in western and developed countries, such as EU and US banks. However, more recent studies have extended the literature by applying the P-R model in other markets; for example, Africa and Asia. Hamza (2011) uses a comprehensive panel

dataset of Tunisian banks covering the period 1999 to 2008 to investigate the market structure of the banking industry in Tunisia. The results imply that the banks in Tunisia are under monopolistic competition. Abdelkader and Mansouri (2013) obtain the same results by using the dataset of 2000 to 2008. Using both static and dynamic version of the P-R model, Fosu (2013) examined the extent of banking competition in African sub-regional markets over the period 2002 to 2009. The results suggest that African banks generally demonstrate monopolistic competitive behaviour consistent with other emerging economies. He also finds that, compared with dynamic P-R, the H-statistic of static P-R is downward biased.

The number of empirical studies on banking competition in China that have used the P-R model is limited. Yuan (2006) used the P-R model to assess the competition in the banking industry in China from 1996 to 2000. Their evidence shows that the banking system in China was near a state of perfect competition before foreign banks entered into China's financial market. Using similar specifications as Yuan (2006), Xu et al. (2013) found that the market structure of the Chinese loan market can be characterized by monopolistic competition for the period 1996 to 2008. Then, Park (2013) compared the market concentration and competition in the South Korean and Chinese commercial banking market for the period 1992 to 2008. He shows that the Korean banking industry has been monopolistically competitive for the whole sample but the Chinese banking industry is highly concentrated and its behaviour is close to oligopolistic competition. For other recent banking literatures of the P-R model, see: Bikker et al. (2012) for 63 countries; Shaffer and Spierdijk (2013) for Dewey County (South Dakota, USA); Owusu-Antwi and Antwi (2013) for Ghanaian banks; Olszak et al.

(2014) for Poland; Najarzadeh et al. (2013), and Kashi and Beynabadi (2013) for Iran's banking system; and, Fadzlan and Muzafar Shah (2013) for the Malaysian banking sector.

#### **5.2.2.4 The case of Hong Kong**

The P-R model has been employed in a small number of empirical studies on bank competition in Hong Kong. Using the P-R approach, Jiang et al. (2004) show that the Hong Kong banking sector remains highly competitive, which can be regarded as perfect competition for the period 1992 to 2002. Then, Wong et al. (2006) confirmed the findings of Jiang et al. (2004) that the degree of competition was fairly high during the period 1992 to 2002. By extending the sample period to 2005, they suggest that the Hong Kong market can be characterized as monopolistic competition during the period 1991 to 2005. They also show that competitive pressure was higher among larger banks and lower among smaller banks. In line with previous findings, Chu et al. (2013) shows that the banking sector in Hong Kong is under a monopolistic competition, and the large banks and small banks face equally competitive pressures based on 20 major banks from 1998 to 2011. They also deduce that the market seems to be very competitive and is dominated by a large amount of banks at the same time.

### **5.2.2.5 Non-banking studies**

The application of P-R method is much broader and can be also used in non-banking studies. For instance, Tsutsui and Kamesaka (2005) investigated the competitive condition of the Japanese securities industry over the period 1983 to 2001 using the P-R approach. Their results indicate that the Japanese securities market was in monopolistic competition during 1983 to 1988 and 1997 to 2002, but in monopoly equilibrium during 1991 to 1996. Coccoresse (2012) applied the P-R method in the Italian car insurance market. He showed that the group of firms which including 30 companies by Italian Antitrust Authority in 2000 is under monopoly or collusive oligopoly conditions. Sepúlveda (2012) estimates the degree of competition among Pension Fund Administrators (PFAs) in the Chilean private pension system for the period 1996 to 2008. The results indicate that the market can be described as a cartel (or monopoly) during that period. For some other literature, see: Wong (1996) for a sample of physicians; Fischer and Kamerschen (2003) for the US airline industry; and, Liu et al. (2013) for China's construction industry, among others.

### **5.2.2.6 The advantages and disadvantages of the P-R approach**

The P-R method has a large number of advantages, which is the reason for its popularity in the empirical literature. First, it has lower data requirements, the P-R method only involves firm-level data and it requires only a few variables. Secondly, it can be estimated by simple, single and linear equations. Lastly, it is robust to the geographic extent of the market (Shaffer, 2004b). As pointed out by

Shaffer (2004a, b), compared with the Bresnahan-Lau model, the P-R method has certain shortcomings. The main disadvantage is that the H-statistic can yield a spurious indication of market power if the sample is not in long-run equilibrium.

Since the market is not always in equilibrium, Goddard and Wilson (2009) modified the static P-R model to allow for partial adjustment towards equilibrium. They proposed a dynamic version of the P-R model, which included a lagged dependent variable in the right hand side of the equation. They used a Monte Carlo simulation to show that the H-statistic of a static P-R model is biased when the market is under disequilibrium. Another concern of the P-R method is caused by the econometric identification problem.<sup>86</sup> Using simulation experiments, Hyde and Perloff (1995) demonstrate the strengths and weaknesses of the P-R, Hall and structural approaches to estimating market power. They conclude that the structural model requires more data and more explicit assumptions than the other two methods. If the specification is correct, then it is the most accurate approach, but there is no way to know whether it is correctly specified. The P-R method is easier to use than the structural model approach, but for many models the P-R method cannot distinguish between collusion and competition.

Although the P-R model has been used in various modified forms, some of the modified forms have been criticized in the literature. According to the choice of dependent variable, the empirical P-R model can be classified into two categories.

---

<sup>86</sup> Panzar and Rosse (1987, p.452) show that in a neoclassical competitive industry with a horizontal long-run industry supply curve, the market demand will not affect a firm's reduced-form revenues. Therefore, the market demand need not be estimated in the empirical model. On the other hand, if the assumption of perfectly elastic aggregate supply is violated, the input prices will increase endogenously as the industry expands, then the empirical model should be modified for this situation.



Some studies use total income or interest income as dependent variables; for example, Bikker and Haaf (2002a). Other studies have used a scaled version of bank income that takes total income or interest income divided by total assets as a dependent variable. In this case, the logarithm of income divided by total assets can be considered as a proxy of the output price. Then, the equation becomes a log-log price equation instead of a revenue equation; for example, De Bandt and Davis (2000) and Olszak et al. (2014). The latter modified form is criticized by Bikker et al. (2006), who suggest that a pricing equation changes the nature of the model, which will lead to a biased H-statistic in the measurement of competition. They further suggest that only an unscaled revenue equation, which does not include total assets as a control variable,<sup>87</sup> yields a valid measure for competitive conduct (Bikker et al., 2012). This conclusion is confirmed by an empirical study based on a sample containing more than 17,000 banks in 63 countries during 1994 to 2004.

### **5.2.3 Methodology**

The P-R model assumes that banks can enter or leave any market quickly without losing their capital. Banks are single product firms and there is no causal relationship with input prices and services quality. Moreover, the model assumes that the banks are profit maximizing firms while the performance of banks needs to be influenced by the actions of other market participants. The price elasticity

---

<sup>87</sup> In some literature, total assets is used to control for the firms size. For instance, Nathan and Neave (1989), Molyneux et al. (1996), Coccoresse (2009).

of demand needs to be greater than one and the cost structures of banks are homogenous. Then, bank  $i$  maximises its profits when marginal revenue is equal to marginal cost:

$$mr_i(y_i, n, \mathbf{z}_i) = mc_i(y_i, \mathbf{w}_i, \mathbf{t}_i) \quad (5.1)$$

where  $mr_i$  and  $mc_i$  are the marginal revenue and marginal costs of bank  $i$ , respectively,  $y_i$  is the output of bank  $i$ ,  $n$  is the number of banks,  $\mathbf{z}_i$  is a vector of exogenous variables that influence the bank  $i$ 's revenue,  $\mathbf{w}_i$  is a vector of  $m$  input prices of bank  $i$ , and  $\mathbf{t}_i$  is a vector of exogenous variables that shifts the bank  $i$ 's cost function.

Then, in the long-run equilibrium, there are no excess profits or entry in the market, a zero profit constraint holds:

$$R_i^*(y_i^*, n, \mathbf{z}_i) = C_i^*(y_i^*, \mathbf{w}_i, \mathbf{t}_i) \quad (5.2)$$

where the variables marked with an asterisk (\*) express the equilibrium values.

The market power can be measured as the extent to which a change in factor input prices is reflected in the equilibrium revenues of bank  $i$ . Therefore, the H-statistic is derived as the sum of input price elasticities:

$$H = \sum_{k=1}^m \frac{\partial R_i^*}{\partial w_{ki}} \frac{w_{ki}}{R_i^*} \quad (5.3)$$

When  $H \leq 0$ , banks are in a pure monopoly market. This situation includes collusive oligopoly and may include a conjectural variation short run oligopoly (Shaffer 1982, 1983). When  $H=1$ , the market is under perfect competition. Finally, when  $0 < H < 1$ , the market is characterized by monopolistic competition.

Followed by Bikker and Haaf (2002a), the empirical application of the P-R approach assumes a log-linear marginal revenue and cost function:

$$\ln mc_{it} = \rho_0 + \rho_1 \ln y_{i,t} + \sum_{k=1}^m \pi_i \ln ip_{k,i,t} + \sum_{j=1}^p v_k \ln EXC_{j,i,t} \quad (5.4)$$

and

$$\ln mr_{it} = \chi_0 + \chi_1 \ln y_{i,t} + \sum_{r=1}^q \xi_r \ln EXR_{r,i,t} \quad (5.5)$$

where  $\ln ip_{k,i,t}$  are the natural logarithms of factor input  $k$  of bank  $i$  at time  $t$ ,  $\ln EXC_{j,i,t}$  and  $\ln EXR_{r,i,t}$  are the natural logarithms of exogenous control variables related to the bank cost function and bank-specific demand function.

In equilibrium the marginal costs are equal to marginal revenues. Then, the equilibrium value for output can be written as

$$\ln y_i^* = (\rho_0 - \chi_0 + \sum_{k=1}^m \pi_i \ln ip_{k,i,t} + \sum_{j=1}^p v_k \ln EXC_{j,i,t} - \sum_{r=1}^q \xi_r \ln EXR_{r,i,t}) / (\chi_1 - \rho_1) \quad (5.6)$$

The reduced-from revenue equation of bank  $i$  is the product of the equilibrium values of output of bank  $i$  and the common price level, which is determined by the inverse demand equation.<sup>88</sup> This is shown in the following equation:

$$\ln Rev_{i,t} = \zeta + \sum_{j=1}^J \pi_j \ln w_{j,i,t} + \sum_{k=1}^K v_k \ln A_{k,i,t} + \sum_{n=1}^N \tau_n \ln M_{n,t} + \varrho_{i,t} \quad (5.7)$$

where  $Rev$  is either total revenue, interest income, or non-interest income; and  $w_j$  are the input prices. Consistent with Chapter 3 and 4, I use a three-dimensional vector of input prices.  $w_{1,i,t}$ ,  $w_{2,i,t}$  and  $w_{3,i,t}$  are three exogenous input prices on

---

<sup>88</sup>  $\ln p = \eta + \varpi \ln(\sum_i y_i^*)$

labour, capital and deposits respectively. A are bank-specific variables that affect the bank's revenue and cost functions, M are the macroeconomic variables that affect the banking market, and  $\varrho$  is a stochastic disturbance term.

The H-statistic can be calculated as the sum of elasticities of revenue with respect to each of the bank's J input prices, as follows:

$$H = \sum_{j=1}^J \pi_j \quad (5.8)$$

As discussed in literature review, an important condition to get accurate results, especially for a perfect competition or monopolistic competition conclusion based on the H-statistic, is that the market should be in a long-run equilibrium (Panzar and Rosse, 1987). Consistent with literature, such as Shaffer (1982), Molyneux et al. (1996) and Günalp and Celik (2006), the equilibrium test is performed by replacing the dependent variable in equation (5.7) with the logarithm of return on assets (*lnROA*), as shown in the following equation:

$$\ln ROA_{i,t} = \zeta' + \sum_{j=1}^J \pi_j' \ln w_{j,i,t} + \sum_{k=1}^K v_k' \ln A_{k,i,t} + \sum_{n=1}^N \tau_n' \ln M_{n,t} + \mu_{i,t} \quad (5.9)$$

The E-statistic is the sum of the elasticity of returns with respect to input prices

$$E = \sum_{j=1}^J \pi_j' \quad (5.10)$$

When  $E=0$ , the market is in the long-run equilibrium, while  $E<0$  indicates disequilibrium.

Since the revenue equation (equation 5.7) and equilibrium condition equation (equation 5.9) contain exactly the same set of regressors on the right hand side.

The error term in equation 5.7,  $\omega_{i,t}$ , seems correlated with the error term in equation 5.9,  $\mu_{i,t}$ . Therefore, equations 5.7 and 5.9 should be estimated jointly using seemingly unrelated regressions (SUR). Both models use bank fixed effect dummies<sup>89</sup>  $D_i$  to control for heterogeneity across banks. The average differences across banks in any observable or unobservable predictors are controlled.

### 5.2.4 Empirical model

In the empirical analysis, the following revenue equation is used:

$$\begin{aligned} \ln Rev_{i,t} = & \zeta + \pi_1 \ln w_{1,i,t} + \pi_2 \ln w_{2,i,t} + \pi_3 \ln w_{3,i,t} + v_1 \ln TA_{i,t} + v_2 \ln NLTA_{i,t} \\ & + v_3 \ln EQTA_{i,t} + v_4 \ln PRTA_{i,t} + \tau_1 \ln rgdp_g_t + o_i D_i + \varrho_{i,t} \end{aligned} \quad (5.11)$$

where TA is total assets to control for bank size, NLTA is the ratio of loans to total assets, which account for credit risk exposure, EQTA is the ratio of equity to total assets, which accounts for the leverage, reflecting differences in the risk preferences across banks, PRTA is the ratio of loan loss provisions to total assets, which controls for bank default risk,  $rgdp_g$  is the growth rate of real GDP, which affects the banking market,  $D_i$  is the bank dummies, measured by 1 for bank  $i$ , 0 for the other banks.  $\varrho$  is an error term.

Similarly, the equilibrium condition is modelled as

---

<sup>89</sup> One dummy variable is omitted to avoid the “dummy variable trap”.

$$\begin{aligned} \ln(ROA + 1)_{i,t} = & \zeta' + \pi_1' \ln w_{1,i,t} + \pi_2' \ln w_{2,i,t} + \pi_3' \ln w_{3,i,t} + v_1' \ln TA_{i,t} + \\ & v_2' \ln NLTA_{i,t} + v_3' \ln EQTA_{i,t} + v_4' \ln PRTA_{i,t} + \\ & \tau_1' \ln r g d p g_t + o_i' D_i + \mu_{i,t} \end{aligned} \quad (5.12)$$

Followed by Claessens and Laeven (2004), the adjusted return on assets,  $\ln(ROA + 1)$ , is used as a dependent variable because some values of return on assets are negative. Then, equations 5.11 and 5.12 are jointly estimated using the SUR approach. I then use a Wald test to test whether  $E = \pi_1' + \pi_2' + \pi_3' = 0$ . If the hypothesis is rejected, then the market is assumed not to be in equilibrium.

### 5.2.5 Summary

One of the most popular methods that is used to measure competition in the empirical literature is the P-R model. This approach estimates a reduced form revenue equation to obtain an H-statistic, which can be used to identify the extent of competition in a market. A great number of empirical studies have attempted to measure competition by using the P-R approach. This section has reviewed the earlier and recent literature using P-R model, especially that related to the banking industry. Furthermore, I have summarised the advantages and disadvantages of the P-R model. In addition, several modified forms of the P-R model and their criticisms have also been discussed here. The P-R model has been presented in this section in order to measure the degree of competition in the Hong Kong banking industry. Considering the correlation of residuals between reduced-from revenue equation (5.11) and equilibrium condition equation (5.12), the innovation of this chapter is jointly estimating these two equations using the SUR approach.

## **5.3 Data and variables**

### **5.3.1 Introduction**

The same dataset is used to test the market competition of the Hong Kong banking industry using the P-R approach. This section provides a relevant definition, measurement, and summary statistics for dependent variables and control variables, while the details of input prices are introduced in Chapter 3.

### **5.3.2 Data**

Consistent with Chapters 3 and 4, the empirical part of this chapter uses an unbalanced panel of Hong Kong bank-level data set taken from Bankscope and the Annual Reports of individual banks, covering the period 1997 to 2012. The data are annual and cover 18 licensed banks incorporated in Hong Kong.<sup>90</sup> I use data from unconsolidated statement to avoid redundant information, if available, otherwise a consolidated statement is selected. All of the nominal data used for measuring the degree of competition is deflated by the CPI (2009M10-2010M9=100), which is collected from DataStream.<sup>91</sup> A few bank observations with negative values of non-interest income are dropped from the data.<sup>92</sup> The details of data cleaning rules can be found in section 3.3.3 (p.94) of Chapter 3.

---

<sup>90</sup> The sample of banks is listed in Appendix A.2.

<sup>91</sup> Data Source: Census and Statistics Department, Hong Kong.

<sup>92</sup> The non-interest income of BOEA in 2008 which is equal to -210.63, CITIC in 2007 which is equal to -101.17 and Wing Lung in 2008 which is equal to -634.25 are dropped from the data.

The bank-level data used in both reduced-form revenue equation (equation 5.11) and the equilibrium condition (equation 5.12) contains total revenue, interest income, non-interest income, total assets, bank loans, equity and loan loss provisions.<sup>93</sup> The definition, measurement and summary of three exogenous input prices<sup>94</sup> is presented in Table 3.1 and Table 3.3 of Chapter 3. Macroeconomic variable include real GDP growth rate is also collected from DataStream.<sup>95</sup> The summary statistics of real GDP growth rate are presented in Table 4.2 of Chapter 4. Table 5.1 gives the definition and measurement of major variables, which are not shown in previous chapters. The summary statistics of these variables over the whole sample are presented in Table 5.2.

**Table 5.1 The definition and measure of variables (apart from the variables presented in Chapters 3 and 4)**

<b>Variable name</b>	<b>Definition of each variables</b>
$Rev_{i,t}$	The total bank revenue of bank $i$ at time $t$ , measured by total income ( $TI_{i,t}$ ) or interest income ( $II_{i,t}$ ) or non-interest income ( $NII_{i,t}$ ).
$TA_{i,t}$	The total assets of bank $i$ at time $t$ .
$NLTA_{i,t}$	The ratio of bank loans to total assets of bank $i$ at time $t$ .
$EQTA_{i,t}$	The ratio of equity capital to total assets of bank $i$ at time $t$ .
$PRTA_{i,t}$	The ratio of loan loss provisions to total assets of bank $i$ at time $t$ .
$rgdpg_t$	Real GDP growth rate in Hong Kong.
$ROA_{i,t}$	Return on assets measured by profits after tax divided by total assets.

<sup>93</sup> The bank level data include personal expenses, number of labours, total operating expenses, personal expense, interest expense, and deposits, which are used to calculate three input prices.

<sup>94</sup>  $W_1$  is the unit price of labour which is equal to personal expense divided by numbers of labour.  $W_2$  is the unit price of capital which can be calculated as non-personal expenses divided by fix assets.  $W_3$  is the unit price of deposits which is equal to interest expense divided by total deposits.

