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Departamento de Teoría e Historia Económica



Three Essays on the Banking and Financial Sector of China

Doctoral Thesis

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To my parents

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Abstract

In the past two decades, China has embraced a series of social and economic reforms and, meanwhile, witnessed a rapid economic development. In 1998, the Chinese government launched a substantive reform of the property market. Since then, a significant change has taken place in housing financing. Additionally, the banking sector has kept on introducing new reforms. The most noteworthy improvement is the liberalization of the banking system, e.g. freeing up interest rates and foreign bank entry. By 2010, all State-Owned banks have successfully completed the process of Initial Public Offering and have been transformed into listed companies. As a consequence, it appears that the performance of Chinese banking sector has enhanced significantly. According to the Banker magazine's annual rankings, Chinese banks accumulated for nearly one third (29.3%) of global banking profits in 2011. Three Chinese banks topped the Banker's profit table. In the mean time, the non-cash payment system in China also enjoyed 20.8% annual growth in card usage. All of these have reflected that China is currently undergoing a massive social and financial transformation. In this thesis we investigate the change in the Chinese financial industry from the perspective of property, banking and non-cash payment sectors.

Resumen

En las últimas dos décadas, China se ha embarcado en una serie de reformas sociales y económicas y, mientras tanto, ha sido testigo de un rápido desarrollo económico. Desde 1998, el Gobierno chino ha lanzado una reforma sustancial sobre el mercado de la propiedad. Desde entonces, ha tenido lugar un cambio significativo en la financiación de la vivienda. Adicionalmente, el sector bancario continúa reformándose por completo. La mejora más notable ha sido la liberalización del sistema bancario, por ejemplo la liberalización de los tipos de interés y la entrada de bancos extranjeros. Hacia 2010, toda la banca pública ha completado exitosamente el proceso de Oferta Pública Inicial y se han transformado en compañías cotizadas en mercados bursátiles. Como consecuencia, se demuestra que los resultados del sector bancario chino han mejorado significativamente. De acuerdo con la clasificación anual de la revista *The Banker*, los bancos chinos acumulan cerca de un tercio (29,3%) de los beneficios bancarios a nivel mundial en 2011. Tres bancos chinos encabezan la clasificación de *The Banker* por beneficios. Al mismo tiempo, el sistema de pagos no basados en el efectivo en China disfruta también de un crecimiento anual del 20,8% en el uso de tarjetas de crédito. Todo esto ha reflejado que China está experimentando actualmente una transformación social y financiera masiva. En esta tesis doctoral se investiga el cambio en la industria financiera china desde la perspectiva de la propiedad, la banca y los

sectores de pago no basados en el efectivo.

Chapter 1: Introduction

Chapter 1: Introduction

1.1 Motivation

1.1.1 The Property Market

As a leading emerging market, China has undergone a rapid economic growth in the past two decades. During this period, the reforms of both property and banking sectors have contributed significantly to the economic development. The Chinese government launched a substantive reform in property sector in 1998, when the state council promulgated the "Circular of the State Council on Further Deepening the Urban Housing System Reform and Accelerating Housing Construction" (No. 23 [1998] of the State Council). It aimed at starting the capitalization process of housing distribution system and then establishing a market-oriented property market. As a result, no working unit is allowed to provide housing allotment to the employees. The funding of a house purchase comes from the wages, Housing Provident Fund (HPF), mortgages and other subsidies. Considering the income gap, the new housing supply system adjusts to the demand of different income stratum: high, medium and low income groups. The high-income population can purchase commercial houses in the market and the "economic houses" are provided to low- and medium-income households. Commercial banks play an important role in the capitalization process of housing distribution. Since 1998, all

domestic banks have been allowed to grant household mortgage loans. Unlike the US market, which is featured by diversified financing channels, the mortgage market in China is dominated by commercial banks. Except for commercial mortgage loans from financial institutions, an alternative way is the Housing Provident Fund (HPF), which aims at bridging the gap between housing prices and residents' income. It is a public housing saving program, in which a certain percentage of the employees' salaries is contributed to HPF accounts. In return, all the participants of this program can benefit from a lower interest rate than a commercial mortgage rate of banks. Commercial banks also recognize the residential mortgage credit as healthy assets in their loan portfolio, given the lower default rate of household mortgage loans compared with that of state-owned entrepreneurs (Deng and Fei 2008). There exists a large body of research on the nexus between bank lending and property prices. (Lacoviello and Minetti, 2008; Goodhart and Hofmann, 2008; Davis and Zhu, 2010) However, there is limited research that reveals the impact of mortgage on the property market. In Chapter 2, I investigate the relationship between mortgage loans and property and to what extent these two factors can affect each other. The findings have important policy implications and are related to the existing monetary policies which are being implemented in China.

However, it is worth to point out the possible risk of real estate bubble. The lessons from USA, Europe, Japan and East Asian property markets have illustrated that the bank loans and household mortgages play significant roles in blowing up the bubble. The rapid rising price to income ratio and the ever-increasing area of vacant houses are a matter of concern for regulators.(Chen et al., 2007; Huang et al. 2010) If banks hold a large proportion of real estate in their asset portfolio, they will have a higher book value on the basis of high property prices. However if the price is volatile, the banks will suffer from the asset depreciation and then be exposed to the financial risk.

1.1.2 The Banking reforms of China

With the development of property market, the Chinese banking sector keeps on reforming all through. Before 1979, the People's Bank of China was the only bank in Mainland China which monopolized the whole banking sector. In the middle of 1980, four State-Owned Banks (SOBs) were established. They were the Bank of China (BOC), Industrial and Commercial Bank of China (ICBC), Agricultural Bank of China (ABC) and China Construction Bank (CCB). The business of each SOB is strictly confined to a given division.¹ By 1998, the state owned specialized banks had been transformed to commercial banks.

¹ For example in 1985, over 85 percent of total agriculture loans are granted by ABC.

The People's bank of China functions as the central bank to manage the money supply through a series of monetary policies. From then on, the commercial banks have started the reform of the shareholding system in order to improve efficiency and corporate governance. After stripping off bad assets and two-round of capital injection in 1998 and 2003, the government began to transform all state-owned banks into joint-stock entities. From that moment, the Chinese banking sector has embarked on the path of "marketization". Another noteworthy improvement is the financial liberalization in the banking system, which is threefold. First, many market-oriented practices and modern corporate government regimes are introduced into the banking business. Second, the government frees up interest rates and implements the bank-favored interest spread policy. Finally, since 2007 all foreign banks have been allowed to operate in Renminbi (RMB) - the local currency- business in China. It was supposed to bring about more competition and foster efficiency of the domestic banking sector. As a consequence of the banking reform and liberalization, Chinese domestic banks have shown better performance, in both sides of the capital management and profitability. By 2010, all State-Owned banks have successfully completed the process of Initial Public Offering and have been transformed into listed companies. Meanwhile, the performance of the Chinese banks has enhanced significantly after the reform. According to the report of "The Banker", until 2011 four Chinese banks had entered into the

top 10 banks by Tier 1 capital, which equals the number of US banks.