<sup>95</sup> Data Source: Oxford Economics.



**Table 5.2 Summary statistics (HKD million)**

<b>Variable</b>	<b>Obs.</b>	<b>Mean</b>	<b>S.D.</b>	<b>Min</b>	<b>Max</b>
$TI_{i,t}$	272	14598.20	27002.14	462.43	177322.00
$II_{i,t}$	272	10411.37	16764.29	401.23	103091.70
$NII_{i,t}$	269	4237.04	12971.16	44.11	96786.04
$TA_{i,t}$	272	327184.30	589309.70	10696.36	3536541.00
$NLTA_{i,t}$	272	0.51	0.11	0.25	0.80
$EQTA_{i,t}$	272	0.10	0.03	0.00	0.22
$PRTA_{i,t}$	271	0.00	0.00	-0.01	0.04
$rgdpg_t$	288	0.0357	0.0387	-0.0588	0.0870
$ROA_{i,t}$	272	0.01	0.01	-0.03	0.03

*Note: all the nominal data in the table is deflated by CPI.*

In order to find out the variation of all of the variables over time, I will break the whole period down year by year. Table 5.3 below shows the summary of above variables for year 1999, 2007 and 2012, which represent the early, middle and late years for the whole sample, respectively. It can be seen from the statistics that the average total income is HKD 11053.71 million (USD 1425.9286 million<sup>96</sup>), the average interest income is HKD 9788.3890 million (USD 1262.7022 million), and the average non- interest income is HKD 1265.3260 (USD 163.2271 million) in 1999. From 1999 to 2007, a considerable increase occurred of these numbers especially for the average non-interest income. In the year 2007, the average total income went up to HKD 23079.68 million (USD 2977.2787 million), which is

<sup>96</sup> In order to be consistent with previous chapters, I use the exchange rate of 1HKD=0.1290 USD. Data source: Bloomberg. Date: 4<sup>th</sup> June 2014.

more than twice as the number of 1999. The average interest income increased to HKD 16675.3700 million (USD 2151.1227 million) and the non-interest income sharply increased to HKD 6786.9870 million (USD 875.5213 million). But it can be seen from the statistics of 2012 that the US subprime crisis has had a certain effect on Hong Kong banking industry. The values of total income and interest income reduced in different degree compare with the values in 2007. The main reason is due to the decline of the lending rate from 2007. Since the Hong Kong dollar is pegged with the US dollar under the linked exchange rate system, HKD interest rates track closely with the US interest rates.

**Table 5.3 Summary statistics- year 1999, 2007 and 2012 (HKD million)**

Variable	1999		2007		2012	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
$TI_{i,t}$	11053.71	21916.45	23079.68	41657.85	18171.48	32555.54
$II_{i,t}$	9788.38	18891.69	16675.37	25108.92	10192.46	11685.42
$NII_{i,t}$	1265.32	3045.78	6786.99	17681.80	7979.02	22451.33
$TA_{i,t}$	145232.30	283079.70	403433.70	701401.90	533596.10	85830.40
$NLTA_{i,t}$	0.51	0.10	0.48	0.10	0.54	0.10
$EQTA_{i,t}$	0.12	0.03	0.09	0.03	0.10	0.02
$PRTA_{i,t}$	0.01	0.01	0.00	0.00	0.00	0.00
$ROA_{i,t}$	0.01	0.12	0.01	0.01	0.01	0.00

*Note: all the nominal data in the table is deflated by CPI.*

After the subprime crisis broke out in August 2007, an influx of hot money into Hong Kong following the Fed's quantitative easing policy. The lending rate then began to decline from 2007. The rate of growth of non-interest income began to shift to a significantly slower level from 2007, the number of non-interest income

is HKD 7979.022 million (USD 1029.2938 million) in 2012. There is an interesting phenomenon in that the structure of bank revenues is changing. The portion of non-interest income increased. In the year 1999 the average non-interest income accounts for 11.45% of the average of banks' total revenues, and then in 2007 the number increased to 29.41%. In 2012, this ratio went up to 43.91%. Nowadays, the banks rely more on non-interest income, which could reduce risk by giving the banks a more diversified portfolio of revenue producing activities. This explains the increasing competition in the non-interest market in recent years.

### **5.3.3 Summary**

In order to ensure consistency with the previous chapters, the database consists of an unbalanced panel of annual observations for the Hong Kong banking industry, covering 16 years from 1997 to 2012. The definition, measurement and summary statistics used to estimate the P-R model are presented in this section. Moreover, I split the whole period year by year, and the descriptive statistics of variables for year 1999, 2007 and 2012 are also provided.

## **5.4 Empirical results**

### **5.4.1 Introduction**

This section presents the estimation results of the P-R model for the Hong Kong banking industry. From these estimation results, the H-statistics and E-statistics using total revenue, interest income or non-interest income as dependent variable are computed. I also present the results from P-R H-statistics estimation by six

years rolling to consider the time evolution of competition in the interest market and the non-interest market.

## **5.4.2 Empirical results: total revenue as a dependent variable**

The reduced form revenue equation (equation 5.11) and equilibrium condition (equation 5.12) are jointly estimated using the SUR approach. The results of the Breusch-Pagan test of independence explain the reason why these two equations should be estimated jointly. Table 5.4 shows the correlation matrix of residuals between two equations and the Breusch-Pagan chi-squared statistic. The Breusch-Pagan chi-squared statistic is equal to 17.215, which suggests that the residuals of the two equations are significantly correlated with each other.

Table 5.5 presents the estimation results using total revenue as dependent variable. As discussed in the previous section, the P-R model is only valid if the market is in long run equilibrium. Based on the Wald tests results, in which  $\chi^2(1) = 1.96$  and  $\text{prob}=0.1637$ , the hypothesis on the long-run equilibrium in the Hong Kong banking industry ( $E = \pi'_1 + \pi'_2 + \pi'_3 = 0$ ) is not rejected,<sup>97</sup> which means that the banks are observed under long-run equilibrium. The H-statistic which can be calculated as the sum of elasticities of revenue with respect to each of the bank's input prices is equal to 0.5069. The Wald tests results confirms that the hypothesis  $H=0$  as well as the hypothesis  $H=1$  are rejected. These findings

---

<sup>97</sup> The Critical Value of chi-squared with degree of freedom 1 at 5% significance level is  $\chi^2(1, 0.05) = 3.84$ .

suggest that the Hong Kong banking markets can be characterised by monopolistic competitive behaviour. These findings are consistent with the results of Jiang et al. (2004), Wong et al. (2006), Chu et al. (2013), and Clasessens and Laeven (2004)<sup>98</sup>.

It can be seen from Table 5.5 that the coefficient of unit price of capital ( $lnw_2$ ) is positive and significant at 0.0455, as expected. Likewise, the coefficient of unit price of deposit ( $lnw_3$ ) is positive and significant at 0.3848. Although the coefficient of unit price of labour ( $lnw_1$ ) is not significant, it is also positive at 0.0766. The price of the deposits seems to be the biggest contributor to the H-statistic for Hong Kong bank market. This proves the strong effect of deposit rate deregulation in Hong Kong. The coefficients of all input prices are in line with both the theory and the previous studies (e.g. Wong et al., 2006, Chu et al., 2013). Then, for the control variables, the coefficient of total assets ( $lnTA$ ) is positive and significant at 0.8072. Total assets are a proxy of bank size. This strong positive coefficient of total assets suggests the existence of economies of scale that maintain large bank size should lead to an increase in total income. The sign of  $lnNLTA$  is positive, as expected, in the revenue equation (Bikker et al. 2012, Bikker and Haaf, 2002a). Generally, banks compensate themselves for credit risk by means of a surcharge on the lending rate, which increases the interest income and bank's revenue. Also, in line with Molyneux et al. (1994), the coefficient of  $lnEQTA$  is negative at -0.004, which shows a negative impact on total revenue. A lower equity assets ratio implies more leverage and, therefore, increases interest

---

<sup>98</sup> Clasessens and Laeven (2004) apply the P-R model to estimate the degree of competition of the banking systems of 50 countries. The H-statistic of Hong Kong based on the data of 1999 is 0.7, which indicates the monopolistic competition for Hong Kong bank market.

income. *lnPRTA* is a control for default risk. The coefficient of *lnPRTA* is positive and significant at 0.0247, which implies a higher default risk higher return for the banks. As for the macroeconomic variable, the coefficient of *lnrgdpg* is positive and significant at 0.0308, which indicates a positive relationship between economic growth and bank total revenue. Overall, all of the signs of the variables are as expected and they are in line with the literature.

**Table 5.4 Correlation matrix of residuals between equations**

<b>Dependent Variable</b>	<i>lnROA</i>	<i>lnRev</i>
<i>LnROA</i>	1	
<i>LnRev</i>	0.2905	1
Breusch-Pagan test of Independence: $\chi^2(1)=17.215$ , Pr=0.0000		

**Table 5.5 Panzar-Rosse H-statistic using total revenue as dependent variable 1997-2012: SUR estimation. Included observation= 204. Standard errors are in parenthesis <sup>99</sup>**

Reduced-form revenue equation (equation 5.11). Dependent Variable $\ln TI$			Equilibrium condition (equation 5.12). Dependent variable $\ln(ROA + 1)$		
Variable	Parameter	Coefficient	Variable	Parameter	Coefficient
Constant	$\zeta$	1.5743*** (0.4686)	Constant	$\zeta'$	0.0424*** (0.0160)
$\ln w_1$	$\pi_1$	0.0766 (0.0517)	$\ln w_1$	$\pi_1'$	0.0001 (0.0017)
$\ln w_2$	$\pi_2$	0.0455*** (0.0169)	$\ln w_2$	$\pi_2'$	0.0013** (0.0006)
$\ln w_3$	$\pi_3$	0.3848*** (0.0129)	$\ln w_3$	$\pi_3'$	0.0013*** (0.0004)
$\ln TA$	$\nu_1$	0.8072*** (0.0327)	$\ln TA$	$\nu_1'$	-0.0010 (0.0011)
$\ln NLTA$	$\nu_2$	0.1435** (0.0682)	$\ln NLTA$	$\nu_2'$	0.0065*** (0.0023)
$\ln EQTA$	$\nu_3$	-0.0040 (0.0334)	$\ln EQTA$	$\nu_3'$	0.0026** (0.0011)
$\ln PRTA$	$\nu_4$	0.0247*** (0.0086)	$\ln PRTA$	$\nu_4'$	-0.0007** (0.0003)
$\ln r_{gdpg}$	$\tau_1$	0.0308*** (0.0114)	$\ln r_{gdpg}$	$\tau_1'$	0.0006 (0.0004)
<b>H-statistic</b>		0.5069	<b>E-statistic</b>		0.0027
Wald Chi-squared statistic H=0		$\chi^2(1) = 84.5***$	Wald Chi-squared statistic E=0		$\chi^2(1) = 1.96$
Wald test H=0 P-value		0.0000	Wald test E=0 P-value		0.1637
Wald Chi-squared statistic H=1		$\chi^2(1) = 80.02***$			
Wald test H=1 P-value		0.0000			
$R^2$		0.9918	$R^2$		0.5588

<sup>99</sup> Note: \* indicates 10% significance level, \*\* indicates 5% significance level, \*\*\* indicates 1% significance level.

### **5.4.3 Empirical results: interest income and non-interest income as dependent variable**

Interest-generating activities have been traditional in Hong Kong's commercial banking sector for many years. Not surprisingly, most banks still rely mainly on income from traditional banking but non-interest activities, which may increase return and diversify risks, have risen rapidly in recent years. The sources of non-interest income mainly comes from securitisation and other major off balance sheet activities. In general, the securitisation is a process whereby individual bank loans and other financial assets are bundled together into tradable securities that are sold to the secondary market (Altunbas, 2009). Hong Kong has a low level of securitisation activity. This mainly due to inexpensive rates of the ready availability of other more conventional types of funding in Hong Kong. During the global financial crisis, the securitisation activity in Hong Kong has remained relatively inactive. And the HKMA has not formally introduced any liquidity schemes to support the securitisation market (Chen et al., 2010). The non-interest income mainly comes from fees and commissions, and income from foreign exchange and derivatives operations. In order to find the degree of competition of the interest and non-interest market, interest income and non-interest income are used as separate dependent variables of the reduced form revenue equation. Table 5.6 presents the correlation matrix of residuals between three equations. The estimation results are provided in Table 5.7.

The Breusch-Pagan Chi-squared statistic from Table 5.6 is equal to 11.099 and the  $\text{prob}=0.0112$ , which states the residuals between the three equations are



correlated. It also shows the evidence for the use of the SUR approach in estimation. The results of Table 5.7 show that the H-statistic is 0.5052 using interest-income as dependent variable, while the H-statistic is 0.4542 using non-interest income as dependent variable. The Wald test is conducted to verify if the H-statistics are significantly different from zero or unity. The results reject hypotheses  $H=0$  and  $H=1$  in both cases, and indicate that both interest market and non-interest market can be described as monopolistic competition. Although the difference is not large, the value of the H-statistic using interest income as a dependent variable is slightly higher than that using non-interest income as a dependent variable. This means that the level of market competition of the interest market seems higher than the competition level of the non-interest market. These results explain the behaviour of banks that move into investment banking-type activities, the fee based business, and related activities. Since the competition level of the interest market is high, the banks come to rely more on non-interest income activities. Moreover, the existence of long-run equilibrium is not rejected. The E-statistic is equal to 0.005. According to the Wald chi-squared statistic, which is equal to 0.09, and the probability, which is equal to 0.7617, hypothesis  $E=0$  cannot be rejected.

As for input prices using interest income as dependent variable, the unit price of capital ( $lnw_2$ ) and deposits ( $lnw_3$ ) are positive and significant at 0.0625 and 0.4882, respectively, but the unit price of labour ( $lnw_3$ ) is negative at -0.0455; however, it is not significant. All of the coefficients of control variables have the same sign as the case of using total revenue as dependent variable, except for  $lnEQTA$ . The coefficient of  $lnEQTA$  is positive and significant at 0.0537, which

is consistent with Bikker and Haaf (2002). They think that the capital requirements increase proportionally with the risk on loans and investment portfolios, and then the coefficient of  $\ln EQTA$  is suggested as positive.

Based on the results using the logarithm of non-interest income as dependent variable, the coefficient of unit price of labour and deposits are positive and significant. However, although the unit price of capital has a positive sign, it is not significant. As for the estimated coefficients of other bank-specific factors, the coefficient of  $\ln TA$  is positive and significant at 0.7716, which shows that economies of scale also exist in the non-interest market. The coefficients of  $\ln NLTA$  and  $\ln EQTA$  are not significant, as expected, since the bank loans and equity seem to have no considerable effect on non-interest income. The coefficient of  $\ln rgdpg$  is positive and significant at 0.0554, which shows that real GDP growth has a positive effect on the banks' non-interest income.

**Table 5.6 Correlation matrix of residuals between equations**

Dependent Variable	$\ln ROA$	$\ln II$	$\ln NII$
$\ln ROA$	1		
$\ln II$	0.2025	1	
$\ln NII$	0.1178	-0.0181	1

Breusch-Pagan test of Independence:  $\chi^2(3)=11.099$ ,  $Pr=0.0112$

**Table 5.7 Panzar-Rosse H-statistic using interest income and non-interest income as dependent variable 1997-2012: SUR estimation. Included observation= 201. Standard errors are in parenthesis <sup>100</sup>**

Reduced-form revenue equation (equation 5.11). Dependent Variable <i>lnII</i>			Reduced-form revenue equation (equation 5.11). Dependent Variable <i>lnNII</i>			Equilibrium condition (equation 5.12). Dependent variable <i>ln(ROA + 1)</i>		
Variable	Parameter	Coefficient	Variable	Parameter	Coefficient	Variable	Parameter	Coefficient
<i>Constant</i>	$\zeta_{II}$	1.4804*** (0.3536)	<i>Constant</i>	$\zeta_{NII}$	-1.6855* (0.9464)	<i>Constant</i>	$\zeta'$	-0.0026 (0.0054)
<i>lnw<sub>1</sub></i>	$\pi_{1,II}$	-0.0455 (0.0396)	<i>lnw<sub>1</sub></i>	$\pi_{1,NII}$	0.3186*** (0.1053)	<i>lnw<sub>1</sub></i>	$\pi_1'$	-0.0013 (0.0016)
<i>lnw<sub>2</sub></i>	$\pi_{2,II}$	0.0625*** (0.0130)	<i>lnw<sub>2</sub></i>	$\pi_{2,NII}$	0.1272*** (0.0347)	<i>lnw<sub>2</sub></i>	$\pi_2'$	0.0004 (0.0004)
<i>lnw<sub>3</sub></i>	$\pi_{3,II}$	0.4882*** (0.0099)	<i>lnw<sub>3</sub></i>	$\pi_{3,NII}$	0.0084 (0.0263)	<i>lnw<sub>3</sub></i>	$\pi_3'$	0.0014*** (0.0005)
<i>lnTA</i>	$v_{1,II}$	0.8328*** (0.0247)	<i>lnTA</i>	$v_{1,NII}$	0.7716*** (0.0662)	<i>lnTA</i>	$v_1'$	0.0015*** (0.0004)
<i>lnNLTA</i>	$v_{2,II}$	0.1761*** (0.0519)	<i>lnNLTA</i>	$v_{2,NII}$	-0.1829 (0.1383)	<i>lnNLTA</i>	$v_2'$	-0.0045** (0.0019)
<i>lnEQTA</i>	$v_{3,II}$	0.0537** (0.0255)	<i>lnEQTA</i>	$v_{3,NII}$	-0.1008 (0.0677)	<i>lnEQTA</i>	$v_3'$	0.0034*** (0.0012)
<i>lnPRTA</i>	$v_{4,II}$	0.0262*** (0.0066)	<i>lnPRTA</i>	$v_{4,NII}$	-0.0321* (0.0175)	<i>lnPRTA</i>	$v_4'$	-0.0010*** (0.0003)
<i>lnrgdpg</i>	$\tau_{1,II}$	0.0128 (0.0088)	<i>lnrgdpg</i>	$\tau_{1,NII}$	0.0554** (0.0233)	<i>lnrgdpg</i>	$\tau_1'$	0.0004 (0.0004)
<b>H-statistic</b>		0.5052	<b>H-statistic</b>		0.4542	<b>E-statistic</b>		0.0005
Wald Chi-squared statistic H=0		142.88***	Wald Chi-squared statistic H=0		16.31***	Wald Chi-squared statistic E=0		0.09
Wald test H=0 P-value		0.0000	Wald test H=0 P-value		0.0001	Wald test E=0 P-value		0.7617
Wald Chi-squared statistic H=1		137.00***	Wald Chi-squared statistic H=1		23.57***			
Wald test H=1 P-value		0.0000	Wald test H=1 P-value		0.0000			
<i>R</i> <sup>2</sup>		0.9945	<i>R</i> <sup>2</sup>		0.9781	<i>R</i> <sup>2</sup>		0.2338

<sup>100</sup> Note: \* indicates 10% significance level, \*\* indicates 5% significance level, \*\*\* indicates 1% significance level.

#### **5.4.4 Development of H-statistic overtime**

In order to consider the time evolution of competition for the interest and non-interest markets, the results from P-R H-statistics estimation by six years<sup>101</sup> rolling are presented in Table 5.8. There is a gradual declining trend in the values of the H-statistics for the interest market. From year 1997 to 2005, the H-statistics are relatively high. The main reason for this is that the interest rate deregulation was fully completed by July 2001, with interest rate restrictions on current and savings account removed. These deregulations lead to a high degree of competition in the interest market. Secondly, the restriction on the number of branches and offices for foreign banks was completely removed in 2001. The market entry criteria have been relaxed since 2002, which also increased the market competition. Thirdly, most major bank consolidations took place in 2001 and 2002; for example, the Bank of China Group. Lastly, the Asia financial crisis has had a certain effect on the interest market in Hong Kong. In Chapter 3, I compare the magnitude of switching costs during the good times and bad times and find that the magnitude of estimated switching costs during the bad time is slightly higher than that in the good time. In order to investigate the linkage between market competition and switching costs, I also compare the degree of market competition for the same periods. The period 2002-2007 is considered as a good time, and the period 2007 to 2012 is considered as a bad time.<sup>102</sup> From the values of the H-statistic using

---

<sup>101</sup> In order to assess changes in H-statistic over time, many studies provide rolling-window estimates of H-statistic and E-statistic. Daley and Matthews (2012) estimates the P-R E-statistic by six years rolling for Jamaican banking sector. Bikker and Spierdijk (2008) estimate yearly and rolling-window H-statistic for eleven major industrial economies and two regions. The number of observations ranges from 66 to 95 in this rolling estimation.

<sup>102</sup> The reason of choosing these two periods is explained in Chapter 3 (p.103).

interest income as dependent variable, the H-statistic for the period 2002 to 2007 is 0.5724 and the H-statistic for the period 2007 to 2012 is 0.4822. These results suggest that the Hong Kong bank interest market is more competitive during the good times. These findings are reasonable. During the bad times, the demand for loans goes down because of an economic recession. Then, in order to maintain profits, the banks will behave anti-competitively and raise switching costs to help lock in their good customers. Because of the anti-competitive behaviour of banks, the interest market during a bad time is less competitive than in a good time.

For the non-interest market, the values of the H-statistic fluctuated sharply over the period. In general, there is an upward trend in the value of H-statistic from 1997 to 2007 but it then fell sharply after that, except for the period from 2007 to 2012. Since the period 2007 to 2012 covers the year 2007 and 2008, when there was a global financial crisis, it is very difficult to assess competition during the market turmoil. Upon analysis of these results, one can conclude that competition in the non-interest market evolved differently over the years in Hong Kong. In some periods, competition was very high; for example, the H-statistic reached a level of 0.8073 for the period 2001 to 2006. This is not significant from unity, which shows that the market was under perfect competition during that period. The H-statistic is also not significant from unity at 0.9608 for the period 2007 to 2012. In some other periods, such as 1997 to 2002, 2003 to 2008, 2004 to 2009 and 2006 to 2011, the H-statistics are not significant from zero, which indicates that the non-interest market can be considered as a monopoly during these periods. The main reason for this large fluctuation is due to competition from outside the bank market. In the non-interest market, the banks are facing competition from other financial

and non-financial institutions. Since these effects are not included in the model, the results seem to be less reliable.

**Table 5.8 Panzar-Rosse H-statistic using interest income and non-interest income as dependent variable for rolling sample<sup>103</sup>**

Period	Dependent variable	
	Interest income: <i>lnII</i>	Non-interest income <i>lnNII</i>
1997-2002	0.6964 <sup>a</sup>	0.1492 <sup>c</sup>
1998-2003	0.6614 <sup>a</sup>	0.3543 <sup>a</sup>
1999-2004	0.6924 <sup>a</sup>	0.3894 <sup>a</sup>
2000-2005	0.7040 <sup>a</sup>	0.5388 <sup>a</sup>
2001-2006	0.5921 <sup>a</sup>	0.8073 <sup>b</sup>
2002-2007	0.5724 <sup>a</sup>	0.5184 <sup>a</sup>
2003-2008	0.4493 <sup>a</sup>	0.0452 <sup>c</sup>
2004-2009	0.5315 <sup>a</sup>	0.1529 <sup>c</sup>
2005-2010	0.3552 <sup>a</sup>	0.5070 <sup>d</sup>
2006-2011	0.3034 <sup>a</sup>	0.3757 <sup>c</sup>
2007-2012	0.4822 <sup>a</sup>	0.9608 <sup>b</sup>

## 5.4.5 Summary

This section presents the estimates of competition in the banking markets in Hong Kong using a P-R approach. Unlike previous studies, in order to solve the problem of residuals correlation I have jointly estimated a reduced form revenue equation and an equilibrium condition equation using the SUR approach. The results suggest that the Hong Kong bank market can be considered as monopolistic competition. These results are consistent with several previous studies for the Hong Kong banking industry. Furthermore, I compare the level of competition

<sup>103</sup> Note: a means significantly different from both zero and unity on Wald test; b means significantly different from zero but not significant different from unity on Wald test; c means significantly different from unity but not significant different from zero on Wald test; d means not significantly different from both zero and unity on Wald test.

between interest market and non-interest markets, and find that the degree of market competition of the interest market is slightly higher than that of the non-interest market. In addition, in order to consider the time evolution of competition for the interest and non-interest markets, I estimate the P-R model for a six year rolling sample. The results show that in the interest market there is a gradual decline trend in the values of H-statistics. Compared with bad times, the Hong Kong bank interest market is more competitive during the good times. For the non-interest market, the values of the H-statistic have fluctuated sharply over the period.

## **5.5 Conclusion**

This chapter has examined the degree of competition in the Hong Kong banking sector during 1997 to 2012 using the P-R approach that was proposed by Roose and Panzar (1997), and Panzar and Rosse (1987). The results suggest that Hong Kong's banking industry is monopolistically competitive. In addition, the market is under long-run equilibrium during this period. These results are consistent with previous studies for the Hong Kong banking market. Although traditional banking is still the major activity in most banks, non-interest income (for instance, fees, commissions, income from foreign exchange and derivative operations) play an increasingly important role in the banks' revenue. In order to find the degree of competition of the interest and non-interest market, I have estimated the P-R model using interest income and non-interest income as the dependent variable of reduced form revenue equation. The evidence from the H-statistics suggests that the degree of market competition of interest market is slightly higher than that of non-interest

market. These findings have policy significance to policymakers. Cross-selling has become a strategic priority for many banks in recent years. By cleverly combining different bank services to create a package, the banks have one of the most powerful levers available to increase customer lock-in. In order to improve the efficiency of non-interest market, the policymakers need to focus on the non-interest bank activities and improve the transparency of bank non-interest earning, which may reduce the barriers of customers' switching. In addition, increasing the competition of the non-interest market may attract more new entrants and improve market efficiency.

Furthermore, I estimate the P-R model over a six year rolling sub-sample. The results show that in the interest market, there is a gradual declining trend in the values of H-statistics. Compared with the bad times, the Hong Kong bank interest market is more competitive during the good times. These results are consistent with the findings of Chapter 3. According to the results from Chapter 3, the magnitude of estimated switching costs during the bad time is slightly higher than that in the good time. During the bad times, the demand for loans goes down because of economic recession. Then, in order to maintain profits, the banks will behave anti-competitively and raise switching costs to help lock in good customers. Because of the anti-competitive behaviour of banks, the interest market during the bad time is less competitive than in good times. For the non-interest market, the values of the H-statistic have fluctuated sharply over the period. The implications of these results suggest that the banks need to pay more attention to competition from other financial institutions. After the financial crisis of 2008, in order to boost the economy, the regulations have gradually been relaxed. Therefore, a higher



level of competition is expected in Hong Kong's banking sector. Hence, market competition needs to be closely monitored in the future.

# Chapter 6

## Conclusion

### 6.1 Introduction

This thesis is an empirical study that investigates bank competition issues in the Hong Kong banking sector. It begins with an overview of the Hong Kong banking industry in Chapter 2, and includes three self-contained empirical chapters related to switching costs, collusion and competition, in Chapters 3, 4 and 5, respectively. By using a sample of 18 licensed banks incorporated in Hong Kong from 1997 to 2012, this thesis provides answers to the following research questions, which also presented in Chapter 1:

1. The significance and magnitude of switching costs in Hong Kong bank loan market and their impacts on prices. Chapter 3 extracts information on both the significance and magnitude of switching costs in Hong Kong bank loan market by applying an empirical model, which is based on Kim et al.'s (2003). My findings suggest that switching costs are significant in the bank loan market of Hong Kong. By comparing the price-cost margin with and without switching costs, the results provide empirical evidence to the conventional wisdom that switching costs make markets less competitive. The price-cost margin was raised by the presence of switching costs in Hong Kong's bank loan market. I

also find that the magnitude of estimated switching costs during a bad time is slightly higher than that in a good time due to the “Lemons Problems”.

2. Bank collusion and competitive condition in Hong Kong bank loan market. Chapter 4 examines the degree of collusion and competition in Hong Kong’s banking sector based on the conjectural variation approach. The empirical results suggest that banks in Hong Kong operated in a competitive fashion in the loan market and the behaviour can be characterized by Nash-Bertrand equilibrium in prices with no significant evidence of collusion on pricing.
3. The degree of competition in Hong Kong banking sector. Chapter 5 assesses the level of competition in Hong Kong banking sector using the P-R approach. My findings suggest that banks in Hong Kong can be characterized as monopolistically competitive. There is also a negative relationship between the magnitude of switching costs and the level of competition.

This chapter concludes this thesis. It is organized as follows. Section 6.2 summarizes the main empirical results of each chapter. Section 6.3 discusses the policy implication of the main research findings. Section 6.4 states the limitations of this thesis. Finally, section 6.5 offers suggestion for future research.

## **6.2 Summary of the empirical results**

This section summarizes the main empirical results presented in Chapters 3, 4 and 5. In order to keep consistency, the same dataset is used in three empirical chapters. I have collected an unbalanced panel of Hong Kong bank level data for

the period of 1997 to 2012 from Bankscope and the banks' Annual Reports. The data are annual and cover 18 licensed banks incorporated in Hong Kong.

Chapter 3 investigates the significance and the magnitude of switching costs in Hong Kong's bank loan market. I use the empirical model presented by Kim et al. (2003) to estimate the magnitude of switching costs in Hong Kong for the period 1997 to 2012. Overall, the point estimates of the switching costs based on the entire sample are significant at 0.1947, using the non-linear 3SLS approach. The estimates on the slope of the transition probability function for the entire sample are negative and significant at -4.7367. This negative slope ensures a downward sloping demand curve for bank loans. The conventional view in economic theory suggests that switching costs make markets less competitive (Farrell and Shapiro 1998, Beggs and Klemperer 1992, Padilla 1995 and Anderson et al. 2004). The findings provide evidence of this conventional view. In general, the average price-cost margin is low, which satisfies the Bertrand behaviour of the market. The effect of the existence of switching costs raises the price-cost margin by 0.52% (52bps)<sup>104</sup>. Compared with the results of Kim et al. (2003) for the Norwegian banking industry, the magnitude of estimated switching costs in the Hong Kong bank loan market is higher. According to Liu et al. (2010), Norway appears to be the most competitive banking system in the European

---

<sup>104</sup> According to the results of Chapter 4, the own price elasticity,  $\varphi_1$ , is negative and significant at -1.0778 using non-linear 3SLS approach. Therefore the changes of aggregate loans can be calculated as  $0.0052 * (-1.0778)$  which is about -0.56%. Since the total loans of the whole sample is 4,730,545 HKD million in 2012. Then, the existence of switching costs decreases the total loans by  $4,730,545 * (-0.56\%)$ , which is about 26,512.62 HKD million.

country, where the Panzar-Rosse H statistic is highly at 0.83 for the period 1997 to 2008. Therefore, it is not surprising that switching costs in Norway are low.

My results also show that the magnitude of estimated switching costs during the bad times is slightly higher than that in good times. Two time periods have been picked up. One period is year 2002 to year 2007, the other period is year 2007 to year 2012. According to the statistics of real GDP growth rate and unemployment rate, the period 2002 to 2007 is considered as a good time and the period 2007 to 2012 can be considered as a bad time. During the bad times, the issue of the “Lemons Problem” is more serious. Banks will be more willing to lend money to creditable customers. For the new borrowers, banks will charge a much higher risk premium or even reject their application. It is most likely that higher estimated switching costs exist during the bad times. Moreover, on average, 2.54% of the customer’s added value is attributed to the lock-in effect generated by switching costs. Utilizing the results from trans-log cost function, I compute AC-MC over the sample period to gauge the economies of scale. Although the value of AC-MC is small, it is positive, which shows that the banks are in the range of economies of scale. These findings are in line with Ho (2010). The GMM approach is applied to the same model as a robustness check. Similar results have been obtained, which indicates that the findings from non-linear 3SLS approach are robust.

In Chapter 4, the degree of collusion and competition in Hong Kong bank loan market is examined using the conjectural variation approach. A conjectural parameter, which is often defined as the bank’s expectation about its rivals’ price

responses to changes in its own price, is used to identify the degree of collusion. The specification and estimation of the model follows Coccoresse (2005), who uses a price-setting model in a duopolistic market, which has heterogeneous products. The results of this study show that the value of the conjectural variation parameter is insignificant at 0.3452 using the non-linear 3SLS approach. This suggests that banks in Hong Kong operated in a competitive fashion in the loan market and the behaviour is coherent with a Nash-Bertrand equilibrium in prices with no significant evidence of collusion on pricing during the period 1997 to 2012. As a robustness check, by using GMM approach the conjectural variation parameter is insignificant at 0.6001, which is relatively higher than using non-linear 3SLS approach. These findings are consistent with previous studies (Wong et al. 2008, Ho 2010).

Chapter 5 investigates the competitive condition in the Hong Kong banking sector using the P-R approach. The novelty of this chapter is to solve the problem of residual correlation between reduced form revenue equation and equilibrium condition equation by jointly estimating these two equations using the SUR approach. The estimated value of H-statistics using total revenue as a dependent variable is equal to 0.5069. These results suggest that Hong Kong banking is monopolistically competitive and the hypothesis on the long-run equilibrium in the Hong Kong banking sector is not rejected. These findings are consistent with evidence from previous research (Jiang et al 2004, Wong et al. 2006, Chu et al. 2013 and Clasesens and Laeven 2004). Furthermore, in order to find the degree of competition of interest and non-interest market, interest income and non-interest income are used as the dependent variable of reduced form revenue

equation. The results exhibit that the value of H-statistic is 0.5052 for interest market and 0.4542 for non-interest market. These results suggest that both the interest and non-interest markets can be described as monopolistic competition. It also reveals that the level of competition of interest market is slightly higher than that of non-interest market. In addition, in order to consider the time evolution of competition of interest and non-interest market, I estimate the H-statistic over a moving sub-sample window of six years duration. The results show that in the interest market there is a gradual decline trend in the values of the H-statistics. They also indicate that Hong Kong's bank interest market is more competitive during the good times. Therefore, by taking the results of Chapter 3 into account, these results verified the presumption that switching costs make markets less competitive. There is a negative relationship between the magnitude of switching costs and the level of competition. But for the non-interest market, the values of the H-statistic have fluctuated sharply over the period.

The findings from various chapters are consistent with each other. I have summarized the major findings of three empirical chapters in Table 6.1. Although compared with the results of Kim et al. (2003) for the Norwegian banking industry, the estimated switching costs in Hong Kong bank loan market are higher, it only increases the price-cost margin by 0.52% (52bps). There are two major switching patterns in the loan market. One is a borrower who may terminate the loan agreement when sufficiently better loan contracts are provided by a rival bank. Another is a borrower who may consider switching to other banks after maturity of the loan. The reasons why switching costs have a low effect may be because the empirical model proposed by Kim et al. (2003) only takes the loan

market into account. Bundled products and services (Llewellyn, 2005) are a successful strategy deployed by banks to increase profits, which increased the magnitude of switching costs to lock-in customers. The bundling products and services may mean that the purchase of one bank service may be dependent on the purchase of another (Llewellyn, 2005). If the lending rates are same across banks, then loans can be considered as homogenous products. However, borrowers are heterogeneous. Banks lock customers in by differently customizing other financial services according to individual the customers' needs. Hence, the different "bundled products" may create high switching costs in the whole market and different customers may face different switching costs. Based on the findings of Chapter 5, the non-interest market in the Hong Kong banking sector lacks a competitiveness compared with the interest market. In recent years, non-interest activities have increase rapidly. These findings provide support for the idea of bundled products. Since customers purchase a bundle of products, the purchase of bank loans may be dependent on the purchase of other financial services. Thus, limited competition in the non-interest market may lock-in customers' demand for other financial services, as well as the demand for loans. Bundling can deter customers switching to the best individual products. In addition, the results from Chapter 4 show that there is no significant evidence of collusive behaviour in Hong Kong bank loan market, reflecting the existence of switching costs in some way and fitting in with the supposition of bundled products.



**Table 6.1 Banking performance in Hong Kong: A summary of the empirical results**

Type of issues	Type of Measures	Interpretation	Estimated value	Results
<b>Switching costs</b>	<i>s</i> index presented by Kim et al. (2003)	A positive <i>s</i> indicates the existence of customer switching costs in the bank loan market	<i>s</i> = 0.1947	Switching costs are significant in the Hong Kong bank loan market.
<b>Collusion</b>	Conjectural variation parameter $\lambda$	$\lambda = 1$ Perfectly collusive $\lambda = -\infty$ Perfect competition $-\infty < \lambda < 1$ Oligopolistic competition. In particular when $\lambda = 0$ the behaviour is regarded as Nash Bertrand equilibrium in prices	$\lambda = 0.3462$ (3SLS) $\lambda = 0.6001$ (GMM) Both parameters are insignificant	No significant evidence of collusion on pricing and the banks behaviour is consistent with a Nash Bertrand equilibrium in prices in Hong Kong bank loan market.
<b>Competition</b>	Panzar-Rosse H statistic	$H \leq 0$ Monopoly or collusive oligopoly and may include conjectural variation short-run oligopoly $H = 1$ Perfect competition $0 < H < 1$ Monopolistic competition	$H=0.5069$ (total revenue as dependent variable) $H=0.5052$ (interest income as dependent variable) $H=0.4542$ (non-interest income as dependent variable)	Monopolistic competition in Hong Kong banking sector. The degree of competition of interest market is slightly higher than that of non-interest market.

### **6.3 Policy implication of the thesis**

Financial reform has been an ongoing feature of Hong Kong's financial sector during the past 50 years. Some financial reforms are crisis-induced, notably the pack of seven technical measures<sup>105</sup> to strengthen the monetary system and stabilize the interbank market and interest rates as a result of the Asian financial crisis in 1997. However, there are more financial reforms that are not due to the financial crisis. For example, since the 1990s the HKMA has used macro-prudential tools extensively to supervise banking. In addition, the introduction of the Hong Kong dollar Real Time Gross Settlement (RTGS) system in 1996 has enabled a safe and efficient interbank market. In 2012, the HKMA and the Treasury Bureau revised the Banking Ordinance again to update certain market entry criteria for the banking sector in Hong Kong to reduce the entry barriers. The previous section has discussed the major findings of this thesis. These findings offer important implications for the bank regulators and policy makers in Hong Kong, relating to the design and formulation of regulatory changes and competitive policies to help promote bank efficiency, financial stability, customer welfare, and maintain economic growth. These findings also have an implication for bank management and strategy.