During the banking reforms in China, the foreign subsidiary banks went on expanding their business in China, in terms of both operating institutions and total assets (see Table 1).² The development of supervisions on foreign subsidiary banks and branches has followed three stages. Before 1994, the opening degree of financial industry was limited. The subsidiary banks focused only on the foreign exchange business of foreign-invested enterprises, and this business was limited to the region of Shanghai and Shenzhen.³ The “Regulations of the People's Republic of China Governing Financial Institutions with Foreign Capital” (1994) opened the foreign currency operations for all foreign subsidiary banks and branches in China. The restriction on the business scopes and market access of subsidiary banks and branches began to loosen. In Nov. 2001 China became a member of the World Trade Organization (WTO) and began to open its domestic financial market according to the commitment of WTO. The “Regulations of the People's Republic of China on Administration of Foreign-funded Financial Institutions (2001)” and “Detailed Rules for the Implementation of the Regulation of the People's Republic of China on the Administration of Foreign-funded Financial Institutions (2004)” eliminated the restrictions on the foreign exchange business, either in geographical or customer types. Meanwhile, foreign

² The total assets of foreign banks between 1996 and 1999 are reported in US dollars. The results here are calculated with the listed Renminbi rate of exchange from Bank of China.

³ In 1992, other 7 cities were opened to foreign financial institutions.

subsidiary banks began to run RMB business with special licenses and limitations.⁴ The regulator provided a national treatment to foreign subsidiary banks and branches, but only for foreign currency businesses. Prudential carve-out is clearly stipulated in the “Regulations of the People's Republic of China on Administration of Foreign-funded Financial Institutions (2001)”. It asked for relatively more strict requirements on subsidiary banks and branches. After 2006, both the foreign and local currency businesses were fully opened to foreign subsidiary banks and branches, without any restriction on geographical or business scopes. Foreign subsidiary banks began to receive deposits from the public without special permission or licenses. In term of the innovation of financial products, the approval system was replaced by the record system, which simplified and facilitated the product innovation. Meanwhile, the supervisors began to accept the Basel Core Principles as a reference. In the face of keen competition and first-mover advantages of domestic banks, foreign subsidiary banks had their own predominance in private retail banking, foreign exchange business, financial innovation, and intermediary business.

Much previous research has revealed the relationship between foreign bank entry and domestic banking performance. (Claessen et al. 2001; Drakos 2003; Claeys & Vennet 2008) In Chapter 3, I investigate to what extent the

⁴ Until 2005, the foreign banks were only allowed to run Renminbi business with Chinese enterprises in 25 cities.

deregulation trends and foreign bank presence can affect the net interest margins of China's banking sector.

Table 1: The development of foreign subsidiary banks in China

Year	Total operating institutions	Total assets (in billion Yuan)	Ratio of foreign banks' assets on total banks' assets
1996	261	248.3	3.23%
1997	275	314.0	3.33%
1998	257	283.0	2.56%
1999	247	263.2	2.14%
2000	191	283.9	2.00%
2001	190	374.1	2.40%
2002	181	307.9	1.90%
2003	192	415.9	1.50%
2004	188	582.3	1.84%
2005	207	715.5	1.91%
2006	224	927.9	2.11%
2007	274	1252.5	2.38%
2008	311	1344.8	2.16%
2009	338	1349.2	1.71%

Source: ALMANAC OF CHINA'S FINANCE AND BANKING.

1.1.3 The Chinese non-cash payment market

Another attractive development of the Chinese financial industry is the rapid growth of the non-cash payment system. From 2001 to 2009, China had scored 20.8% annual growth of card usage. In 2009, the bankcard usage in China was 65% of the payment mix. However, this number was only 12% in 2001. (World Payments Report 2010). The establishment of *ChinaUnionPay* (CUP) scheme in 2002 had increased the acceptance and diffusion of

bankcards usage and non-cash payments. Meanwhile, the infrastructure of payment network also witnessed a noticeable improvement. According to the statistics of the People’s Bank of China, by the end of 2010, there were 3.33 million POS terminals and 271,000 ATM machines connected to the payment network. Compared with 2009, the increasing rates of POS and ATM were 38.44% and 26.11% respectively. The detailed numbers are listed in Table 2. In August 2012, China promised to open the domestic payment market to foreign card associations. Foreign banks and bankcard suppliers were allowed to issue credit cards in Mainland China. Therefore, understanding the current situation and growth pattern of the Chinese non-cash payment system has become important for the card industry. In chapter 4, the diffusion pattern of non-cash payment instruments in the Chinese market is investigated. Based on both exponential and Gompertz curves, I shed lights on the diffusion patterns of the Chinese non-cash payment market.

Table 2: the growth of POS and ATM machines

		2002	2003	2004	2005	2006	2007	2008	2009	2010
POS	Number	270	349	450	608	818	1181	1845	2408	3334
	Increase	52	79	101	158	210	363	664	563	926
ATM	Number	49	59.7	68.3	82.1	97.8	123	168	215	271
	Increase	11	10.7	8.6	13.8	15.7	25.2	44.5	47.4	56.1

Source: China Payment System Development Report (2010)

1.2 Main Contributions

The background and development of the Chinese Banking, Property and Payment markets have been discussed above. In this section, I will describe the main contributions of this thesis. Chapter 2 supplements the existing literature in two ways. First, a unique bank-level mortgage loan data is used in our investigation. Since the most recent research focus on the relationship between total bank loans and property prices, it aims to sweep out the influence of other kind of commercial loans on the estimation. On the other hand, China has experienced a rapid economic growth and an urban modernization over the past twenty years, more and more internal immigrants moved to and settled down in cities. In this chapter, I include the urbanization and monetary policy measures to capture the effects of socio-demographic changes and regulatory constraints respectively as well.

In Chapter 3, the banking liberalization and the presence of foreign banks are of my research focus. In 2011, Chinese banks accumulated for nearly one third (29.3%) of global banking profits, comparing with only 4% in 2007. The main contribution of this chapter is using comprehensive data to study the effect of banking liberalization and foreign entry in China. By comparing the banks' net interest margins before and after the banking liberalization, I attempt to investigate the impact of the financial deregulation and the presence of

foreign banks on the profitability of the Chinese banking sector.