---

<sup>105</sup> HKMA announced a package of seven technical measures on 5 September 1998 to strengthen the currency board arrangements and stabilize the conditions in the interbank market and interest rates.

The results from Chapter 3 show that switching costs are significant in Hong Kong's bank loan market. Switching costs hinder banking competition. But the question is whether or not the significant switching costs in loan market reduce customer welfare? Should the government encourage policies that lower switching costs and reduce barriers to entry? Klemperer (1995), and Farrell and Klemperer (2007) suggest that the existence of switching costs generally raise prices, increase deadweight loss, and discourage market entry. Park (2011) agrees with their ideas and shows that in the wireless industry a reduction in switching costs increases market competition and lowers prices. The reduction in switching costs has had positive welfare benefits in the wireless industry. However, Pesic (2010) investigates the impact of switching costs and market entry in the mortgage industry, and suggests that lower switching costs exacerbate adverse selection problem. Therefore, government policies should solve this market failure before encouraging activities that reduce switching costs. Since the research on switching costs in the loan market is a partial analysis, the significant switching costs I found in the Hong Kong loan market are not necessarily welfare reducing. Although some evidence has found that the switching costs in the deposit market are low (Ho, 2014), no research has been done for the financial services market. As a result, policy makers should focus on issues of consumer welfare due to the switching costs in the whole market before implementing policies that encourage activities

which reduce switching costs. Such as, improving transparency<sup>106</sup> by publishing information on the prices of other financial services (e.g. bank fees) or reducing the consumer inertia that arises from the banks' "bundled products" (Matthews et al. 2007).

Furthermore, the results from Chapter 4 and 5 suggest that Hong Kong banking is monopolistically competitive with no significant evidence of collusion on pricing during 1997 to 2012. A series of financial reform measures, such as deregulation interest rate and relaxation barriers to new entry implemented by HKMA to promote the market competition in the banking industry in Hong Kong, have also increased pressure on the banks' interest margin. As a result, increasing non-interest income has become an attractive strategy for the banks to maintain profits. In order to further promote market competition in the current ongoing bank consolidation, policymakers could focus on improving transparency between customers and banks (BIS, 2001). From the banks' aspect, better information flows between customers and banks may also help enhance the banks' credit risk management (Jiang, 2004).

Although most commercial banks still mainly rely on income from traditional banking, non-interest activities that may increase return and diversify the income

---

<sup>106</sup> However, it is worth noting that improving transparency is not always a good thing. Improving transparency may also accelerate collusion among banks (Pomp et al. 2005). Therefore, this risk should be considered when making the policies.

structure have increased rapidly in recent years. Take HSBC as an example, there was a dramatic increase in the ratio of non-interest income to total revenue from 1997 to 2012. In 1997, the ratio was 15% but in 2012 the number sharply rose to 69%. In general, non-interest income can be divided into two components: trading income and fee and commission income. Although the banks continued to look for opportunities to grow their income from sales of wealth management, higher operational and reputational risks may be associated with the sales of wealth management products (KPMG, 2013). In addition, Köhler (2014) indicates that increasing the share of non-interest income only makes retail-oriented banks more stable. For investment-oriented banks, since they already have a large non-interest income share and engage in different activities than retail-oriented banks, increasing their share of non-interest income will make these banks significantly less stable. Thus, bank managers should consider the possible risks brought by increasing non-interest activities when developing their bank's strategies.

In addition, the results of AC-MC from Chapter 3 suggest that banks are in the range of economies of scale. The strong positive coefficient of total assets in Chapter 5 proves this point of view. These findings suggest that an increase in bank size should lead to an increase in total income. Therefore, the managers of small banks could encourage consolidation through mergers and acquisitions in

order to improve the profits of banks. However, mergers and acquisitions may increase bank concentration, which may lead to a decrease in bank competition.

Since China adopted its ‘open door’ policy in 1978, Hong Kong and Mainland China, especially the Pearl River Delta (PRD) region in Guangdong province, rapidly developed a close economic relationship. The model “front shop, back factory” describe the economic relationship between Hong Kong and the PRD. This is an effective division of labour between them which marketing, financing, design and administration took place in front shop in Hong Kong, but manufacturing and labour-intensive assembly activities were completed in the back factory in PRD (So et al., 2001). After more than three decades of cooperation, both Hong Kong and Mainland China have experienced dramatic economic changes. With the rapid growth of the Mainland economy, the costs of labour, land and materials in PRD became expensive and the previous “front shop, back factory” cooperation model has been challenged. One of the most important factors which influence the development of Hong Kong banking industry is its relationship with Mainland China. There are many events that affected the economic relationship between Hong Kong and Mainland China, the handover of Hong Kong in 1997, Asian Financial Crisis, China entered WTO in 2001, Mainland and Hong Kong Closer Economic Partnership Arrangement (CEPA) in 2003 are several typical events.

Hong Kong has long served as the bridge between the Mainland China and international markets. Foreign companies use Hong Kong's financial services to invest in China since Hong Kong offers them something that no mainland city does: a free market system, a stable investment environment, well-educated labour force, and a sound legal and institutional frameworks. According to the statistics from National Bureau of Statistics of China, Hong Kong was reported as the largest source of FDI flows to China in 2012, followed by Virgins Islands, Japan and Singapore. After the handover in 1997, The FDI flow to Hong Kong from Mainland China continued growth which showed an enhanced economic integration between Hong Kong and Mainland China. According to the statistics from Census and Statistic Department of Hong Kong, Mainland China replaced the UK as the largest source of direct investment in Hong Kong in 2006 which contributed 35.1% of the total inward direct investment to Hong Kong in that year. And in 2013, Mainland China contributed 31.9% of the total inward direct investment to Hong Kong. The close economic integration between Hong Kong and Mainland China also provided the opportunities for Hong Kong banks.

By the end of 2013, there were 13 Hong Kong-incorporated banks with business operations on the Chinese mainland, maintaining over 440 branches or sub-branches in Mainland<sup>107</sup>. In this sense, Mainland China plays an important role in the development of Hong Kong banking industry. However, with the development

---

<sup>107</sup> Data Source: Hong Kong Trade Development Council

of Chinese economy, China opened its borders to the global economy. It is clearly that Hong Kong became less important than in the past. Hong Kong also has its own advantages, such as its stock market, is significantly more reliable and better developed than the Shanghai and Shenzhen Stock Exchanges. According to the statistics from Dealogic, since 2002, Chinese companies have raised USD 43 billion in initial public offering in Hong Kong, but only USD 25 billion on mainland Stock Exchanges. If the relationship between Hong Kong and Mainland China becomes not smooth, a series of policies favouring economic integration between them such as CEPA, the individual travel scheme and the Pan-PRD regional cooperation framework will not be introduced. The decline of investment from Mainland will direct result the decrease of demand of loans in Hong Kong. In order to lock-in creditable customer, the switching costs in the Hong Kong loan markets may become higher. And the degree of competition in the Hong Kong bank market may be affected as well.

Hong Kong has one of the largest representation of international banks in the world. More than 70 of the world's 100 largest banks have an operation in Hong Kong. As of end 2013, there was 156 licensed banks incorporated in Hong Kong. Of these, 21 are locally incorporated and the rest 135 are branches of foreign banks. The large foreign participation in Hong Kong banking market make international banking markets has a certain influence in Hong Kong banks. Some foreign banks like DBS (Hong Kong) which is a subsidiary of DBS bank headquartered in



Singapore started their operation in Hong Kong many years ago. And these foreign banks carry on both retail and wholesale banking business through their extensive network of branches in Hong Kong. The large number of foreign banks in the Hong Kong bank market gives rise to the concern that foreign banks will be less determined to engage in the domestic economy, and therefore will reduce their activity more abruptly during downturns or more likely to cut back if head office change the operation strategy (Lopez et al.,2008). For instance, during the Asian Financial Crisis, Japanese banks reduced both their physical presence and their lending in Hong Kong (Carse, 2001). According to the statistics from HKMA, in March 1997, there were 91 Japanese authorised institution in Hong Kong. But by June of 2000, the number has been reduced by about 60% to 35. And between March 1997 and June 2000, the total lending of the Japanese banks in Hong Kong fell from just over HKD 2000 billion to HKD 643 billion, a decline of almost 70%. This cut back affected the volatility of the supply of credit in Hong Kong bank market. Since the credit are hardly to get, switching costs in the loan market may become higher since banks will be more willing to lend money to creditable customers. For the new customers, banks will charge a much higher risk premium or even reject loan applications. The empirical results from Chapter 3 suggest that the switching costs during the financial crisis periods were slightly higher, consistent with this view.

## **6.4 Limitations of this thesis**

Before moving into some possible recommendations for future research, it is important to mention several limitations and methodological problems that this thesis has observed.

The first limitation concerns the limited number of observations. This is mainly due to the small number of banks included in the sample and the relatively short sample period of these banks. According to the statistics from the HKMA, the number of all authorized institutions in Hong Kong was 200 in 2013. Until June 2013, there were 21 licensed banks incorporated in Hong Kong. However, the sample of this thesis only covers 18 licensed banks for the period 1997 to 2012. The main reason why only these 18 commercial banks were included in the sample was because the data availability for other banks is limited. In addition, the annual reports of banks incorporated outside Hong Kong are not released by HKMA. In the loan market, wholesale banks offer heterogeneous products for different people. In order to estimate the switching costs in the bank loan market, retail banks which offer homogenous products are better choices. And the level of competition may also differ for the retail banking market and other banking market. Moreover, Cohen and Mazzeo (2007) show that different types of banks compete differently. This indicates that switching costs for borrowers from commercial banks may differ from those from other types of banks. The level of competition may also differ for the commercial banking market and other

banking markets. In addition, these 18 banks dominate the market. The statistics from HKMA show that the total assets of these 18 banks was HKD 11,681,441 million (which at that time was equal to USD 1,506,699 million)<sup>108</sup> which accounted for 78.62% of the whole market in 2012. This data limitation may lead to a bias in the estimators of 3SLS and GMM (Nagar, 1959). To avoid the loss of degrees of freedom, especially for the small sample, some external instrumental variables have been chosen for the system estimation of Chapters 3 and 4.

Secondly, the panel data used for estimation is unbalanced because the data for some banks are missing for some years. Analysing unbalanced panel data may raise a few additional issues compared with the analysis of balanced data (Baltagi 2008). The major drawback of an unbalanced panel is that people may mistake changes resulting from differences in the sample of banks for true changes in the parameter values over time (Hirsch and Morgan 1994).

Thirdly, since the lending rates are not reported in bank statements and other databases, I calculate the interest rate on loans by using equation 3.32 (p.95) presented in Chapter 3. The 91-day exchange fund bill rates are used as a proxy of interest rate on other earning assets. Therefore, the calculated lending rates may have some differences from the real lending rates. Similarly, due to the lack

---

<sup>108</sup>1 HKD= 0.1290 USD. Data source: Bloomberg. Date: 4 June 2014.

of data, the number of employees is also calculated, which may exhibit certain deviations.

Finally, considering the empirical model provided by Kim et al. (2003), concerns about the magnitude and significance of switching costs mean that a considerable drawback of this model is that it only takes the loan market into account. The bundled products may create high switching costs in the whole market and the switching costs from the non-interest market are not accounted for in the model. As a result, the magnitude of estimated switching costs may be much less than the magnitude of real switching costs in the whole market. Another methodological issue is the use of a trans-log cost system. Although when compared with the Cob-Douglas function form the trans-log cost function has less restrictions on elasticities, which allows economies of scale to change with output, the trans-log cost function has certain drawbacks. The main disadvantage is that it can be difficult to interpret the coefficient estimates due to the quadratic terms and cross terms, it also requires the estimation of more parameters.

## **6.5 Suggestions for further research**

This section makes a number of suggestions for further research.

Firstly, from a theoretical perspective, Kim et al. (2003)'s model is the only structural model available for econometric estimation of the magnitude and significance of switching costs that uses an aggregated panel data that does not contain customer-specific information. Ho (2014) argues the model presented by Kim et al. (2003) do not model consumer preferences, therefore the model is unable to analyse consumer willingness to pay for bank attributes, quantify switching costs and examine the impacts of switching costs on the price elasticity of demand. And as discussed in the previous section, a considerable drawback of this model is that it only takes the loan market into account. Further research can focus on these shortcomings and estimate the switching costs of the deposit and the whole market. Ho (2014) develops and estimates a dynamic structural model of consumer deposits demand, in which service quality and switching costs are important factors in their decision. This empirical model can be used as a reference to develop new model.

Secondly, a new method of modelling switching costs can be developed based on Kim et al. (2003)'s model in order to take non-interest activities into account. Although the magnitude of switching costs in the Hong Kong bank loan market is estimated in this thesis, it does not explain which variables have direct impacts on switching costs. Further work can be undertaken to explore the relationship between switching costs and several impact factors, such as market concentration. In addition, the relationship between the switching costs and the macro or

financial variables that measures informational asymmetries between borrowers and lenders can be estimated in the further work.

Thirdly, the sample of this thesis only covers 18 licensed banks for the period 1997 to 2012. The major reasons why only these 18 retail banks were included in the sample were because the data availability. And in the loan market, wholesale banks offer heterogeneous products for different client. In order to estimate the switching costs in the bank loan market, retail banks which offer homogenous products are better choices. However, a larger data set may be used in further research to produce more accurate results. And a balanced panel data can be used if the data is available

Finally, this thesis makes a contribution to the literature by extending the limited number of studies analysing the competitive condition in Hong Kong's banking sector. An interesting avenue for further research might involve the use of other methods, such as the Boone indicator, which was introduced by Boone (2008) to measure the degree of competition. Furthermore, bank efficiency is another popular topic in banking research. Although a large number of literatures study the bank efficiency in Hong Kong, there has been limited study on the relation between bank competition and efficiency. This may suggest an interesting direction for further research. The uniqueness of Hong Kong mainly due to its close relationship with Mainland China. Its advantage to act as the

bridge for linking Chinese mainland and international markets. The close economic integration between Hong Kong and China boosts Hong Kong's economic development and increased Hong Kong's welfare. The impact of Mainland China and other regional markets on Hong Kong bank competition can be further discussed in future research.

## References

- Aaker, D. A., 1992. The Value of Brand Equity, *Journal of business strategy* 13, 27-32.
- Abdelkader, I. B., and F. Mansouri, 2013. Competitive Conditions of the Tunisian Banking Industry: An Application of the Panzar-Rosse Model, *African Development Review* 25, 526-536.
- Aghion, P., and P. Bolton, 1987. Contracts as a Barrier to Entry, *American Economic Review*, 388-401.
- Ahtiala, P., 2006. The Optimal Pricing of Computer Software and Other Products with High Switching Costs, *International Review of Economics & Finance* 15, 202-211.
- Aigner, D. J., C. A. Knox Lovell, and P. Schmidt, 1977. Formulation and estimation of stochastic frontier production function models, *Journal of econometrics* 6, 21-37.
- Alba, J. W., and J. W. Hutchinson, 1987. Dimensions of Consumer Expertise, *Journal of consumer Research*, 411-454.
- Altunbas, Y., L. Gambacorta, and D. Marques-Ibanez, 2009. Securitisation and the Bank Lending Channel, *European Economic Review* 53, 996-1009.
- Amir, R., 2000. *Market Structure, Scale Economies, and Industry Performance*(Discussion papers//WZB, Wissenschaftszentrum Berlin für Sozialforschung, Forschungsschwerpunkt Marktprozeß und Unternehmensentwicklung).
- Anderson, E. T., N. Kumar, and S. Rajiv, 2004. A Comment on:“Revisiting Dynamic Duopoly with Consumer Switching Costs”, *Journal of Economic Theory* 116, 177-186.
- Arrawatia, R., and A. Misra, 2012. Competition in Banking Industry: A Literature Review, *International Journal of Commerce, Business and Management* 1, No 3, 120-126.
- Aydemir, R., 2013. Competition and Collusion in the Turkish Banking Industry, *Emerging Markets Finance and Trade* 49, 31-40.
- Bain, J. S., 1951. Relation of Profit Rate to Industry Concentration: American Manufacturing, 1936-1940, *Quarterly Journal of Economics* 65, 293-324.
- Bain, J. S., 1956. *Barriers to New Competition: Their Character and Consequences in Manufacturing Industries*(Harvard University Press Cambridge, MA).
- Baker, J. B., and T. F. Bresnahan, 1988. Estimating the Residual Demand Curve Facing a Single Firm, *International Journal of Industrial Organization* 6, 283-300.
- Baltagi, B., 2008. *Econometric Analysis of Panel Data*(John Wiley & Sons).



- Banerjee, A. V., and L. H. Summers, 1987. *On Frequent Flyer Programs and Other Loyalty-inducing Economic Arrangements*(Harvard Institute of Economic Research).
- Bank of International Settlements, 2001. *Group of Ten - Consolidation in the Financial Sector*(Bank for International Settlements).
- Bank of International Settlements, 2010. Triennial Central Bank Survey: Foreign Exchange and Derivatives Market Activity in April 2010. Basel, Switzerland.
- Barone, G., R. Felici, and M. Pagnini, 2011. Switching Costs in Local Credit Markets, *International Journal of Industrial Organization* 29, 694-704.
- Basic Law: Chapter II, 1997. Chapter II: Relationship Between the Central Authorities and the Hong Kong Special Administrative Region. H.K.S.A. Region. Hong Kong.
- Basu, K., and C. Bell, 1991. Fragmented Duopoly: Theory and Applications to Backward Agriculture, *Journal of Development Economics* 36, 145-65.
- Baumol, W. J., J. C. Panzar, and R. D. Willig, 1983. Contestable Markets: An Uprising in the Theory of Industry Structure: Reply, *American Economic Review*, 491-496.
- Beggs, A., and P. Klemperer, 1992. Multi-period Competition with Switching Costs, *Econometrica: Journal of the Econometric Society*, 651-666.
- Berg, S. A., and M. Kim, 1998. Banks as Multioutput Oligopolies: An Empirical Evaluation of the Retail and Corporate Banking Markets, *Journal of Money, Credit and Banking*, 135-153.
- Berger, A. N., A. Demirgüç-Kunt, R. Levine, and J. G. Haubrich, 2004. Bank Concentration and Competition: An Evolution in the Making, *Journal of Money, Credit and Banking* 36, 433-451.
- Berger, A. N., and T. H. Hannan, 1989. The Price-concentration Relationship in Banking, *Review of Economics and Statistics* 71, 291-299.
- Berger, A. N., and T. H. Hannan, 1997. Using Efficiency Measures to Distinguish Among Alternative Explanations of the Structure-performance Relationship in Banking, *Managerial Finance* 23, 6-31.
- Bikker, J., and L. Spierdijk, 2008. *How Banking Competition Changed Over Time*(De Nederlandsche Bank).
- Bikker, J. A., 2004. *Competition and Efficiency in a Unified European Banking Market*(Edward Elgar Publishing).
- Bikker, J. A., and J. M. Groeneveld, 2000. Competition and Concentration in the EU Banking Industry, *Kredit und Kapital* 33, 62-98.
- Bikker, J. A., and K. Haaf, 2002a. Measures of Competition and Concentration in the Banking Industry: A Review of the Literature, *Economic & Financial Modelling* 9, 53-98.

- Bikker, J. A., and K. Haaf, 2002b. Competition, Concentration and Their Relationship: An Empirical Analysis of the Banking Industry, *Journal of Banking and Finance* 26, 2191-2214.
- Bikker, J. A., S. Shaffer, and L. Spierdijk, 2012. Assessing Competition with the Panzar-Rosse Model: The Role of Scale, Costs, and Equilibrium, *Review of Economics and Statistics* 94, 1025-1044.
- Bikker, J. A., L. Spierdijk, and P. Finnie, 2006. *Misspecification of the Panzar-Rosse Model: Assessing Competition in the Banking Industry*(De Nederlandsche Bank).
- Boone, J., 2008. A New Way to Measure Competition, *Economic Journal* 118, 1245-1261.
- Boone, J., J. C. Van Ours, and H. Van Der Wiel, 2007. *How (Not) to Measure Competition*(Centre for Economic Policy Research).
- Borenstein, S., 1991. Selling Costs and Switching Costs: Explaining Retail Gasoline Margins, *RAND journal of Economics*, 354-369.
- Bresnahan, T. F., 1982. The Oligopoly Solution Concept Is Identified, *Economics Letters* 10, 87-92.
- Bucklin, R. E., S. Gupta, and S. Han, 1995. A brand's Eye View of Response Segmentation in Consumer Brand Choice Behavior, *Journal of Marketing Research* 32, 66-74.
- Bulow, J., and P. Klemperer, 2002. Prices and the Winner's Curse, *RAND journal of Economics* 33, 1-21.
- Burnham, T. A., J. K. Frels, and V. Mahajan, 2003. Consumer Switching Costs: A Typology, Antecedents, and Consequences, *Journal of the academy of marketing science* 31, 109-126.
- Cabral, L., and S. Greenstein, 1990. Switching Costs and Bidding Parity in Government Procurement of Computer Systems, *Journal of Law, Economics and Organization* 6, 453.
- Calem, P. S., and G. A. Carlino, 1991. The Concentration / Conduct Relationship in Bank Deposit Markets, *Review of Economics and Statistics* 73, 268-276.
- Caminal, R., and C. Matutes, 1990. Endogenous Switching Costs in a Duopoly Model, *International Journal of Industrial Organization* 8, 353-373.
- Carbó S., J. F. de Guevara, D. Humphrey, and J. Maudos, 2009. Estimating the Intensity of Price and Non-price Competition in Banking, *Journal of Banks and Bank Systems* 4, 4-19.
- Carbo, S., D. Humphrey, J. Maudos, and P. Molyneux, 2009. Cross-country Comparisons of Competition and Pricing Power in European Banking, *Journal of International Money and Finance* 28, 115-134.
- Carlström, M., 2010. *Switching Costs in Local Finnish Retail Bank Lending*(Hanken School of Economics).
- Carse, D., 2001. The banking industry: competition, consolidation and systemic stability: the Hong Kong experience, *BIS background paper*, 71.

- Census and Statistics Department, 2007. Geography and Climate, Hong Kong.
- Census and Statistics Department, 2013. Hong Kong: The Facts, Hong Kong Government.
- Chaffai, M., and S. Sellami, 2014. Banking Competition and Efficiency: The Case of the Tunisian Commercial Banks.
- Che, H., K. Sudhir, and P. Seetharaman, 2007. Bounded Rationality in Pricing Under State-dependent Demand: Do Firms Look Ahead, and If So, How Far?, *Journal of Marketing Research* 44, 434-449.
- Chen, J., 2011. How do Switching Costs Affect Market Concentration and Prices in Network Industries?, *Unpublished manuscript* 7.
- Chen, J. H., M. Brown, and K. O. Ong, 2010. *Structured Lending and Securitisation in Hong Kong: Overview*(Practical Law Company).
- Chen, P.-Y., and L. M. Hitt, 2002. Measuring Switching Costs and the Determinants of Customer Retention in Internet-enabled Businesses: A Study of the Online Brokerage industry, *Information Systems Research* 13, 255-274.
- Chen, P.-Y., and L. M. Hitt, 2006. Information Technology and Switching Costs, *Handbook on Economics and Information Systems* 1, 437-470.
- Chen, Y., 1997. Paying Customers to Switch, *Journal of Economics and Management Strategy* 6, 877-897.
- Chiu, P., 2003. Hong Kong's Banking Industry Facing Keen Competition, *China Perspectives* 46, 50-60.
- Chu, L. Y., Y. Cui, N. Ye, and Y. Yan, 2013. Competition in Hong Kong's Banking Industry, *Lingnan Journal of Banking, Finance and Economics* 4, 6.
- Church, J. R., and R. Ware, 2000. Industrial Organization: A Strategic Approach.
- Claessens, S., and L. Laeven, 2004. What Drives Bank Competition? Some International Evidence, *Journal of Money, Credit and Banking*, 563-583.
- Coccorese, P., 1998. Assessing the Competitive Conditions in the Italian Banking System: Some Empirical Evidence, *Banca Nazionale del Lavoro Quarterly Review* 51, 171-191.
- Coccorese, P., 2004. Banking Competition and Macroeconomic Conditions: A Disaggregate Analysis, *Journal of International Financial Markets, Institutions and Money* 14, 203-219.
- Coccorese, P., 2005. Competition in Markets with Dominant Firms: A Note on the Evidence from the Italian Banking Industry, *Journal of Banking and Finance* 29, 1083-1093.
- Coccorese, P., 2009. Market Power in Local Banking Monopolies, *Journal of Banking and Finance* 33, 1196-1210.
- Coccorese, P., 2012. Information Sharing, Market Competition and Antitrust Intervention: A Lesson from the Italian Insurance Sector, *Applied Economics* 44, 351.

- Cohen, A. M., and M. J. Mazzeo, 2007. Market Structure and Competition Among Retail Depository Institutions, *Review of Economics and Statistics* 89, 60-74.
- Daley, J., and K. Matthews, 2012. Competitive Conditions in the Jamaican Banking Market 1998-2009, *International Review of Financial Analysis* 25, 131-135.
- David, P. A., 1985. Clio and the Economics of QWERTY, *American Economic Review* 75, 332-337.
- De Bandt, O., and E. P. Davis, 2000. Competition, Contestability and Market Structure in European Banking Sectors on the Eve of EMU, *Journal of Banking and Finance* 24, 1045-1066.
- De Ruyter, K., M. Wetzels, and J. Bloemer, 1998. On the Relationship Between Perceived Service Quality, Service Loyalty and Switching Costs, *International Journal of Service Industry Management* 9, 436-453.
- Degryse, H., M. Kim, and S. Ongena, 2009. *Microeconometrics of Banking: Methods, Applications, and Results*(Oxford University Press).
- Demirguc-Kunt, A., and M. S. Martínez Per á, 2010. A Framework for Analyzing Competition in the Banking Sector: An Application to the Case of Jordan.
- Demsetz, H., 1973. Industry Structure, Market Rivalry, and Public Policy, *Journal of Law and Economics*, 1-9.
- Dick, A. A., 2008. Demand Estimation and Consumer Welfare in the Banking Industry, *Journal of Banking and Finance* 32, 1661-1676.
- Dick, A. S., and K. Basu, 1994. Customer Loyalty: Toward an Integrated Conceptual Framework, *Journal of the academy of marketing science* 22, 99-113.
- Dub é J.-P., G. J. Hitsch, and P. E. Rossi, 2009. Do Switching Costs Make Markets Less Competitive?, *Journal of Marketing Research* 46, 435-445.
- Eliashberg, J., and T. S. Robertson, 1988. New Product Preannouncing Behavior: A Market Signaling Study, *Journal of Marketing Research*, 282-292.
- Ellison, G., 2005. A Model of Add-on Pricing, *Quarterly Journal of Economics* 120, 585-637.
- Elzinga, K. G., and D. E. Mills, 2001. Independent Service Organizations and Economic Efficiency, *Economic Inquiry* 39, 549-560.
- Epling, N., 2002. Price Discrimination Amid Heterogeneous Switching Costs: A Competitive Tactic of the Telephony Resale Fringe, *Yale University*, unpublished.
- Fadzlan, S., and H. Muzafar Shah, 2013. Financial Sector Consolidation and Competition in Malaysia, *Journal of Economic Studies* 40, 390-410.
- Farrell, J., and P. Klemperer, 2007. Coordination and Lock-in: Competition with Switching Costs and Network Effects, *Handbook of industrial organization* 3, 1967-2072.

- Farrell, J., and C. Shapiro, 1988. Dynamic Competition with Switching Costs, *RAND journal of Economics*, 123-137.
- Fischer, T., and D. R. Kamerschen, 2003. Measuring Competition in the US Airline Industry Using the Rosse-Panzar Test and Cross-sectional Regression Analyses, *Journal of Applied Economics* 6, 73-93.
- Florian, L., 2012. Financial Sector Competition in West African Economic and Monetary Union, *CERDI Working Paper*.
- Fornell, C., 1992. A National Customer Satisfaction Barometer: the Swedish Experience, *Journal of Marketing*, 6-21.
- Fosu, S., 2013. Banking Competition in Africa: Subregional Comparative Studies, *Emerging Markets Review* 15, 233-254.
- Freixas, X., and J.-C. Rochet, 1997. *Microeconomics of banking*(MIT press Cambridge, MA).
- Friedman, M., and R. D. Friedman, 1990. *Free to Choose: A Personal Statement* (Harcourt Brace Jovanovich).
- Frühlich, C., and B. Kavan, 2000. An Examination of Bank Merger Activity: A Strategic Framework Content Analysis, *Academy of Accounting and Financial Studies*, 1-5.
- Gayle, P. G., and C.-Y. Wu, 2013. A Re-examination of Incumbents' response to the Threat of Entry: Evidence from the Airline Industry, *Economics of Transportation* 2, 119-130.
- Gehrig, T., and R. Stenbacka, 2002. Introductory Offers in a Model of Strategic Competition. *CEPR Discussion Paper*, No.3189.
- Gelman, J. R., and S. C. Salop, 1983. Judo economics: Capacity Limitation and Coupon Competition, *Bell Journal of Economics*, 315-325.
- Genesove, D., and W. P. Mullin, 1998. Testing Static Oligopoly Models: Conduct and Cost in the Sugar Industry, 1890-1914, *RAND journal of Economics*, 355-377.
- Gilbert, R. A., 1984. Bank Market Structure and Competition: A Survey, *Journal of Money, Credit and Banking*, 617-645.
- Goddard, J., and J. O. Wilson, 2009. Competition in Banking: A Disequilibrium Approach, *Journal of Banking and Finance* 33, 2282-2292.
- Goldberg, L. G., and A. Rai, 1996. The Structure-performance Relationship for European Banking, *Journal of Banking and Finance* 20, 745-771.
- Government of Hong Kong, 2012. Hong Kong Ranked World's Freest Economy for 18<sup>th</sup> Consecutive Year. Retrieved January 12, 2012.
- Greenstein, S. M., 1993. Did Installed Base Give an Incumbent any (Measureable) Advantages in Federal Computer Procurement?, *RAND journal of Economics*, 19-39.
- Guiltinan, J. P., 1989. *A Classification of Switching Costs with Implications for Relationship Marketing*, in AMA Winter Educators' Conference:

- Marketing Theory and Practice, T. L. Childers, Richard P. Bagozzi, and J. P. Peter, eds. Chicago: American Medical Association, 216-20.
- Günel, B., and T. Çelik, 2006. Competition in the Turkish Banking Industry, *Applied Economics* 38, 1335-1342.
- Hamza, R. A., 2011. Validation Panzar-Rosse Model in Determining the Structural Characteristics of Tunisian Banking Industry, *Journal of Economics and International Finance* 3, 259-268.
- Haucap, J., 2003. Endogenous Switching Costs and Exclusive Systems Applications, *Review of Network Economics* 2, 29-35.
- Heide, J. B., and A. M. Weiss, 1995. Vendor Consideration and Switching Behavior for Buyers in High-technology Markets, *Journal of Marketing*, 30-43.
- Hirsch, B. T., and B. A. Morgan, 1994. Shareholder Risk and Returns in Union and Nonunion Firms, *Industrial and Labor Relations Review*, 302-318.
- HKEx, 2014. Our Market. HKEx.
- HKMA, 2005. *The "Three Refinements" of the Hong Kong Dollar Linked Exchange Rate System Two Years on.*
- HKMA, 2013. Hong Kong: The Premier Offshore Renminbi Business Centre.
- Ho, A., 2014. Economies of Scale in Hong Kong's Banking Industry, *Web Journal of Chinese Management Review* 17, 1.
- Ho, C.-Y., 2010. Deregulation, Competition and Consumer Welfare in a Banking Market: Evidence from Hong Kong, *Journal of regulatory economics* 37, 70-97.
- Ho, C.-Y., 2014. Switching Cost and the Deposit Demand in China, *Hong KONG Institute for Monetary Research Working Paper No.06/2014.*
- Ho, W.-Y., 2013. *Islam and China's Hong Kong: Ethnic identity, Muslim networks and the new Silk road*(Routledge).
- Hou, Y. a. D. D., 2007. *The Non-performing Loans: Some Bank-level Evidences*( Euro-Philippines Network in Banking and Finance).
- Hong Kong Economic Analysis Division, 2014. 2013 Economic Background and 2014 Prospects. Hong Kong.
- Hyde, C. E., and J. M. Perloff, 1995. Can Market Power be Estimated?, *Review of Industrial Organization* 10, 465-485.
- Industry, 2013. *Industry Benchmark Report.*
- Iwata, G., 1974. Measurement of Conjectural Variations in Oligopoly, *Econometrica: Journal of the Econometric Society*, 947-966.
- Jackson, B. B., 1985. *Winning and Keeping Industrial Customers: The Dynamics of Customer Relationships*(Lexington Books Lexington, MA).
- 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* 30, 40.

- Jones, M. A., D. L. Mothersbaugh, and S. E. Beatty, 2002. Why Customers Stay: Measuring the Underlying Dimensions of Services Switching Costs and Managing Their Differential Strategic Outcomes, *Journal of Business Research* 55, 441-450.
- Kashi, F. k., and J. Z. Beynabadi, 2013. The Degree of Competition in Iranian Banking Industry: Panzar-Rosse Approach, *African Journal of Business Management* 7, 4380.
- Kim, M.-K., M.-C. Park, and D.-H. Jeong, 2004. The Effects of Customer Satisfaction and Switching Barrier on Customer Loyalty in Korean Mobile Telecommunication Services, *Telecommunications policy* 28, 145-159.
- Kim, M., D. Kliger, and B. Vale, 2003. Estimating Switching Costs: The Case of Banking, *Journal of Financial Intermediation* 12, 25-56.
- Klemperer, P., 1987a. Markets with Consumer Switching Costs, *Quarterly Journal of Economics* 102, 375-394.
- Klemperer, P., 1987b. The Competitiveness of Markets with Switching Costs, *RAND journal of Economics*, 138-150.
- Klemperer, P., 1987c. Entry Deterrence in Markets with Consumer Switching Costs, *Economic Journal* 97, 99-117.
- Klemperer, P., 1995. Competition when Consumers Have Switching Costs: An Overview with Applications to Industrial Organization, Macroeconomics, and International Trade, *Review of Economic Studies* 62, 515-539.
- Klemperer, P., and I. Png, 1986. Frequent-flyer Plans: Marketing Device with Insidious Effects, *Los Angeles Times, Section IV, June 8*.
- Knittel, C. R., 1997. Interstate Long Distance Rates: Search Costs, Switching Costs, and Market Power, *Review of Industrial Organization* 12, 519-536.
- Köhler, M., 2014. Does Non-interest Income Make Banks More Risky? Retail-versus Investment-oriented Banks, *Review of Financial Economics* 23, 182-293.
- KPMG, 2013. *Hong Kong Banking Survey 2013*.
- Kwan, S. H., 2006. The X-efficiency of Commercial Banks in Hong Kong, *Journal of Banking and Finance* 30, 1127-1147.
- Kwan, Y. K., and F. T. Lui, 2000. *Deregulation, Profit, and Cost in Commercial Banking: The Case of Hong Kong*(University of Chicago Press).
- Lal, R., and C. Matutes, 1994. Retail Pricing and Advertising Strategies, *Journal of Business*, 345-370.
- Lau, L. J., 1982. On Identifying the Degree of Competitiveness from Industry Price and Output Data, *Economics Letters* 10, 93-99.
- Lee, S.-Y. T., and I. P. Png, 2004. Buyer Shopping Costs and Retail Pricing: An Indirect Empirical Test, *Review of Marketing Science* 2.
- Lóon, F., 2014. How Has Bank Competition Evolved in Africa? Evidence from WAEMU. *CERDI Working Paper*.

- Lerner, A. P., 1934. The Concept of Monopoly and the Measurement of Monopoly Power, *Review of Economic Studies* 1, 157-175.
- Liu, B., X. Wang, Y. Chen, and Y. Shen, 2013. Market Structure of China's Construction Industry Based on the Panzar-Rosse model, *Construction Management and Economics* 31, 731-745.
- Liu, H., P. Molyneux, and J. O. S. Wilson, 2010. *Measuring Competition and Stability: Recent Evidence for European Banking* (Bangor Business School Working Paper), BBSWP/10/020.
- Llewellyn, D. T., 2005. Competition and Profitability in European Banking: Why Are British Banks So Profitable?, *Economic Notes* 34, 279-311.
- Lopez, J. A., and M. M. Spiegel, 2008. 11 Foreign bank lending and bond underwriting in Japan during the lost decade, *China and Asia: Economic and Financial Interactions*, 197.
- MacKie-Mason, J. K., and J. Metzler, 2002. Links Between Vertically Related Markets: ITS v. Kodak. in *The Antitrust Revolution*, 3rd ed., J. Kwoka and L. White, eds., 1999. Revised for Kwoka and White, 4th ed., 2002.
- Marinosa, B. G., 2001. Technological Incompatibility, Endogenous Switching Costs and Lock-in, *Journal of Industrial Economics* 49, 281-298.
- Matthews, C. D., 2013. New Zealand's Bank Switching Costs: The Regulatory Response, *Banks & Banking Systems* 8.
- Matthews, K., V. Murinde, and T. Zhao, 2007. Competitive Conditions Among the Major British Banks, *Journal of Banking and Finance* 31, 2025-2042.
- Matthews, K., and N. Zhang, 2010. Bank Productivity in China 1997–2007: Measurement and Convergence, *China Economic Review* 21, 617-628.
- McFadden, D., 1973. Conditional Logit Analysis of Qualitative Choice Behavior. in P. Zarembka (ed.), *Frontiers in Econometrics*, 105-142, Academic Press: New York, 1974.
- Misra, A. K., and R. Arrawatia, 2013. A Conjectural Variation Approach for Assessment of Competition: A Case on Indian Commercial Banks, *Journal of Advances in Management Research* 10, 7-21.
- Molyneux, P., Y. Altunbas, and E. P. Gardener, 1996. *Efficiency in European banking*(Wiley Chichester).
- Molyneux, P., D. M. Lloyd-Williams, and J. Thornton, 1994. Competitive Conditions in European Banking, *Journal of Banking and Finance* 18, 445-459.
- Molyneux, P., J. Thornton, and D. Michael Llyod-Williams, 1996. Competition and Market Contestability in Japanese Commercial Banking, *Journal of Economics and Business* 48, 33-45.
- Morgan, P. B., and O. Shy, 1996. *Undercut-proof Equilibria*(Foerder Institute for Economic Research, Eitan Berglas School of Economics, Tel-Aviv University).