The study of the Chinese non-cash payments has been limited in the international literature. Most of the previous studies focused on the adoption of payment cards from the perspective of cultural environment. (Antonides et al. 1999, Worthington 2003, 2005, Worthington et al. 2007, Worthington et al. 2011). Chapter 4 will hence contribute to the literature by investigating the diffusion pattern of non-cash payments in China including the impact of network effects, infrastructure improvement and market concentration. To my knowledge it is the first time that the diffusion pattern of the non-cash payment system of an emerging market, such as China, has been analyzed and investigated.

References

- Alexander, P. (2012): Top 1000 World Banks 2012. *The Banker*. (Published: July, 2012).
- Antonides, G.; H. B. Ames and I. C. Hulscher (1999): Adoption of payment systems in ten countries – a case study of diffusion of innovations, *European Journal of Marketing*, Vol. 33, pp.1123 – 1135.
- Chen, M. C.; Tsai, I. C., and Chang, C. O., (2007): House prices and household income: Do they move apart? Evidence from Taiwan, *Habitat International*, Vol. 31, pp. 243-256.
- “China Payment System Development Report (2010)”: Payment and Settlement Department of People’s Bank of China.

Claessens, S.; A. Demirguc-Kunt and H. Huizinga (2001): How does foreign entry affect domestic banking markets? *Journal of Banking and Finance*, Vol.25, pp. 891-911.

Claeys S. and R. V. Vennet (2008): Determinants of bank interest margins in Central and Eastern Europe: A comparison with the West. *Economic Systems*, Vol. 32, pp. 197-216.

Davis, E.P. and H., Zhu (2009): Commercial property prices and bank performance. *The Quarterly Review of Economics and Finance*, Vol. 49, Issue 4, pp. 1341-1359.

Deng, Y. H. and P., Fei (2008): The Emerging Mortgage Markets in China. In D. Ben-Shaher, C. K. Y. Leung & S. E. Ong (Eds.), *Mortgage Market Worldwide*. pp. 1-33

“Detailed Rules for the Implementation of the Regulation of the People's Republic of China on the Administration of Foreign-funded Financial Institutions (2004)”: promulgated by the China Banking Regulatory Commission.

Drakos, K.(2003): Assessing the success of reform in transition banking 10 years later: an interest margins analysis. *Journal of Policy Modeling*, Vol. 25, pp.309-317.

Goodhart, C. and B., Hofmann (2008): House prices, money, credit, and the macroeconomy. *Oxford Review of Economic Policy*, Vol. 24, pp.180–205.

Huang, L., W. Chen, X. Wei, and P. Huang (2010): The Research of Vacant Housing in China Based on the “Smart Growth” Theory. *Journal of Management and Strategy*, Vol.1, pp. 63 – 67

Lacoviello, M. and R., Minetti (2008): The credit channel of monetary policy: Evidence from the housing market. *Journal of Macroeconomics*, Vol. 30, pp. 69-96.

“Regulations of the People's Republic of China on Administration of Foreign-funded Financial Institutions (2001)”: promulgated by the State Council of the People's Republic of China.

“Regulations of the People's Republic of China Governing Financial Institutions with Foreign Capital (1994)”: promulgated by the State Council of the People's Republic of China.

“The World Payments Report (2010)”: by Capgemini, RBS and EFMA.

Worthington, S. (2003) “The Chinese payment card market: an exploratory study”, *International Journal of Bank Marketing*, Vol. 21, pp.324 – 334.

----- (2005) "Entering the market for financial services in transitional economies: A case study of credit cards in China", *International Journal of Bank Marketing*, Vol. 23, pp.381 – 396.

Worthington, S.; D. Stewart, X. Lu (2007) "The adoption and usage of credit cards by urban-affluent consumers in China", *International Journal of Bank Marketing*, Vol. 25, pp. 238 – 252.

Worthington, S.; F. M. Thompson; D. B. Stewart (2011) "Credit cards in a Chinese cultural context—The young, affluent Chinese as early adopters", *Journal of Retailing and Consumer Services*, Vol. 18, pp. 534-541.

Chapter 2: The Determinants of the Mortgage Credit Boom in China

Chapter 2: The Determinants of the Mortgage Credit Boom in China⁵

Abstract

In this paper we investigate the nexus between housing prices and mortgage loans in China. We analyze a sample of 28 Chinese domestic commercial banks during the period 2003 -2009. Our results suggest the existence of reserve causality between mortgage lending and housing prices in the long run. The urbanization process in China contributes substantively to the mortgage credit boom. We find a distinct behavior of the economic housing market, in which the housing price and mortgage credit affect each other. The monetary policy has a greater impact on the mortgage lending than banks' characteristics. Raising bank reserves is a relatively effective instrument to control the mortgage credit boom. On the other hand, change in interest rates seems to be a more effective way of tempering property prices. Our findings have important policy implications for housing markets and for the existing monetary policies which are being implemented in China.

⁵ This chapter is the result of joint work with Prof. Santiago Carbó Valverde and Prof. Francisco Rodríguez Fernández. An earlier version of this manuscript has been presented at: Annual Meeting of the European Association of University Teachers in Banking and Finance 2011 in Valencia; XXXVI Simposio de la Asociación Española de Economía-Spanish Economic Association (SAEe) in Malaga and research seminar in Hohenheim University in Stuttgart, Germany. Part of this Chapter is published in "Modern Bank Behaviour", Palgrave Macmillan Publisher, England.

2.1 Introduction

Over the past decade, both the mortgage market and the property sector have experienced a dynamic change. The current financial crisis is largely attributed to the meltdown of US subprime mortgage market. The rapid growth of housing prices and mortgage credit has been extensively documented across many countries. (Miles and Pillonca 2008; Wolswijk 2006). Meanwhile, China, as one of the largest emerging markets, has witnessed the soaring property price and mortgage credit boom in domestic market. (Liang and Cao 2007). Figure 1 and figure 2 illustrate the movements of mortgage loans and property prices in mainland China respectively.

In an international context, it is a stylized fact that the amount of bank lending is strongly correlated to property prices. Many empirical studies have highlighted a strong correlation between bank lending and property prices. (Hofmann, 2003; Gerlach and Peng, 2005; Fitzpatrick and McQuinn, 2007; Davis and Zhu, 2010). China provides a representative example of an emerging property market which experienced the mortgage boom and soaring property prices during the past decades. At the same time, China also experienced a tremendous reform in both banking and house financing sectors.