- Morgans, O., 2010. *Sitck or Twist? An Analysis of Consumer Behaviour in the Personal Current Account Market*(Consumer Focus Report).
- Morita, H., and M. Waldman, 2010. Competition, Monopoly Maintenance, and Consumer Switching Costs, *American Economic Journal: Microeconomics* 2, 230-255.
- Nagar, A., 1959. The Bias and Moment Matrix of the General K-class Estimators of the Parameters in Simultaneous Equations, *Econometrica: Journal of the Econometric Society*, 575-595.
- Najarzadeh, R., M. Reed, and H. Mirzanejad, 2013. A Study of the Competitiveness of Iran's Banking System, *Journal of Economic Cooperation and Development* 34, 93-109.
- Nathan, A., and E. H. Neave, 1989. Competition and Contestability in Canada's Financial System: Empirical Results, *Canadian Journal of Economics*, 576-594.
- NERA, 2003. Switching Costs: A Report Prepared for the Office of Fair Trading and the Department of Trade and Industry, *Economic Discussion Paper* 5.
- Nilssen, T., 1992. Two Kinds of Consumer Switching Costs, *RAND journal of Economics* 23, 579-589.
- Olszak, M. A., F. Światała, and I. Kowalska, 2013. Competition in Commercial Banks in Poland – Analysis of Panzar-Rosse H-Statistics, *UW Faculty of Management Working Paper Series* 4/2013, 1-28.
- Owusu-Antwi, G., and J. Antwi, 2013. Do Financial Sector Reforms Improve Competition of Banks? An Application of Panzar and Rosse Model: The Case of Ghanaian Banks, *International Journal of Financial Research* 4, 43-61.
- Padilla, A. J., 1992. Mixed Pricing in Oligopoly with Consumer Switching Costs, *International Journal of Industrial Organization* 10, 393-411.
- Padilla, A. J., 1995. Revisiting Dynamic Duopoly with Consumer Switching Costs, *Journal of Economic Theory* 67, 520-530.
- Panzar, J. C., and J. N. Rosse, 1982. *Structure, Conduct, and Comparative Statistics*(Bell Telephone Laboratories).
- Panzar, J. C., and J. N. Rosse, 1987. Testing For "Monopoly" Equilibrium, *Journal of Industrial Economics* 35, 443-456.
- Park, K. H., 2013. Testing for Competition in the South Korean and Chinese Commercial Banking Markets, *Asia-Pacific Journal of Financial Studies* 42, 56.
- Park, M., 2011. The Economic Impact of Wireless Number Portability, *Journal of Industrial Economics* 59, 714-745.
- Peltzman, S., 1977. *The Gains and Losses from Industrial Concentration*(National Bureau of Economic Research Cambridge, Massachusetts, USA).
- Pesic, A., 2010. Switching Costs and Entry in the Mortgage Industry, *University of California Working Paper*.

- Pomp, M., V. Shestalova, and L. Rangel, 2005. *Switch on the Competition: Causes, Consequences and Policy Implications of Consumer Switching Costs*(CPB Netherlands Bureau for Economic Policy Analysis).
- Porter, M. E., 1980. *Competitive Strategy: Techniques for Analyzing Industries and Competitors*(New York: Free Press).
- Rosenthal, R. W., 1980. A Model in Which an Increase in the Number of Sellers Leads to a Higher Price, *Econometrica: Journal of the Econometric Society*, 1575-1579.
- Rosse, J. N., and J. C. Panzar, 1977. *Chamberlin vs. Robinson: An Empirical Test for Monopoly Rents*(Bell Laboratories).
- Ruiz-Moreno, F., A. Ladrón-de-Guevara, and F. Mas-Ruiz, 2010. Development of a Model of Price Competition in the Spanish Loans Market, *International Journal of Bank Marketing* 28, 479-496.
- Samuelson, W., and R. Zeckhauser, 1988. Status Quo Bias in Decision Making, *Journal of risk and uncertainty* 1, 7-59.
- Schaeck, K., M. Cihak, and S. Wolfe, 2009. Are Competitive Banking Systems More Stable?, *Journal of Money, Credit and Banking* 41, 711-734.
- Schiersch, A., and J. Schmidt-Ehmcke, 2010. *Empiricism Meets Theory: Is the Boone-Indicator Applicable?*(Discussion Papers, German Institute for Economic Research).
- Sepúlveda, J. P., 2012. On the Relationship Between Concentration and Competition: Evidence from the Chilean Private Pension System, *Applied Economics Letters* 19, 1385.
- Settlements, B. f. I., 2001. *Group of Ten-consolidation in the Financial Sector*.
- Shaffer, G., and Z. J. Zhang, 2000. Pay to Switch or Pay to Stay: Preference-Based Price Discrimination in Markets with Switching Costs, *Journal of Economics and Management Strategy* 9, 397-424.
- Shaffer, S., 1982. A Non-structural Test for Competition in Financial Markets, in Proceedings of a Conference on Bank Structure and Competition. Federal Reserve Bank of Chicago, Chicago.
- Shaffer, S., 1983. Non-structural Measures of Competition: Toward a Synthesis of Alternatives, *Economics Letters* 12, 349-353.
- Shaffer, S., 1989. Competition in the US Banking Industry, *Economics Letters* 29, 321-323.
- Shaffer, S., 1993. A Test of Competition in Canadian Banking, *Journal of Money, Credit and Banking*, 49-61.
- Shaffer, S., 2004a. Comment on "What Drives Bank Competition? Some International Evidence" by Stijn Claessens and Luc Laeven, *Journal of Money, Credit and Banking* 36, 585-592.
- Shaffer, S., 2004b. Patterns of Competition in Banking, *Journal of Economics and Business* 56, 287-313.

- Shaffer, S., and L. Spierdijk, 2013. Duopoly Conduct and the Panzar-Rosse Revenue Test.
- Shapiro, C., 1995. Aftermarkets and Consumer Welfare: Making Sense of Kodak, *Antitrust Law Journal* 63, 483-511.
- Shcherbakov, O., 2008. *Switching costs, Investment, and Collusion: Essays in Empirical Industrial Organization*(The University of Arizona, Ann Arbor).
- Shen, J., 2004a. Urban competitiveness and urban governance in the globalizing world, *Asian geographer* 23, 19-36.
- Shen, J., 2004b. Cross-border Urban Governance in Hong Kong: The Role of State in a Globalizing City-Region\*, *The Professional Geographer* 56, 530-543.
- Shen, J., 2008. Hong Kong under Chinese sovereignty: Economic relations with mainland China, 1978-2007, *Eurasian Geography and Economics* 49, 326-340.
- Shi, M., 2013. A Theoretical Analysis of Endogenous and Exogenous Switching Costs, *Quantitative Marketing and Economics* 11, 205-230.
- Shi, M., J. Chiang, and B.-D. Rhee, 2006. Price Competition with Reduced Consumer Switching Costs: The Case of “Wireless Number Portability” in the Cellular Phone Industry, *Management Science* 52, 27-38.
- Shugan, S. M., 1980. The Cost of Thinking, *Journal of consumer Research*, 99-111.
- Shum, M., 2004. Does Advertising Overcome Brand Loyalty? Evidence from the Breakfast-Cereals Market, *Journal of Economics and Management Strategy* 13, 241-272.
- Shy, O., 2002. A Quick-and-easy Method for Estimating Switching Costs, *International Journal of Industrial Organization* 20, 71-87.
- Sjöberg, P., 2004. Market Power and Performance in Swedish Banking, *Department of Economics, Goteborg University*.
- So, A. Y., N. Lin, and D. L. Poston, 2001. *The Chinese Triangle of Mainland China, Taiwan, and Hong Kong: Comparative Institutional Analyses*(Greenwood Publishing Group).
- Stango, V., 2002. Pricing with Consumer Switching Costs: Evidence from the Credit Card Market, *Journal of Industrial Economics* 50, 475-492.
- Stiglitz, J. E., 1989. Imperfect Information in the Product Market, *Handbook of industrial organization* 1, 769-847.
- Sun, Y., 2011. *Recent Developments in European Bank Competition* (International Monetary Fund).
- Thompson, R. L., and W. L. Cats-Baril, 2002. *Information Technology and Management*(McGraw-Hill, Inc.).
- Tsutsui, Y., and A. Kamesaka, 2005. Degree of Competition in the Japanese Securities Industry, *Journal of Economics and Business* 57, 360-374.
- Van Leuvensteijn, M., 2008. The Boone-indicator: Identifying Different Regimes of Competition for the American Sugar Refining Company 1890-1914,

- Tjalling C. Koopmans Research Institute*, Discussion Paper Series No. 08-37.
- Van Leuvensteijn, M., J. A. Bikker, A. A. van Rixtel, and C. K. Sørensen, 2011. A New Approach to Measuring Competition in the Loan Markets of the Euro Area, *Applied Economics* 43, 3155-3167.
- Vesala, J. M., 1995. *Testing for Competition in Banking : Behavioral Evidence from Finland*(Helsinki).
- Viard, V. B., 2007. Do Switching Costs Make Markets More or Less Competitive? The Case of 800-number Portability, *RAND journal of Economics* 38, 146-163.
- Vickers, J. S., 2011. *Independent Commission on Banking Final Report: Recommendations*(The Stationery Office).
- Villas-Boas, J. M., 2014. A Short Survey on Switching Costs and Dynamic Competition.
- Von Weizsäcker, C. C., 1984. The Costs of Substitution, *Econometrica: Journal of the Econometric Society*, 1085-1116.
- Wang, R., and Q. Wen, 1998. Strategic Invasion in Markets with Switching Costs, *Journal of Economics and Management Strategy* 7, 521-549.
- Weiss, A. M., and J. B. Heide, 1993. The Nature of Organizational Search in High Technology Markets, *Journal of Marketing Research*, 220-233.
- Weiss, L., 1974. *The Concentration-profits Relationship and Antitrust*(Little, Brown, Boston).
- Wernerfelt, B., 1985. Brand Loyalty and User Skills, *Journal of Economic Behavior and Organization* 6, 381-385.
- Whitten, D., and R. L. Wakefield, 2006. Measuring Switching Costs in IT Outsourcing Services, *Journal of Strategic Information Systems* 15, 219-248.
- Wong, H. S., 1996. Market Structure and the Role of Consumer Information in the Physician Services Industry: An Empirical Test, *Journal of Health Economics* 15, 139-160.
- Wong, J., E. Wong, T. Fong, and K.-f. Choi, 2006. Competition in Hong Kong's Banking Sector: A Panzar-Rosse Assessment, *Hong Kong Monetary Authority Working Paper Series*.
- Wong, J., T.-C. Wong, T. Fong, and K.-F. Choi, 2007. Testing for Collusion in the Hong Kong Banking Sector, *Hong Kong Monetary Authority Working Paper Series*.
- Xu, B., A. v. Rixtel, and M. v. Leuvensteijn, 2013. *Measuring Bank Competition in China : A Comparison of New Versus Conventional Approaches Applied to Loan Markets*([Basel] : Bank for Internat. Settlements).
- Yeung, Y., J. Shen, and L. Zhang, 2006. China's 11th five-year plan: Opportunities and challenges for Hong Kong final report, *Hong Kong: Hong Kong Institute of Asia—Pacific Studies*.

- Yoffie, D. B., and M. Kwak, 2001. *Judo Strategy*(Harvard Business School Press).
- Yuan, Y., 2006. The State of Competition of the Chinese Banking Industry, *Journal of Asian Economics* 17, 519-534.
- Yuan, Y., 2010. Three Essays on Switching Costs in Banking, the Lending Channel and Entry in the Banking Industry, *Working Paper, Drexel University*.
- Zhu, G., S. Ao, and J. Dai, 2011. Estimating the Switching Costs in Wireless Telecommunication Market, *Nankai Business Review International* 2, 213-236.

# Appendix A

## Chapter 3 Appendix

### Appendix A.1 The derivation of the optimal interest rate strategy (equation 3.24)

As shown in equation 3.23 (p.83), the optimal interest rate charged by bank  $i$  at period  $\tau$ :

$$\frac{\partial V_{i,\tau}}{\partial p_{i,\tau}} = \sum_{t=\tau}^{\infty} \delta^{t-\tau} \frac{\partial \pi_{i,t}}{\partial p_{i,\tau}} = 0 \quad (\text{A.1})$$

Then, by substituting equation (3.22) (p.83) into (A.1), equation (A.1) becomes

$$\begin{aligned} \frac{\partial V_{i,\tau}}{\partial p_{i,\tau}} &= \sum_{t=\tau}^{\infty} \delta^{t-\tau} \frac{\partial (y_{1,i,t} * p_{i,t} - C_{i,t})}{\partial p_{i,\tau}} \\ &= y_{1,i,\tau} + \sum_{t=\tau}^{\infty} \delta^{t-\tau} \left( \frac{\partial y_{1,i,t}}{\partial p_{i,\tau}} p_{i,t} - \frac{\partial C_{i,t}}{\partial y_{1,i,t}} \frac{\partial y_{1,i,t}}{\partial p_{i,\tau}} \right) = 0 \end{aligned} \quad (\text{A.2})$$

or

$$\frac{\partial V_{i,\tau}}{\partial p_{i,\tau}} = y_{1,i,\tau} + \sum_{t=\tau}^{\infty} \delta^{t-\tau} \left( p_{i,t} - \frac{\partial C_{i,t}}{\partial y_{1,i,t}} \right) \frac{\partial y_{1,i,t}}{\partial p_{i,\tau}} = 0 \quad (\text{A.3})$$

where the effect of the current interest rate on the quantity demanded  $kt$  periods ahead is

$$\frac{\partial y_{1,i,\tau+kt}}{\partial p_{i,\tau}} = \frac{\partial y_{1,i,\tau+kt}}{\partial y_{1,i,\tau+kt-1}} \cdot \frac{\partial y_{1,i,\tau+kt-1}}{\partial y_{1,i,\tau+kt-2}} \dots \dots \frac{\partial y_{1,i,\tau}}{\partial p_{i,\tau}} \text{ for } kt=t-\tau \quad (\text{A.4})$$

For similar arguments, another requirement for the bank's optimal behaviour is that the derivative of (3.21) (p.83) w.r.t. the time  $\tau + 1$  interest rate,  $p_{i,\tau+1}$ , is zero along the optimal path:

$$\frac{\partial V_{i,\tau}}{\partial p_{i,\tau+1}} = y_{1,i,\tau+1} + \sum_{t=\tau}^{\infty} \delta^{t-\tau+1} \left( p_{i,t} - \frac{\partial c_{i,t}}{\partial y_{1,i,t}} \right) \frac{\partial y_{1,i,t}}{\partial p_{i,\tau+1}} = 0 \quad (\text{A.5})$$

where

$$\frac{\partial y_{1,i,\tau+kt}}{\partial p_{i,\tau+1}} = \frac{\partial y_{1,i,\tau+kt}}{\partial y_{1,i,\tau+kt-1}} \cdot \frac{\partial y_{1,i,\tau+kt-1}}{\partial y_{1,i,\tau+kt-2}} \dots \frac{\partial y_{1,i,\tau+1}}{\partial p_{i,\tau+1}} \text{ for } k=t-\tau \quad (\text{A.6})$$

Since both (A.3) and (A.5) are necessary conditions, any linear combination of them should hold as well. Thus, for any  $dp_{i,\tau}$  and  $dp_{i,\tau+1}$ , the following should hold:

$$\frac{\partial V_{i,\tau}}{\partial p_{i,\tau}} dp_{i,\tau} + \frac{\partial V_{i,\tau}}{\partial p_{i,\tau+1}} dp_{i,\tau+1} = 0 \quad (\text{A.7})$$

In particular, Kim et al. (2003) choose the differentials  $dp_{i,\tau}$  and  $dp_{i,\tau+1}$  that keeps  $y_{1,i,\tau+1}$  constant:

$$\frac{\partial y_{1,i,\tau+1}}{\partial p_{i,\tau}} dp_{i,\tau} + \frac{\partial y_{1,i,\tau+1}}{\partial p_{i,\tau+1}} dp_{i,\tau+1} = 0 \quad (\text{A.8})$$

or

$$dp_{i,\tau+1} = - \frac{\partial y_{1,i,\tau+1}}{\partial p_{i,\tau}} / \frac{\partial y_{1,i,\tau+1}}{\partial p_{i,\tau+1}} dp_{i,\tau} \quad (\text{A.9})$$

Substituting

$$\frac{\partial y_{1,i,t+1}}{\partial p_{i,\tau}} = -y_{1,t-1}\alpha_1 \frac{n}{n-1} \alpha_1 s g_t g_{t+1} \quad \text{and} \quad \frac{\partial y_{1,i,t+1}}{\partial p_{i,\tau+1}} = -y_{1,t-1}\alpha_1 s g_t g_{t+1}^{109} \quad \text{into}$$

(A.9), then

$$dp_{i,\tau+1} = dp_{i,\tau} \frac{n}{n-1} \alpha_1 s \quad (\text{A.10})$$

Since  $y_{i,\tau+1}$  is unchanged, the condition (A.7) becomes:

$$\left( \frac{\partial \pi_{i,\tau}}{\partial p_{i,\tau+1}} + \delta \frac{\partial \pi_{i,\tau}}{\partial p_{i,\tau}} \right) dp_{i,t} + \delta \frac{\partial \pi_{i,\tau+1}}{\partial p_{i,\tau+1}} dp_{i,t+1} = 0 \quad (\text{A.11})$$

Furthermore, as  $y_{i,\tau+1}$  is constant, (A.11) becomes:

$$\frac{\partial \pi_{i,\tau}}{\partial p_{i,\tau}} dp_{i,t} + \delta y_{i,\tau+1} dp_{i,t+1} = 0 \quad (\text{A.12})$$

Inserting (A.10) into (A.12) and rearranging:

---

<sup>109</sup> The demand faced by the bank, after substituting the linear transition probabilities is

$$y_{1,i,t} = \left( y_{1,i,t-1} \left( \alpha_0^i + \alpha_1 (p_{i,t} - \bar{p}_{i,R,t} - s) \right) + y_{1,i,R,t-1} \left( \alpha_0^i + \alpha_1 \left( p_{i,t} - \bar{p}_{i,R,t} + \frac{s}{n-1} \right) \right) \right) g_t \quad \text{or}$$

$$y_{1,i,t} = \left( -y_{1,i,t-1} \frac{n}{n-1} s \alpha_1 + y_{1,t-1} \alpha_0^i + y_{1,t-1} \alpha_1 (p_{i,t} - \bar{p}_{i,R,t} + \frac{s}{n-1}) \right) g_t \quad \text{where} \quad y_{1,t-1} = \sum y_{1,i,t-1}$$

Differentiating w.r.t the bank's interest rate and rivals' average interest rate gives

$$\frac{\partial y_{1,i,t}}{\partial p_{i,t}} = y_{1,t-1} \alpha_1 g_t \quad \text{and} \quad \frac{\partial y_{1,i,t}}{\partial \bar{p}_{i,R,t}} = -y_{1,t-1} \alpha_1 g_t$$

The time t+1 demand is

$$y_{1,i,t+1} = \left( -y_{1,i,t} \frac{n}{n-1} s \alpha_1 + y_{1,t} \alpha_0^i + y_{1,t} \alpha_1 \left( p_{i,t+1} - \bar{p}_{i,R,t+1} + \frac{s}{n-1} \right) \right) g_{t+1}$$

Differentiating w.r.t. the bank's time t interest rate and rivals' time t+1 average interest rate gives

$$\frac{\partial y_{1,i,t+1}}{\partial p_{i,t}} = \frac{-\partial y_{1,i,t}}{\partial p_{i,t}} \frac{n}{n-1} s \alpha_1 g_{t+1} = -y_{1,t-1} \alpha_1 \frac{n}{n-1} s \alpha_1 g_t g_{t+1} \quad \text{and} \quad \frac{\partial y_{1,i,t+1}}{\partial \bar{p}_{i,R,t+1}} = y_{1,t-1} \alpha_1 g_t g_{t+1}$$



$$\frac{\partial \pi_{i,\tau}}{\partial p_{i,\tau}} + \delta y_{i,\tau+1} \frac{n}{n-1} \alpha_1 s = 0 \quad (\text{A.13})$$

Writing the derivative of the time  $\tau$  profit explicitly, yields

$$y_{i,t} + \left( p_{i,t} - \frac{\partial c_{i,t}}{\partial y_{i,t}} \right) \frac{\partial y_{i,t}}{\partial p_{i,t}} + \delta y_{i,t+1} \frac{n}{n-1} \alpha_1 s = 0 \quad (\text{A.14})$$

As  $\frac{\partial y_{i,\tau}}{\partial p_{i,\tau}} = y_{t-1} \alpha_1 s g_t$ , equation A.14 can be expressed as

$$pcm_{i,t} = -\delta \cdot \sigma_{i,t+1} \frac{n}{n-1} s g_{t+1} - \frac{\sigma_{i,t}}{\alpha_1} \quad (\text{A.15})$$

where  $pcm_{i,t} = p_{i,t} - mc_{i,t}$  is the price-cost margin in period  $t$ .