The development of the Chinese commercial mortgage market began to accelerate in 1998, when the People's Bank of China authorized all domestic

commercial banks to issue household mortgage loans. From then on, the Chinese government has embarked upon an effort to introduce market-oriented mechanisms into property financing system. All these measures had promoted and contributed to the housing reform in mainland China. (Zhang 2000). The market competition is then brought about into the house financing market. Although the household mortgage was first introduced in 1998, the outstanding mortgage loans soared from 51 billion Yuan in 1999 to 6,060 billion Yuan at the end of 2010. The mortgage to loan ratio for all financial institutions increased from 0.59% in 1999 to 12.65% at the end of 2010. During this period, the property prices increased with the volume of outstanding mortgage loans except for 2008, when the influence of the financial crisis spread to China. On the other hand, the real estate bubble received more and more attention from practitioners. The rapid increase in property prices may bring about the real estate speculation.⁶ As a fund-intensive industry, the property sector relies heavily on the financial - especially the banking - sector. Once the real estate price falls, the property industry suffers from recession, which breaks the fund chain. As a result, the bank lending in real estate sector is exposed to high default risk.⁷ In this paper we unveil the relationship between the outstanding mortgage loans and the housing prices in China. In addition, we test the real effects of bank's

⁶ A speculator can purchase a house with bank loans and then use this house as a mortgage to finance another property. The repeated mortgage arising from there will fuel the housing bubble and cause the inflationary boom of property market.

⁷ In 2008, when the influence of financial crisis spread to China, the housing prices fell in some major cities. As a result, some mortgagors default on the mortgage payment, in that the market value of their houses become lower than total mortgage loans.

characteristics and monetary policies as well. The Chinese mortgage market is featured in two aspects. First, a uniform and adjustable mortgage rate is set by the People's Bank of China, which is the central bank, for all mortgagers.⁸ Once a new mortgage rate is announced, it applies to all types of mortgages, including the existing ones. Second, there has not been yet mature secondary mortgage market in China. Until now only two Mortgage-Backed Securities (MBS) have been issued⁹. Consequently, the Chinese mortgage holders have limited alternative ways to invest their mortgage products. They are sensitive to the change of mortgage rates.

The paper is organized as follows. Section 2 reviews the literature on the relationship between mortgage lending and property prices and highlights the main contributions of our work. Section 3 describes the data, methodology and variables employed in the estimation. The Granger causality test and empirical results are presented in section 4. Section 5 concludes this paper.

2.2 Literature Review

Various models and empirical frameworks have been proposed to explain the close relationship between bank lending and property price movements. It is

⁸ Since 2005, commercial banks can set individual rate, which cannot be lower than 90 percent of the rate set by the People's Bank of China.

⁹According to the report by the People's Bank of China, only China Construction Bank (CCB) are authorized to issue MBS in the domestic inter-bank Bond Market, amounting to ¥3.018 billion and ¥ 4.16 billion respectively.

supported by the cross-country evidence (Tsatsaronis and Zhu, 2004; Égert and Mihaljek, 2007; Lacoviello and Minetti, 2008; Goodhart and Hofmann, 2008; Davis and Zhu, 2010) and the indications of individual countries, such as the USA (Capozza et al. 2002), Spain (Gimeno and Martinez-Carrascal 2006), Ireland (Fitzpatrick and McQuinn 2007), and China (Liang and Cao 2007). Hofmann (2003) and Basurto et al. (2006) suggest a bi-directional causality relationship between housing prices and bank credit. However, Goodhart and Hofmann (2004) and Gerlach and Peng(2005) find that the change of property prices have a significant impact on bank lending, but not vice versa. In contrast, Liang and Cao (2007) investigate the case of China and suggest a unidirectional causality from bank lending, income and interest rate to property prices. The latter differs from the conventional empirical evidence of the developed economies.

There are two alternative models in the literature to interpret the housing prices systematically. The first one is the inverted demand model, which includes the per capita housing supply and an index of credit conditioning as additional explanatory variables. (Muellbauer and Murphy 1997; Meen 2002) This model is more appropriate to those countries, in which the housing supply rockets up considerably. The alternative one is the house price-to-rent model. It assumes the house rent-to-price ratio depends only on the user costs and investigates the arbitrage between occupied and rental houses. (Ayuso

and Restoy 2006) This model is more appropriate to those countries, in which housing rent is fully market-oriented, such as the U.S.

In terms of the bank-level analysis, Davis and Zhu (2009) use a sample of 904 banks of 17 countries during the period of 1989-2002 and find a strong correlation between bank credit and commercial property prices in those countries which suffered from a bank crisis. The previous research that investigated the Chinese case using a bank level data is rare. Our paper supplements the existing literature in two ways. First, a unique bank-level mortgage loan data, instead of the bank lending, is employed in our paper. We intend to sweep out the influence of other kinds of commercial loans in the estimation. Next, we include the urbanization and monetary policy measures to capture the effects of socio-demographic change and regulatory constraints respectively.

2.3 Data Description and methodology

2.3.1 Methodology

We aim to investigate the interrelation between banks' mortgage credit and property prices. Two hypotheses are proposed as follows:

H1: The mortgage credit and housing prices tend to be closely associated with each other.

H2: The process of urbanization has a positive impact on the mortgage credit boom.

In addition, the central bank can carry out different monetary policies to intervene with the property and mortgage markets indirectly. We also uncover the real effects of the interest rate instrument and the required reserve ratio on both mortgage and the property market.

In order to test the hypotheses above, we first of all propose a model to understand borrowers' and banks' behavior.

Borrower's behavior:

We assume that there are two kinds of goods in the market - the house occupation and a composite consumption good. We use Cobb-Douglas utility function to analyze borrower's behavior:¹⁰

$$U = X^\alpha \cdot Y^{1-\alpha} \quad (1)$$

Where U denotes the utility of a borrower, X is the consumption of a composite good; Y is the house occupation of the household and α is the indicator of house purchase intensity. Considering the monotonicity of utility

¹⁰ Yuan and Fan (2003) and Zhou (2006) used the Cobb-Douglas utility function to analyze the behavior of the borrower and property developer, from the perspective of bubble in the real estate market.

function, we take logarithmic transformation of the utility function.

$$\log U = \alpha \cdot \log X + (1 - \alpha) \cdot \log Y \quad (2)$$

Suppose the households use mortgage loans to finance the house occupation, and then use the dispensable income to support the consumption of house service and the composite good. We can maximize the borrower's utility under the constraint of dispensable income.

$$\max_{X,Y} \log U = \alpha \cdot \log X + (1 - \alpha) \cdot \log Y \quad (3)$$

$$\text{s.t. } X + [1 + (r - i)] \cdot M = I \quad (4)$$

$$M = P \cdot Y \quad (5)$$

where I represent the dispensable income of borrowers, r is the real interest rate of individual banks, i denotes the inflation rate, M is the total mortgage loans, and P is the house price. Optimal allocation is solved through the Lagrange function:

$$L = \alpha \cdot \log X + (1 - \alpha) \cdot \log Y - \lambda [X + (1 + r - i) \cdot P \cdot Y - I] \quad (6)$$

Thesis of the Lagrange function is shown as follows:

$$\begin{cases} \frac{\partial L}{\partial X} = \frac{\alpha}{X} - \lambda = 0 \\ \frac{\partial L}{\partial Y} = \frac{1 - \alpha}{Y} - \lambda \cdot (1 + r - i) \cdot P = 0 \\ \frac{\partial L}{\partial \lambda} = X + (1 + r - i) \cdot P \cdot Y - I = 0 \end{cases} \quad (7)$$

By solving the linear equation system above with three unknowns, which are P , M , and λ respectively, we get:

$$M = P \cdot Y = \frac{(1-\alpha) \cdot I}{(1+r-i)} \quad (8)$$

It implies that the mortgage demand increases with borrower's income and house price, but decreases with house purchase intensity and interest rates. In addition, the inflation rate has a positive impact on mortgage demand.

Bank's behavior:

We assume that the deposits of banks are interest-bearing assets. They allocate a proportion of total deposits on the mortgage market. The total mortgage lending is denoted as Y , which is equal to consumers' demand of mortgage loans. The Loan_To_Deposit ratio is θ . Then the mortgage lending can be rewritten as $Y = \theta \cdot D$. An individual bank earns the interest rate r on its mortgage loans and pays out the interest rate r^d for customers' deposits. The lending business incurs a cost C , which is a quadratic function of total mortgage loans, i.e. $C(Y) = c(1+Y^2)$. The individual bank aims to maximize its total profits, which are denoted as π . Then the maximization function of banks is proposed as follows:

$$\max \pi = r \cdot M - N \cdot c[1+Y^2] - r^d \cdot D \quad (9)$$

$$\text{s.t. } M = N \cdot P \cdot Y \quad (10)$$

$$M = \theta \cdot D \quad (11)$$

If we plug M and D into our target function, we get:

$$\max_M \pi = r \cdot M - N \cdot c \left[1 + \left(\frac{M}{N \cdot P} \right)^2 \right] - r^d \cdot \frac{M}{\theta} \quad (12)$$

$$\Leftrightarrow \frac{\partial \pi}{\partial M} = \left(r - \frac{r^d}{\theta}\right) - \frac{2cN \cdot M}{(N \cdot P)^2} = 0$$

$$M = \frac{(r - r^d / \theta) \cdot N \cdot P^2}{2c} \quad (13)$$

then we replace the loan to deposit ratio θ by Y/D and get:

$$M = \frac{\left(r - \frac{r^d}{M/D}\right) \cdot N \cdot P^2}{2c} = \frac{\left(r - \frac{r^d \cdot D}{M}\right) \cdot N \cdot P^2}{2c} = \frac{(r \cdot M - r^d \cdot D) \cdot N \cdot P^2}{2cM} = \frac{\frac{r \cdot M - r^d \cdot D}{D} \cdot N \cdot P^2}{2c \frac{M}{D}} \quad (14)$$

Now, we can find that $\frac{r \cdot M - r^d \cdot D}{D}$ is the net interest margin (NIM) of the individual bank, and the denominator is $2cM/D = 2c \cdot \theta$. The optimal mortgage supply provided by the bank increases with its NIM, the number of mortgagers (N), housing price (P) but decrease with the Loan_To_Deposit ratio (ϑ).

2.3.2 The determinants of mortgage lending and property prices

Based on the theoretical analysis in section 3, we propose an empirical framework to estimate the change in mortgage lending as follows:

$$\text{Mortgage}_{it} = f\{ \text{Pop}_{it}, \text{Interest Rate}_{it}, \text{Inflation}_{it}, \text{NIM}_{i,t-1}, \text{LTD}_{i,t-1}, \text{RR}_{it-1}, \text{House Prices}_{it} \}$$

The index of urbanization is Pop , which is proxied by the percentage of urban

population to the total population. It also refers to the effect of internal migration and socio-demographic change. *Inflation* and *House Prices* are macroeconomic factors which have potential impact on the mortgage market. *NIM*, *LTD* represents the Net Interest Margins and Loan to Deposit ratio respectively, which reflect the characteristics of individual banks. We use the *Interest Rate* and Required Reserves, which are denoted as *RR*, as measures of monetary policy constraints. Previous research also indicates that House price is rather an endogenous variable and driven by market factors including credit/mortgage rationing. We employ a simplified Inverted demand model, which was introduced by Muellbauer and Murphy (1997), to estimate the movements of housing price.¹⁰

$$HS / Pop = f(I, \mu, D) \quad (15)$$

$$\mu = P(r + \delta - \dot{P}^e / P) \quad (16)$$

Where μ is the real user cost of housing service; P is the housing price and \dot{P}^e / P is the expected appreciation rate of housing price.¹¹ Muellbauer and Murphy (1997) pointed out that a proxy of mortgage rationing is often included in measuring the housing price. Considering the shadow price, the rationing constraint can increase the users cost in the property market. By substituting the user cost into the housing stock function and involving the proxy of credit conditions, we get the inverted demand function to estimate

¹⁰Dougherty and Order investigate the measurement of the housing cost through two alternative approaches. They deduct the capital cost by maximizing household utility or implicit rent of the landlord and come up with the same results.