## Appendix A.2 Sample of banks<sup>110</sup>

Bank Name	Short Name	Data Missing Periods
Bank of China (Hong Kong) Limited	BOC	1997-1999
Bank of East Asia, Limited (The)	BOEA	NA
China Construction Bank (Asia) Corporation	CCB	NA
Chiyu Banking Corporation Limited	CHIYU	Personal expense in 2001
Chong Hing Bank Limited	CH	1997
CITIC Bank International	CITIC	NA
Dah Sing Bank	DS	NA
DBS Bank (Hong Kong) Limited	DBS	1997
Fubon Bank (Hong Kong)	FUBON	1997
Hang Seng Bank Limited	HS	NA
Hong Kong and Shanghai Banking Corporation (The)	HSBC	NA
Industrial and Commercial Bank of China (Asia)	ICBC	1997
Nanyang Commercial Bank	NY	1997
Public Bank (Hong Kong)	PUBLIC	NA
Shanghai Commercial Bank Limited	SHANGHAI	NA
Standard Chartered Bank (Hong Kong) Limited	SCB	1997-1999
Wing Hang Bank	WH	1997
Wing Lung Bank	WL	1997

<sup>110</sup> Note 1: DBS Bank (Hong Kong) Limited merged with DBS Kwong On Bank in 2003.

Note 2: Wing Hang acquired Chekiang First Bank in 2003.

Note 3: Public Bank (Hong Kong), originally named Asia Commercial Bank Limited, was acquired by Public Financial Holdings Limited. It was renamed in 2006.

Note 4: Chong Hing Bank Limited was renamed from Liu Chong Hing Bank Limited in 2006.

Note 5: China Construction Bank (Asia) was renamed from Bank of Amercia (Asia) in 2007.

Note 6. DBS Bank lists in Stock Exchange of Singapore.

### Appendix A.3 Coefficients interpretations of normalized trans-log cost function

The one output, three inputs translog cost function of bank  $i$  at different time is as follows:

$$\begin{aligned}
 \ln C_{i,t} = & \beta_0 + \delta_1 \ln y_{1,i,t} + \frac{1}{2} \delta_{11} \ln y_{1,i,t}^2 + \gamma_{11} \ln y_{1,i,t} \ln w_{1,i,t} + \gamma_{12} \ln y_{1,i,t} \ln w_{2,i,t} \\
 & + \gamma_{13} \ln y_{1,i,t} \ln w_{3,i,t} + \beta_1 \ln w_{1,i,t} + \beta_2 \ln w_{2,i,t} + \beta_3 \ln w_{3,i,t} + \frac{1}{2} \beta_{11} \ln w_{1,i,t}^2 \\
 & + \frac{1}{2} \beta_{22} \ln w_{2,i,t}^2 + \frac{1}{2} \beta_{33} \ln w_{3,i,t}^2 + \beta_{12} \ln w_{1,i,t} \ln w_{2,i,t} + \beta_{13} \ln w_{1,i,t} \ln w_{3,i,t} \\
 & + \beta_{23} \ln w_{2,i,t} \ln w_{3,i,t} \tag{A.16}
 \end{aligned}$$

where  $\sum_k \beta_k = 1$ ;  $\sum_k \gamma_{1k} = 0$ ;  $\sum_l \beta_{kl} = 0, \forall k, l = 1, 2, 3$  are imposed.

If all of the explanatory variables are normalized by their sample mean, then the equation (A.16) can be changed into

$$\begin{aligned}
 \ln C_{i,t} = & \beta_0 + \delta_1 \ln \left( \frac{y_{1,i,t}}{\bar{y}_{1,t}} \right) + \frac{1}{2} \delta_{11} \ln \left( \frac{y_{1,i,t}}{\bar{y}_{1,t}} \right)^2 + \gamma_{11} \ln \left( \frac{y_{1,i,t}}{\bar{y}_{1,t}} \right) \ln \left( \frac{w_{1,i,t}}{\bar{w}_{1,t}} \right) \\
 & + \gamma_{12} \ln \left( \frac{y_{1,i,t}}{\bar{y}_{1,t}} \right) \ln \left( \frac{w_{2,i,t}}{\bar{w}_{2,t}} \right) + \gamma_{13} \ln \left( \frac{y_{1,i,t}}{\bar{y}_{1,t}} \right) \ln \left( \frac{w_{3,i,t}}{\bar{w}_{3,t}} \right) + \beta_1 \ln \left( \frac{w_{1,i,t}}{\bar{w}_{1,t}} \right) + \beta_2 \ln \left( \frac{w_{2,i,t}}{\bar{w}_{2,t}} \right) + \\
 & \beta_3 \ln \left( \frac{w_{3,i,t}}{\bar{w}_{3,t}} \right) + \frac{1}{2} \beta_{11} \ln \left( \frac{w_{1,i,t}}{\bar{w}_{1,t}} \right)^2 + \frac{1}{2} \beta_{22} \ln \left( \frac{w_{2,i,t}}{\bar{w}_{2,t}} \right)^2 + \frac{1}{2} \beta_{33} \ln \left( \frac{w_{3,i,t}}{\bar{w}_{3,t}} \right)^2 + \\
 & \beta_{12} \ln \left( \frac{w_{1,i,t}}{\bar{w}_{1,t}} \right) \ln \left( \frac{w_{2,i,t}}{\bar{w}_{2,t}} \right) + \beta_{13} \ln \left( \frac{w_{1,i,t}}{\bar{w}_{1,t}} \right) \ln \left( \frac{w_{3,i,t}}{\bar{w}_{3,t}} \right) + \beta_{23} \ln \left( \frac{w_{2,i,t}}{\bar{w}_{2,t}} \right) \ln \left( \frac{w_{3,i,t}}{\bar{w}_{3,t}} \right) \tag{A.17}
 \end{aligned}$$

where  $\overline{y_{1,t}}$  is the sample mean of bank loans,  $y_{1,t}$ ,  $\overline{w_{1,t}}$ ,  $\overline{w_{2,t}}$  and  $\overline{w_{3,t}}$  are sample means of input price on labors, input price on capitals and input price on deposits, respectively.

Then, the elasticity of total cost w.r.t. output is given by:

$$\frac{\partial \ln TC_{i,t}}{\partial \ln y_{1,t}} = \frac{\partial TC_{i,t}}{\partial y_{1,t}} * \frac{y_{1,t}}{TC_{i,t}} = \delta_1 + \delta_{11} \ln\left(\frac{y_{1,t}}{\overline{y_{1,t}}}\right) \quad (\text{A.18})$$

Note that at the means of the conditioning variables,  $\overline{y_{1,t}}$ , then  $\ln\left(\frac{y_{1,t}}{\overline{y_{1,t}}}\right) = 0$ , therefore,

$$\left. \frac{\partial \ln TC_{i,t}}{\partial \ln y_{1,t}} \right|_{y_{1,t}=\overline{y_{1,t}}} = \delta_1 \quad (\text{A.19})$$

So  $\delta_1$  is the elasticity of total cost w.r.t. output, at the means of the data.

## Appendix A.4 Coefficient variance-covariance matrix

**Table A.1 Coefficient variance-covariance matrix of system estimation of trans-log cost system and switching costs equations using non-linear 3SLS approach**

Coefficient	$\beta_0$	$\delta_1$	$\delta_{11}$	$\gamma_{12}$	$\gamma_{13}$	$\beta_1$	$\beta_2$	$\beta_{12}$	$\beta_{13}$	$\beta_{23}$	$s$	$\alpha_1$
$\beta_0$	0.002462	0.002336	-0.00024	0.000218	-2.86E-05	-6.34E-05	9.44E-05	0.000259	-0.00014	-5.47E-05	-2.59E-05	0.002775
$\delta_1$	0.002336	0.003374	-0.00033	0.000288	-0.00014	-0.00016	2.41E-05	0.000226	-0.00017	-6.97E-05	-2.50E-05	0.002224
$\delta_{11}$	-0.00024	-0.00033	0.000106	-0.00015	0.000278	-9.94E-05	-9.66E-05	3.48E-06	-4.08E-05	-3.97E-05	1.50E-05	-0.00138
$\gamma_{12}$	0.000218	0.000288	-0.00015	0.000348	-0.00049	0.000147	0.000196	7.56E-05	6.33E-05	0.000119	-1.59E-05	0.000454
$\gamma_{13}$	-2.86E-05	-0.00014	0.000278	-0.00049	0.001082	-0.00044	-0.00036	0.000101	-0.00023	-0.0002	3.19E-05	-0.00104
$\beta_1$	-6.34E-05	-0.00016	-9.94E-05	0.000147	-0.00044	0.000288	0.000121	1.08E-07	0.000128	5.66E-05	-1.19E-05	0.000462
$\beta_2$	9.44E-05	2.41E-05	-9.66E-05	0.000196	-0.00036	0.000121	0.000196	-8.19E-05	5.75E-05	7.71E-05	-1.19E-05	0.000316
$\beta_{12}$	0.000259	0.000226	3.48E-06	7.56E-05	0.000101	1.08E-07	-8.19E-05	0.000329	-5.47E-05	-1.59E-05	1.53E-06	1.74E-05
$\beta_{13}$	-0.00014	-0.00017	-4.08E-05	6.33E-05	-0.00023	0.000128	5.75E-05	-5.47E-05	0.000103	5.15E-05	-4.32E-06	0.000171
$\beta_{23}$	-5.47E-05	-6.97E-05	-3.97E-05	0.000119	-0.0002	5.66E-05	7.71E-05	-1.59E-05	5.15E-05	7.13E-05	-4.04E-06	3.11E-05
$s$	-2.59E-05	-2.50E-05	1.50E-05	-1.59E-05	3.19E-05	-1.19E-05	-1.19E-05	1.53E-06	-4.32E-06	-4.04E-06	0.004552	0.002053
$\alpha_1$	0.002775	0.002224	-0.00138	0.000454	-0.00104	0.000462	0.000316	1.74E-05	0.000171	3.11E-05	0.002053	0.440645

**Table A.2 Coefficient variance-covariance matrix of system estimation of trans-log cost system  
and switching costs equations using GMM approach**

Coefficient	$\beta_0$	$\delta_1$	$\delta_{11}$	$\gamma_{12}$	$\gamma_{13}$	$\beta_1$	$\beta_2$	$\beta_{12}$	$\beta_{13}$	$\beta_{23}$	$s$	$\alpha_1$
$\beta_0$	0.002238	0.001712	-0.00027	0.000315	-0.00034	0.00018	0.000276	0.00022	-8.82E-05	-3.31E-05	-0.00016	-0.00753
$\delta_1$	0.001712	0.001837	-0.00025	0.000272	-0.0003	5.51E-05	0.000159	0.000176	-0.00011	-4.33E-05	-5.08E-05	-0.00433
$\delta_{11}$	-0.00027	-0.00025	9.10E-05	-0.00013	0.000239	-0.0001	-9.11E-05	-1.23E-05	-3.05E-05	-2.97E-05	-1.63E-05	-0.00031
$\gamma_{12}$	0.000315	0.000272	-0.00013	0.000304	-0.00041	0.000139	0.00017	9.83E-05	5.04E-05	0.0001016	7.34E-05	-0.00257
$\gamma_{13}$	-0.00034	-0.0003	0.000239	-0.00041	0.000885	-0.00038	-0.00031	4.69E-05	-0.00018	-0.000148	-9.65E-05	0.005661
$\beta_1$	0.00018	5.51E-05	-0.0001	0.000139	-0.00038	0.000246	0.000123	7.33E-06	0.000102	5.16E-05	5.42E-06	-0.00282
$\beta_2$	0.000276	0.000159	-9.11E-05	0.00017	-0.00031	0.000123	0.000178	-5.66E-05	5.71E-05	5.92E-05	1.04E-05	-0.00326
$\beta_{12}$	0.00022	0.000176	-1.23E-05	9.83E-05	4.69E-05	7.33E-06	-5.66E-05	0.000286	-4.68E-05	6.53E-06	1.27E-05	0.000614
$\beta_{13}$	-8.82E-05	-0.00011	-3.05E-05	5.04E-05	-0.00018	0.000102	5.71E-05	-4.68E-05	8.39E-05	4.18E-05	2.17E-05	-0.00147
$\beta_{23}$	-3.31E-05	-4.33E-05	-2.97E-05	0.000102	-0.00015	5.16E-05	5.92E-05	6.53E-06	4.18E-05	6.04E-05	4.00E-05	-0.00067
$s$	-0.00016	-5.08E-05	-1.63E-05	7.34E-05	-9.65E-05	5.42E-06	1.04E-05	1.27E-05	2.17E-05	4.00E-05	0.001326	0.000414
$\alpha_1$	-0.00753	-0.00433	-0.00031	-0.00257	0.005661	-0.00282	-0.00326	0.000614	-0.00147	-0.000675	0.000414	0.948827

## Appendix A.5 Derivation of equation (3.37)

$$\frac{mvl_{i,t}}{\partial PV_{i,t}/\partial y_{1,i,t}} = -\delta \frac{n}{n-1} s\alpha_1$$

The derivation is based on Kim et al. (2003). The marginal value of a locked-in customer,  $mvl_{i,t}$ , is equal to the discounted marginal increase in the firm's present value due to an additional locked-in customer in the next period.

$$mvl_{i,t} = \delta \frac{\partial PV_{i,t+1}}{\partial y_{1,i,t}} = \delta \frac{\partial PV_{i,t+1}}{\partial y_{1,i,t+1}} * \frac{\partial y_{1,i,t+1}}{\partial y_{1,i,t}} \quad (\text{A.20})$$

If growth rate is not changing over times,  $y_{1,i,t+1} \approx y_{1,i,t}$ , therefore  $\partial PV_{i,t+1}/\partial y_{1,i,t+1} \approx \partial PV_{i,t}/\partial y_{1,i,t}$ . Then, equation (A.20) becomes

$$\begin{aligned} \frac{\partial PV_{i,t}}{\partial y_{1,i,t}} &= \frac{\partial \pi_{i,t}}{\partial y_{1,i,t}} + \delta \frac{\partial PV_{i,t+1}}{\partial y_{1,i,t}} = \frac{\partial \pi_{i,t}}{\partial y_{1,i,t}} + \delta \frac{\partial PV_{i,t+1}}{\partial y_{1,i,t+1}} * \frac{\partial y_{1,i,t+1}}{\partial y_{1,i,t}} \approx \frac{\partial \pi_{i,t}}{\partial y_{1,i,t}} + \delta \frac{\partial PV_{i,t}}{\partial y_{1,i,t}} * \\ &\frac{\partial y_{1,i,t+1}}{\partial y_{1,i,t}} \end{aligned} \quad (\text{A.21})$$

$\frac{\partial y_{1,i,t+1}}{\partial y_{1,i,t}}$  can be obtained from equation (3.18) which equal to  $-\frac{n}{n-1} s\alpha_1$ , then

$$\frac{\partial PV_{i,t}}{\partial y_{1,i,t}} = \frac{\partial \pi_{i,t}}{\partial y_{1,i,t}} (1 + \delta \frac{n}{n-1} s\alpha_1)^{-1} \quad (\text{A.22})$$

Therefore, a proportion of the added value of an additional customer is

$$\frac{\partial \pi_{i,t}/\partial y_{1,i,t}}{\partial PV_{i,t}/\partial y_{1,i,t}} = (1 + \delta \frac{n}{n-1} s\alpha_1) \quad (\text{A.23})$$

And the marginal value of a locked-in customer as a proportion of the marginal increase in the firm's present value due to an additional locked-in customer is

$$\frac{mvl_{i,t}}{\partial PV_{i,t}/\partial y_{1,i,t}} = \left( 1 - \frac{\frac{\partial \pi_{i,t}}{\partial y_{1,i,t}}}{\frac{\partial PV_{i,t}}{\partial y_{1,i,t}}} \right) = -\delta \frac{n}{n-1} s\alpha_1 \quad (\text{A.24})$$

# Appendix B

## Chapter 4 Appendix

### Appendix B.1 Coefficient variance-covariance matrix

**Table B.1 Coefficient variance-covariance matrix of system estimation of trans-log cost system, demand equation and pricing equation using non-linear 3SLS**