¹¹ Murphy also pointed that the long-run price-to-rent ratio can be estimated by real user cost and loan-to-value ratio.

the housing price.

$$P = f(HS, \dot{P}^e / P, I, credit_rationing) \quad (17)$$

Where HS , \dot{P}^e / P and I represent the housing stock, housing price appreciation rate and the Income respectively. We employ the ratio of house price to rental index as the measure of housing appreciation rate in our estimation. Although the down payment ratio is a good and popular index of credit rationing, the house financing system in China has not experienced a significant change of this ratio. However the change of Mortgage can partially reflect the bank's credit rationing. The increase of mortgage loans is associated with loosened credit criteria and lower interest rates. Therefore we employ the change in mortgage loans to measure banks' credit rationing. Taking into account the estimation of mortgage lending, we then rely on a simultaneous equation system to estimate the movements of mortgage loans and housing prices. Considering the bank-level mortgage data, we use a panel data two-stage least squares/Instrument variable method for the estimation.

$$\left\{ \begin{array}{l} Mortgage_{it} = f\{ Pop_{it}, Inflation_{it}, RR_{it-1}, NIM_{i,t-1}, LTD_{i,t-1}, House\ Prices_{it} \} \\ House\ Price_{it} = f\{ HS_{it}; Mortgage_{it}; Income; Interest\ Rate_{it}; RR_{it-1}, appreciation_{i,t-1}; \} \end{array} \right\} \quad (18)$$

2.3.3 Data description

Compared with developed countries, the Chinese mortgage market has a relative short history and thus limited data availability. In this paper, an

unbalanced panel of annual mortgage loans of Commercial Banks is employed.¹² Our sample consists of all State-Owned-Banks (SOBs), Joint-Stock-Banks (JSBs) and major City-Commercial-Banks (CCBs). The sum of mortgage credit covers more than 80% of total mortgage outstanding. It makes our sample highly representative. Since the fixed-effects estimation allows for the unobserved heterogeneity that can be freely correlated with time-varying covariates, it is robust to the presence of individual-specific slopes on the individual-specific covariates (Wooldridge 2005). In this paper, we use fixed effect model to control for the unobserved heterogeneity among individual banks. Next we carefully select explanatory variables for the empirical analysis so as to ensure our estimation is robust to omitted variables. The macro data is collected from the People's Bank of China and National Bureau of Statistics of China. Mortgage loans, bank specific variables and house prices are collected from ALMANAC OF CHINA'S FINANCE AND BANKING, which is the official annual publication of People's Bank of China. The variables are described in groups as follows:

Dependent variables:

We are more interested in the movements of both mortgage loans and housing prices within a given year. Therefore the change of mortgage loans and housing prices are employed as dependent variables. In addition, both

¹²Since the financial reform in Chinese banking sector and new enforcement of information disclosure by China Bank Regulatory Commission, the mortgage data for some banks in early years is not available.

variables are log-transformed in order to obtain a more homogeneous variance and to make their distributions more normal. (Lütkepohl and Xu 2012).

Macroeconomic factors:

Although the GDP is a popular variable to assess the macroeconomic situation (Liang and Cao 2007, Davis and Zhu 2010), a large body of literature employs the disposable income as an alternative. McQuinn and O'Reilly (2007), Hill and Gan (2008) established the relationship between the income and house prices from both theoretical and empirical sides.¹³ We use the national average disposable income for SOBs and JSBs, given their nationwide business line; and local average disposable income for CCBs, considering their local market focus. In addition, urban disposable income is log transformed in order to avoid heteroscedasticity problem.

Urbanization is an important factor in this context as it may drive the change in mortgage credit. Over the past decade, China has experienced a dramatic process of industrialization and urbanization. Comparing to industrialization, China's urbanization has developed faster. (Zheng et al. 2007). More and more people move from the countryside to cities. We use the percentage of urban

¹³Other existing researches also corroborate the influence of household income on the dynamics of housing prices, such as Jud and Winkler 2002; Gimeno and Martinez-Carrascal 2006; Bourassa and Hoesli 2006. Nevertheless, some other literature is not in favor of this point of view. Gallin (2006) analyzes a panel of 95 U.S. metropolitan areas over 23 years, and does not find evidence of long-run relationship between the property prices and income in level. This result is also proved by Tsatsaronis and Zhu (2004), who find little impact of household income on housing prices in their cross-country analysis.

population to the total population as the measure of urbanization process. Taking into account more potential homebuyers, as the effect of socio-demographic change, a positive impact of urbanization on mortgage loans is expected.

House stock refers to the total number of existing residential units. It is also regarded as the response to the land-use regulation through the elasticity of new housing supply. (Quigley and Raphael 2005) We employ the number of house sales to proxy the housing stocks. Furthermore, the expected rate of appreciation of house prices reflects consumers' purchase intention of houses. The ratio of house price index to rental index is used to measure the house prices appreciation level. It is lagged one period to reduce the simultaneity bias.

Bank specific variables:

The interest rate, which is an indicator of monetary policy, is another widely accepted variable to estimate housing prices.¹⁴ A declining interest rate environment contributes to the increasing demand for real estate and housing investment. (Green and Shoven 1986; Kearl 1979; Tsatsaronis and Zhu 2004;). In order to capture the heterogeneity among banks, we employ the interest margin of individual banks, which is more influenced by the interest rate policy, to proxy this variable. It is calculated as the ratio of the interest revenues over

¹⁴Hofmann (2003) concludes that real interest rate is more closely associated with property prices than with bank lending. Wolswijk (2006) and Égertand Mihaljek (2007) find the negative effect of interest rate on housing prices.

total interest bearing assets. In terms of the Chinese housing market, Liang and Cao (2007) suggest that the property price movements have no sensitivity to the change of the real interest rate. We reinvestigate to what extent the raising interest rate can affect the mortgage credit and property prices.

The required reserves are the deposits of commercial banks in the form of reserves at the central bank. Over the past decade, along with the soaring property prices and mortgage credit boom, the central bank has raised the required reserve ratio several times, from 6% in 1999 to over 20% in 2011. It is regarded as another frequently used monetary policy other than the interest rate in China. We explore whether the change of banks' required reserves has an impact on the movements of property prices and mortgage loans. And we will compare the real effects of rising interest rate and the required reserve ratio.

Loan_to_asset ratio is an important measure of banks' balance sheet risk. Since the bank cannot grant credit at all costs, they need to conduct a credit audit and an efficient monitoring effectively so as to maintain low levels of non-performing loans and increase margins. (Abreu and Mendes 2001) In spite of a positive relationship between Loan to deposit ratio and bank profitability, a high loan to deposit ratio is a warning sign of banks' loan risk and discourages then the credit expansion. In order to reduce simultaneity, one

period lagged Loan_to_asset ratio is used to capture the real effects of banks' risk taking behavior. NIM is referred to as the net yield on interest-earning assets and an indicator of profitability of a bank's lending activities.¹⁵ In addition, NIM is also a proxy of bank performance and profitability for the Chinese banking sector. (Matthews 2009) We would like to test the favor of individual banks on mortgage profits.

Property prices as explanatory variables

The growth of four different property prices is employed in the empirical framework. They are condominium price, the average real estate price and an indicator of the whole property market; residential price, the indicator of solo residential market; high_grade houses price, a measure of luxury and high-end real estate market; and economic houses price, the price of affordable houses for low-and-medium income households. Crone and Voith(1992) compare five popular methods to estimate the housing price. They suggest that the mean sales price is least affected by the sample size and it is more accurate than other estimating methods.