Coefficient	$\beta_0$	$\delta_1$	$\delta_{11}$	$\gamma_{12}$	$\gamma_{13}$	$\beta_1$	$\beta_2$	$\beta_{12}$	$\beta_{13}$	$\beta_{23}$
$\beta_0$	0.003633	0.003512	-0.00045	0.00048	-0.00041	5.21E-06	0.000359	0.000187	-9.66E-05	-3.39E-05
$\delta_1$	0.003512	0.005511	-0.00026	0.000921	-0.00113	0.00012	0.000515	0.000129	-3.27E-05	6.77E-05
$\delta_{11}$	-0.00045	-0.00026	0.000305	-2.89E-05	8.89E-06	2.02E-05	-1.26E-05	-1.44E-05	2.39E-05	2.11E-05
$\gamma_{12}$	0.00048	0.000921	-2.89E-05	0.000504	-0.00075	0.000214	0.000327	3.71E-05	8.53E-05	0.000148
$\gamma_{13}$	-0.00041	-0.00113	8.89E-06	-0.00075	0.001384	-0.00049	-0.00055	0.000105	-0.00023	-0.00024
$\beta_1$	5.21E-06	0.00012	2.02E-05	0.000214	-0.00049	0.000256	0.000174	-8.55E-06	0.00011	7.21E-05
$\beta_2$	0.000359	0.000515	-1.26E-05	0.000327	-0.00055	0.000174	0.000295	-7.56E-05	7.31E-05	0.000101
$\beta_{12}$	0.000187	0.000129	-1.44E-05	3.71E-05	0.000105	-8.55E-06	-7.56E-05	0.000247	-4.39E-05	-1.91E-05
$\beta_{13}$	-9.66E-05	-3.27E-05	2.39E-05	8.53E-05	-0.00023	0.00011	7.31E-05	-4.39E-05	7.98E-05	5.16E-05
$\beta_{23}$	-3.39E-05	6.77E-05	2.11E-05	0.000148	-0.00024	7.21E-05	0.000101	-1.91E-05	5.16E-05	7.56E-05
$\varphi_0$	0.057194	0.056299	-0.01889	0.011941	0.005801	-0.01411	0.005109	0.005943	-0.00873	0.000885
$\varphi_1$	0.000588	-0.00365	-0.00236	-0.00163	0.002966	-0.00102	-0.00114	0.000196	-0.00054	-0.00062



$\varphi_2$	-0.00034	0.004594	0.002662	0.001872	-0.00413	0.001805	0.00146	-0.00038	0.00098	0.000625
$\varphi_3$	-0.004	-0.00375	0.001391	-0.00079	-0.00065	0.001151	-0.0003	-0.00046	0.000704	-5.98E-05
$\varphi_4$	-1.80E-06	-2.00E-05	-6.15E-06	-6.72E-06	2.18E-05	-9.56E-06	-8.60E-06	8.05E-06	-5.39E-06	-1.71E-06
$\lambda$	-0.00013	-0.00175	-0.00084	-0.00058	0.001347	-0.00062	-0.00047	0.000131	-0.00034	-0.00017

Coefficient	$\varphi_0$	$\varphi_1$	$\varphi_2$	$\varphi_3$	$\varphi_4$	$\lambda$
$\beta_0$	0.057194	0.000588	-0.00034	-0.004	-1.80E-06	-0.00013
$\delta_1$	0.056299	-0.00365	0.004594	-0.00375	-2.00E-05	-0.00175
$\delta_{11}$	-0.01889	-0.00236	0.002662	0.001391	-6.15E-06	-0.00084
$\gamma_{12}$	0.011941	-0.00163	0.001872	-0.00079	-6.72E-06	-0.00058
$\gamma_{13}$	0.005801	0.002966	-0.00413	-0.00065	2.18E-05	0.001347
$\beta_1$	-0.01411	-0.00102	0.001805	0.001151	-9.56E-06	-0.00062
$\beta_2$	0.005109	-0.00114	0.00146	-0.0003	-8.60E-06	-0.00047
$\beta_{12}$	0.005943	0.000196	-0.00038	-0.00046	8.05E-06	0.000131
$\beta_{13}$	-0.00873	-0.00054	0.00098	0.000704	-5.39E-06	-0.00034
$\beta_{23}$	0.000885	-0.00062	0.000625	-5.98E-05	-1.71E-06	-0.00017
$\varphi_0$	91.54552	0.984838	-4.41358	-7.16163	0.084315	0.825914
$\varphi_1$	0.984838	0.105355	-0.14852	-0.07832	0.001044	-0.03233
$\varphi_2$	-4.41358	-0.14852	0.348167	0.352166	-0.00419	-0.00643
$\varphi_3$	-7.16163	-0.07832	0.352166	0.561811	-0.0074	-0.06617
$\varphi_4$	0.084315	0.001044	-0.00419	-0.0074	0.001609	0.000636
$\lambda$	0.825914	-0.03233	-0.00643	-0.06617	0.000636	0.052496

**Table B.2 Coefficient variance-covariance matrix of system estimation of trans-log cost system, demand equation and pricing equation using GMM**

Coefficient	$\beta_0$	$\delta_1$	$\delta_{11}$	$\gamma_{12}$	$\gamma_{13}$	$\beta_1$	$\beta_2$	$\beta_{12}$	$\beta_{13}$	$\beta_{23}$
$\beta_0$	0.004094	0.003371	-0.00042	0.000781	-0.00093	0.000262	0.000704	0.000214	-4.61E-05	2.09E-05
$\delta_1$	0.003371	0.004259	2.58E-05	0.001092	-0.00151	0.000378	0.000791	0.000157	5.38E-05	0.00016
$\delta_{11}$	-0.00042	2.58E-05	0.000352	3.20E-05	-7.73E-05	4.25E-05	1.28E-05	-1.95E-05	5.01E-05	5.43E-05
$\gamma_{12}$	0.000781	0.001092	3.20E-05	0.000558	-0.0008	0.00023	0.000364	7.69E-05	8.48E-05	0.00016
$\gamma_{13}$	-0.00093	-0.00151	-7.73E-05	-0.0008	0.001412	-0.00047	-0.00059	5.71E-05	-0.00022	-0.00024
$\beta_1$	0.000262	0.000378	4.25E-05	0.00023	-0.00047	0.00022	0.00018	4.60E-06	9.70E-05	7.40E-05
$\beta_2$	0.000704	0.000791	1.28E-05	0.000364	-0.00059	0.00018	0.000328	-5.75E-05	7.78E-05	1.00E-04
$\beta_{12}$	0.000214	0.000157	-1.95E-05	7.69E-05	5.71E-05	4.60E-06	-5.75E-05	0.000254	-4.20E-05	4.27E-06
$\beta_{13}$	-4.61E-05	5.38E-05	5.01E-05	8.48E-05	-0.00022	9.70E-05	7.78E-05	-4.20E-05	7.22E-05	4.65E-05
$\beta_{23}$	2.09E-05	0.00016	5.43E-05	0.00016	-0.00024	7.40E-05	1.00E-04	4.27E-06	4.65E-05	7.39E-05
$\varphi_0$	0.115809	0.094389	-0.02562	0.004272	0.0172	-0.01946	0.00466	0.004267	-0.01722	-0.01075
$\varphi_1$	0.000668	-0.00452	-0.00261	-0.00123	0.002254	-0.00074	-0.00091	0.000459	-0.00059	-0.00071
$\varphi_2$	-0.00205	0.003697	0.003092	0.001882	-0.00443	0.002054	0.001667	-0.00093	0.001466	0.001202
$\varphi_3$	-0.00831	-0.00652	0.001889	-6.86E-05	-0.00176	0.001642	-0.00012	-0.00038	0.001376	0.000872
$\varphi_4$	-0.0003	-0.00061	1.09E-05	-0.00022	0.000258	-3.45E-05	-0.00013	-2.13E-05	1.24E-05	-4.17E-05
$\lambda$	0.000946	-0.00212	-0.00228	-0.0032	0.007055	-0.00334	-0.00265	0.000546	-0.00193	-0.00142

Coefficient	$\varphi_0$	$\varphi_1$	$\varphi_2$	$\varphi_3$	$\varphi_4$	$\lambda$
$\beta_0$	0.115809	0.000668	-0.00205	-0.00831	-0.0003	0.000946
$\delta_1$	0.094389	-0.00452	0.003697	-0.00652	-0.00061	-0.00212
$\delta_{11}$	-0.02562	-0.00261	0.003092	0.001889	1.09E-05	-0.00228
$\gamma_{12}$	0.004272	-0.00123	0.001882	-6.86E-05	-0.00022	-0.0032
$\gamma_{13}$	0.0172	0.002254	-0.00443	-0.00176	0.000258	0.007055
$\beta_1$	-0.01946	-0.00074	0.002054	0.001642	-3.45E-05	-0.00334
$\beta_2$	0.00466	-0.00091	0.001667	-0.00012	-0.00013	-0.00265
$\beta_{12}$	0.004267	0.000459	-0.00093	-0.00038	-2.13E-05	0.000546
$\beta_{13}$	-0.01722	-0.00059	0.001466	0.001376	1.24E-05	-0.00193
$\beta_{23}$	-0.01075	-0.00071	0.001202	0.000872	-4.17E-05	-0.00142
$\varphi_0$	77.7656	0.279074	-2.89375	-6.04363	0.106364	4.161947
$\varphi_1$	0.279074	0.065895	-0.07747	-0.02195	0.000314	-0.00935
$\varphi_2$	-2.89375	-0.07747	0.201436	0.229468	-0.003	-0.17063
$\varphi_3$	-6.04363	-0.02195	0.229468	0.4708	-0.00874	-0.33099
$\varphi_4$	0.106364	0.000314	-0.003	-0.00874	0.00133	0.005024
$\lambda$	4.161947	-0.00935	-0.17063	-0.33099	0.005024	0.347456

# Appendix C

## List of Symbols

Symbol	Meaning
$A$	Bank-specific variables that affect the bank's revenue and cost functions
$AC_{i,t}$	Average cost of bank $i$ at time $t$
$\alpha_0^i$	Coefficient which represents the bank-specific heterogeneity
$\alpha_1$	Coefficient which measures the sensitivity of the transition probability to the bank's own interest rate
$\alpha_2$	Coefficient which measures the sensitivity of the transition probability to another bank's price
$\beta_0$	The constant of trans-log cost equation
$\beta_1$	The coefficient of $\ln w_{1,i,t}$ (Trans-log cost function)
$\beta_2$	The coefficient of $\ln w_{2,i,t}$ (Trans-log cost function)
$\beta_3$	The coefficient of $\ln w_{3,i,t}$ (Trans-log cost function)
$\beta_{11}$	The coefficient of $\frac{1}{2} \ln w_{1,i,t}^2$ (Trans-log cost function)
$\beta_{12}$	The coefficient of $\ln w_{1,i,t} \ln w_{2,i,t}$ (Trans-log cost function)
$\beta_{13}$	The coefficient of $\ln w_{1,i,t} \ln w_{3,i,t}$ (Trans-log cost function)
$\beta_{22}$	The coefficient of $\frac{1}{2} \ln w_{2,i,t}^2$ (Trans-log cost function)
$\beta_{23}$	The coefficient of $\ln w_{2,i,t} \ln w_{3,i,t}$ (Trans-log cost function)
$\beta_{33}$	The coefficient of $\frac{1}{2} \ln w_{3,i,t}^2$ (Trans-log cost function)
$C_{i,t}$	Total costs of bank $i$ at time $t$
CPI	Consumer price index
$D_{i,t}$	The deposits of bank $i$ at time $t$ .
$DM_{it}$	A vector of exogenous factors affect quantity demand
$\Delta$	First-order difference
$\delta$	The one-period discount factor
$\delta_1$	The coefficient of $\ln y_{i,t}$ (Trans-log cost function)
$\delta_{11}$	The coefficient of $\frac{1}{2} \ln y_{1,i,t}^2$ (Trans-log cost function)
$E$	E-statistic
$EQTA_{i,t}$	The ratio of equity capital to total assets of bank $i$ at time $t$
$\epsilon_{i,t}$	An error term of equation 3.26
$\epsilon_{i,t}'$	An error term of equation 3.27
$\epsilon_{ii}$	The own-price elasticity of demand
$\epsilon_{ij}$	The cross-price elasticity of demand
$FA_{i,t}$	The fix assets of bank $i$ at time $t$

$g_t$	The market growth rate at period $t$
$\gamma_{11}$	The coefficient of $\ln y_{i,t} \ln w_{1,i,t}$ (Trans-log cost function)
$\gamma_{12}$	The coefficient of $\ln y_{i,t} \ln w_{2,i,t}$ (Trans-log cost function)
$\gamma_{13}$	The coefficient of $\ln y_{i,t} \ln w_{3,i,t}$ (Trans-log cost function)
$H$	The Panzar-Rosse $H$ statistic
$HIBOR_t$	Hong Kong Interbank Offered Rate
$II_{i,t}$	Interest income
$\ln EXc_{j,i,t}$	The natural logarithms of exogenous control variables related to the bank cost function
$\ln EXr_{r,i,t}$	The natural logarithms of exogenous control variables related to the bank-specific demand function.
$\text{infl}_t$	Inflation rate in Hong Kong
$\ln ip_{k,i,t}$	The natural logarithms of factor input $k$ of bank $i$ at time $t$
$\kappa_{i,t}$	An error term of equation 4.8
$L_{i,t}$	The number of labour of bank $i$ at time $t$
$\lambda$	conjectural variation parameter
$M$	The macroeconomic variables that affect the banking market
$mc_{i,t}$	The marginal cost of bank $i$ in period $t$
$mv_{i,t}$	The marginal value of a locked-in customer
$\mu_{i,t}$	An error term of equation 4.12
$n$	The number of banks in the sample
$NII_{i,t}$	Non-interest income
$NLTA_{i,t}$	The ratio of bank loans to total assets of bank $i$ at time $t$
$v_1$	The coefficient of $\ln TA_{i,t}$ (equation 5.11)
$v_2$	The coefficient of $\ln NLTA_{i,t}$ (equation 5.11)
$v_3$	The coefficient of $\ln EQTA_{i,t}$ (equation 5.11)
$v_4$	The coefficient of $\ln PRTA_{i,t}$ (equation 5.11)
$v_1'$	The coefficient of $\ln TA_{i,t}$ (equation 5.12)
$v_2'$	The coefficient of $\ln NLTA_{i,t}$ (equation 5.12)
$v_3'$	The coefficient of $\ln EQTA_{i,t}$ (equation 5.12)
$v_4'$	The coefficient of $\ln PRTA_{i,t}$ (equation 5.12)
$O$	The other earning assets
$o_i$	The coefficient of $D_i$ (equation 5.11)
$o_i'$	The coefficient of $D_i$ (equation 5.12)
$p$	The interest rate on loans
$p_{i,t}$	The interest rate charged by bank $i$ in period $t$
$\bar{p}_{iR,t}$	The average interest rate charged by the rival banks
$\mathbf{p}_{iR,t}$	the alternative interest rate charged by bank $i$ 's rivals
$p_l$	The labour price
$pcm_{i,t}$	The price-cost margin of bank $i$ in period $t$
$PE$	the personal expenses
$Pr_{i \rightarrow i,t}$	The probability that a customer who borrowed in period $t-1$ from bank $i$ will continue to borrow from the same bank in the subsequent period

$Pr_{iR \rightarrow i,t}$	The probability that a customer who borrowed from the bank $i$ 's rivals will switch to borrow from bank $i$ in current period
$Pr_{j \rightarrow i,t}$	The probability that a customer who previously borrow from bank $j$ will switch to borrow from bank $i$ in the subsequent period
$PRTA_{i,t}$	The ratio of loan loss provisions to total assets of bank $i$ at time $t$ .
$\pi_{i,t}$	the bank's profit in period $t$ .
$\pi_1$	The coefficient of $lnw_1$ (equation 5.11)
$\pi_2$	The coefficient of $lnw_2$ (equation 5.11)
$\pi_3$	The coefficient of $lnw_3$ (equation 5.11)
$\pi_1'$	The coefficient of $lnw_1$ (equation 5.12)
$\pi_2'$	The coefficient of $lnw_2$ (equation 5.12)
$\pi_3'$	The coefficient of $lnw_3$ (equation 5.12)
$\pi i_k$	The coefficient of $lnip_{k,i,t}$ (equation 5.4)
$r_E$	Interest rate on earning assets
$r_O$	Interest rate on other earning assets
$Rev$	Either total revenue, interest income, or non-interest income
$rgdp_t$	Real GDP in Hong Kong
$ROA_{i,t}$	Return on assets of bank $i$ at time $t$
$\rho_0$	The constant of equation 5.4
$\rho_1$	The coefficient of $lny_{i,t}$ (equation 5.4)
$s$	The mean switching costs
$s$	$s \equiv s \cdot I$ , here $I$ is an $(n-1)$ unity vector
$s_j$	an $(n-1)$ vector in which each of the elements equals $s$ , except for the $j^{\text{th}}$ element, which is zero
$Sh_{k,i}$	the share of the $k$ th factor in bank $i$ 's period $t$ production cost
$Sh_{1,i}$	The labour costs share in bank $i$ 's time $t$
$Sh_{2,i}$	The capital costs share in bank $i$ 's time $t$
$Sh_{3,i}$	The deposits costs share in bank $i$ 's time $t$
$\sigma_{i,t}$	The market share of bank $i$ in period $t$
$t_i$	A vector of exogenous variables that shifts the bank $i$ 's cost function
$TA_{i,t}$	The total assets of bank $i$ at time $t$ .
TE	The total earning assets
$TI_{i,t}$	Total income
$\tau$	Time period
$\tau_n$	The coefficient of $lnM_{n,t}$
$\tau_1$	The coefficient of $lnrgdp_g_t$ (equation 5.11)
$\tau_1'$	The coefficient of $lnrgdp_g_t$ (equation 5.12)
$u_{i,t}$	An error term of equation 3.25
$v_k$	The coefficient of $lnEXc_{j,i,t}$ (equation 5.4)
$V_{i,\tau}$	The present value of bank $i$ 's profit
$w_{i,t}$	A vector of input prices of bank $i$ in period $t$
$w_{1,i,t}$	The exogenous input prices on labour.
$w_{2,i,t}$	The exogenous input price on capital.

$w_{3,i,t}$	The exogenous input price on deposits.
$wage_t$	Wage rate in Hong Kong
$X$	Bank-specific variables that affect the bank's revenue and cost functions
$\xi_r$	The coefficient of $lnEXR_{r,i,t}$ (equation 5.5)
$Y$	Loans
$y_i$	The total loan of bank $i$
$y_{1,i,t}$	The bank $i$ 's total loan at period $t$
$y_{1,j,t-1}$	Bank $j$ 's total loans in period $t-1$
$\frac{y_{1,j,t-1}}{\sum_{k \neq i} y_{1,k,t-1}}$	The probability that a randomly selected rival's borrower is one who borrows from bank $j$ in the previous period
$y_2$	Bank other earning assets
$y_3$	Net fees and commissions
$z_i$	A vector of exogenous variables that influence the bank $i$ 's revenue
$\zeta$	The constant of equation 5.11
$\zeta'$	The constant of equation 5.12
$\varphi_0$	The constant of equation 4.7
$\varphi_1$	The coefficient of $lnp_{it}$ which representing the own price elasticity (equation 4.7)
$\varphi_2$	The coefficient of $ln\overline{p_{i,Rt}}$ , which representing the cross-price elasticity (equation 4.7)
$\varphi_3$	The coefficient of $lnrgdp_t$ (equation 4.7)
$\varphi_4$	The coefficient of $lnFA_{i,t}$ (E\equation 4.7)
$\chi_0$	The constant of equation 5.5
$\chi_1$	The coefficient of $lny_{i,t}$ (equation 5.5)
$\vartheta_{i,t}$	An error term of equation 4.7
$\omega_{i,t}$	An error term of equation 3.28