We look into the impacts of different price measures on the change of mortgage loans separately. The same as disposable income and mortgage outstanding, property prices are converted to logarithm form in order to avoid

¹⁵ Hanweck and Ryu (2005) capture NIM dynamics in response to unanticipated credit, and find negative relationship between NIM and expected credit loss.

heteroscedasticity problem. Figure 4 illustrates the movements of property prices in four separate real estate markets.

2.4 Results

2.4.1 Panel Granger Causality Test

Before getting to the Granger-causality test methodology to evaluate causality/predictability relationships, it is necessary to test the stationarity of variables. Since the panels of mortgage and property prices are unbalanced, we use Fisher panel unit root test to check stationarity. As shown in Table 1, both mortgage lending and condominium prices are proved to be stationary panels. Then we use panel Granger-causality approach to test the casual relationship between mortgage lending and property prices. Following Holtz-Eakin et al. (1998) and Hartwig (2010), we estimate the time-stationary VAR model in the context of panel data as follows:

$$Y_{it} = \alpha_0 + \sum_{k=1}^m \alpha_k Y_{it-k} + \sum_{k=1}^m \beta_k P_{it-k} + \mu_i + \varepsilon_{it} \quad (19)$$

here we use Y_{it} and P_{it} to denote the mortgage lending and property price. The condominium price is employed as the representative of average property price. Both variables are log transformed in order to avoid heteroscedasticity problem. μ_i is the Bank-specific effect and ε_{it} is a white disturbance term. On

the other hand, we test whether the causality from property price to bank lending exists. The equation is as follows,

$$P_{it} = \alpha_0 + \sum_{k=1}^m \beta_k P_{it-k} + \sum_{k=1}^m \alpha_k Y_{it-k} + \mu_i + \varepsilon_{it} \quad (20)$$

Taking into account the limitation of sample size, we use 2 periods lag for the explanatory variables. We firstly use the fixed effect method to estimate the equations above. Since the fixed-effect regression can reduce the unobserved heterogeneity, we argue that the fixed effects estimation, along with the lagged variables, help us to find the relationship between the dependant and independent variables. It applies also to the Granger causality test. (King and Lenox 2002). However, the fixed effect regression may be challenged by the endogeneity problem. Arellano and Bond (1991), Blundell and Bond (1998) introduced Generalized Method of Moments (GMM) method - as known as system GMM estimator - to mitigate endogeneity concerns. We report the results of both one-step and two-step GMM estimations. They provide the consistent and efficient estimators, which are robust to both time series and cross-sectional heteroscedasticity¹⁶ (Podrecca and Carmeci 2001). The GMM estimations also apply to the VAR model in the context of panel data, which is proposed by Holtz-Eaking et al. (1998). The results of Sargan test for over identification and the autocorrelation test are reported as well. Finally, the

¹⁶ The two-step Arellano-Bond GMM estimator is asymptotically more efficient than the one-step estimator, at the expense of downward bias. (Arellano and Bond, 1991; Blundell and Bond, 1998)

“long-run effect” is checked through hypothesis of $\beta_1+\beta_2=0$. If it is rejected, we argue that there is evidence of a long-run effect of X (or Y) on Y (or X). (Casu and Girardone 2009).

The Fisher panel unit root test suggests that both panels of Mortgage and Property prices are stationary, as shown in Table 1. Then the results of Granger causality test between Property Price and Mortgage loans are presented in Table 2 and Table 3. The results in Table 2 indicate that the coefficients of second-order lagged condominium price are positive and significant at the 1% level. Then we demonstrate that there is a positive causal relation running from the property price to the mortgage lending in the long run. Through Sargan and Arellano-Bond tests, the estimation cannot reject the non-over-identifying and non second-order autocorrelation hypothesis. As shown in Table 3, the estimation results of condominium price are similar. The mortgage lending is proved to have significantly positive causal relationship with the property price in a long run. Besides, the rejection of $\beta_1+\beta_2=0$ in both estimations confirms the evidence of casual relationship in the context of panel data. In general, the results above suggest that there exists a long-run Granger causal relationship between mortgage lending and property prices. This result is somehow inconsistent with Liang and Cao (2007), who find only unidirectional causality from bank lending to property price and rather than

the opposite.¹⁷ In the next part, we will outline the determinants of mortgage lending and property prices, while taking into account other control variables.

2.4.2 Mortgage loans

The determinants of mortgage loan are illustrated in table 5. Our results so far suggest that the volume of outstanding mortgage loans increases with housing prices except for the economic housing market. This finding is not surprising and in line with most recent evidence of developed countries. However, we find the elasticity of condominium (and residential) price to mortgage credit is around 1.7, which is much higher than that of other countries.¹⁸ It reflects a higher dependence of property market on the mortgage loans in China. The condominium and residential prices follow similar impact on mortgage lending. This is simply because after the housing reformation in 1998, no work unit is allowed to provide houses to employees. As a result, the fully market-oriented residential houses contribute to the majority of condominium supply in housing market, and their prices also follows similar movements. On the other hand, we find an opposite result for the economical house price, which has a negative impact on mortgage movements. Since the economical houses focus on the market of low & medium income households and internal migrants, the

¹⁷ However, Liang and Cao (2007) use the total bank lending rather than the mortgage loans in their estimation.

¹⁸ The impact of housing price on mortgage credits is tested to be 0.5 for Ireland, 0.62 for Spain and 0.75 for European Area. (Fitzpatrick and McQuinn 2007; CarboValverde and Francisco Rodriguez 2010; Annett 2005)

increasing price will weaken the affordability of some potential buyers and vice versa. The fallen price is favored by more potential buyers, most of whom need to rely on the mortgage loans to finance their house occupation.

Hypothesis H2 is also supported by our estimation results. Over the past two decades China has been witnessing a rapid urbanization process, more and more new internal immigrants choose to settle down in cities. The massive internal migration has brought about more potential home buyers and contributed to the mortgage credit boom in China. This impact of urbanization is significant, which is reflected by the estimated coefficients of population. The coefficients of urbanization on the mortgage lending are over 4, which are higher than any other coefficient in the estimation. In equation (3), the urbanization has a relatively higher coefficient of 6.306. It suggests that the mortgage lending in High_Grade housing market is more influenced by the urbanization process than the average residential market. Another interesting feature is that the change of urban population has a more significant impact on the economic housing market. Since the purchasing power of new migrants is not as strong as that of the city natives, the economical houses are of more concern to them and, therefore, are more sensitive to the change of socio-demographic change.

In terms of monetary policies, we find that the interest rate increase with

mortgage loans. It suggests that the raising interest rates have little effect in controlling the credit boom in China. On the other hand, a negative correlation between banks' mortgage loans and required reserves in condominium and residential markets is observed. However, the required reserves cannot curb down the credit boom in neither High_Grade nor economic housing market. It implies that although bankers were bracing for a slowdown of home loans, the High_Grade and economic house mortgage loans -which are regarded as health assets in the loan portfolio- are still favored by banks,. Then we argue that, comparing with the interest tool, the required reserve ratio seems to be a relatively more effective instrument in controlling the mortgage credit boom. CPI is the index of composite consumption goods.¹⁹ Increased CPI implies a higher living expenditure, which undermines the individual's risk taking intention of long-term mortgage loans. In particular, its impact on High_Grade and economical housing markets is more significant. In addition, we find another notable phenomenon which is neither the net interest margin nor the loan to deposit ratio affect the banks' mortgage loans. It implies that the lending behavior of the Chinese commercial banks is more market-oriented, rather than risk- or profit-adjusted. To meet the fast growing demand of household mortgage, the whole banking sector extents the credit to property market on the expense of increasing loan risks. Although the default rate of mortgage loans was much lower than that of commercial and Industrial loans

¹⁹According to the National Statistic Bureau of China, property price is not calculated into CPI.

to state-owned enterprises, the accumulation of risk might undermine the banks' profitability if the housing price turns down.

2.4.3 House Prices

The determinants of housing prices are illustrated in table 6. We find that the mortgage loan has a significant impact on the property prices. Their effects on both condominium and residential prices are positive. It implies the procyclical behavior of the credit boom and condominium prices as a general trend. However, the prices of High_Grade and Economical Houses have shown an entirely different response to the movement of mortgage credit. The economic houses in China are also referred to as the capped-price houses. Their price is more like an administrative interference, rather than market-oriented. And the market of High_Grade houses is featured by the high demand rigidity. The movements of these two special property markets cannot meet the boom of mortgage credit. In spite of the little effect of raising reserve ratio, interest rates are negatively related to the condominium prices and play an active role in restraining the housing prices. We do not find a significant impact of Housing Stock, expected appreciation rate of housing price or inflation rate on the movements of housing prices.

2.5 Conclusions

We use a bank level mortgage data and panel data approach to gain insight into the factors which explain the growth of mortgage lending and housing prices in China. We first investigate the relationship between mortgage and property prices using Granger Causality tests. A positive reserve long-run relationship between these two variables is found within the Granger causality framework. Then we use a Two-Stage Least Squared/Instrumental Variable approach to investigate the determinants of mortgage lending and property prices, taking into account other control variables. The results suggest a bi-directional relationship between housing prices and mortgage credit. We document a positive impact of urbanization on the growth of mortgage lending. In terms of monetary policy, we find negative effects of the required reserves on the change in mortgage credit and the interest rate on property prices, but not vice versa. Our findings have important implications and the existing monetary policies which are implemented in China, such as raising the deposit reserve ratio and interest rates. From Sept. 2003 until Jun. 2011, the People's Bank of China has increased the deposit reserve ratio for 36 times, from 7% to 21.5% for large financial institutions, and 17.5% for small and medium financial institutions. The Medium-term & Long-time Loan rate increase also from 4.05% in 2002 to 4.9% in July 2011.

Appendix

Description of Variables:

Variables	Descriptions
Macroeconomic	
Disposable Income	To assess the domestic macroeconomic situation and house affordability
Interest rate	Five-year commercial interest rate is employed as an indicator of Monetary Policy.
Population	The percentage of urban population to total in China. It is an proxy of urbanization.
Expected appreciation rate of housing price	We employ the ratio of house price index to house rental index to proxy the appreciation rate.
House Stock	We use the number of house sales to proxy the housing stocks.
Bank Specific Variables	
Interest Rate	It is an indicator of monetary policy and calculated as the ratio of total interest revenue over to interest bearing assets of individual banks
Required Reserves	Minimum reserves by commercial banks in the form of deposits at the central bank. It is another indicator of monetary policy.
Loan To Deposit ratio (LTD)	<i>ex ante</i> assessment of bank lending decision
Net Interest Margin (NIM)	<i>ex post</i> measure of bank's interest spread
Property prices	
Condominium price	The average real estate price and an indicator of the whole property market.
Residential price	The indicator of solo residential market.
Highgrade houses price	A measure of luxury and high-end real estate market.
Economic houses price	The price of affordable houses for low-and-medium wage households

Tables

Table 1: Panel unit root test results

H ₀ : Unit root in level	Mortgage			Condominium Price		
	Statistic	P-value	Obs.	Statistic	P-value	Obs.
ADF – Fisher Chi-square	108.76	0.00	143	300.84	0.00	143
PP – Fisher Chi-square	108.76	0.00	143	300.84	0.00	143

Note: since the dataset is unbalanced, only Fisher panel unit root test is applied for the stationary test. Time trend is included in the test.

Table 2: Granger Causality estimation of Property Price to Mortgage lending

	Mortgage		
	Fixed Effect method	Arellano-Bond one-step GMM	Arellano-Bond two-step GMM
Mortgage (-1)	0.3918*** (3.20)	0.3215*** (3.10)	0.2425*** (2.66)
Mortgage (-2)	0.1326 (1.26)	0.1804** (2.59)	0.2036*** (3.88)
Condominium (-1)	-1.0347*** (-3.65)	-1.0062*** (-4.33)	-0.8153*** (-6.11)
Condominium (-2)	1.5454*** (7.18)	1.5589*** (8.83)	1.5717*** (15.71)
Observations	81	53	53
Wald Chi2 (<i>p</i> -value)	N/A	0.00	0.00
Sargan test (<i>p</i> -value)	N/A	0.07	0.99
AR(1) (<i>p</i> -value)	N/A	N/A	0.05
AR(2) (<i>p</i> -value)	N/A	N/A	0.23
Test of $\beta_1 + \beta_2 = 0$ (<i>p</i> -value)	0.01	0.00	0.00

Note: The condominium price is employed as the representative of average property price. AR(1) and AR(2) are first- and second-order autocorrelation tests. They are only applied to the two-step GMM estimation. The “long-run effect” is tested under the null hypothesis that $\beta_1 + \beta_2 = 0$. Standard errors are reported in Parenthesis, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Constant terms are not shown in the table.

Table 3: Granger Causality estimation of Mortgage lending to Property Price

	Condominium Price		
	Fixed Effect method	Arellano-Bond one-step GMM	Arellano-Bond two-step GMM
Condominium (-1)	-0.1630 (-1.09)	-0.1794 (-1.35)	-0.1877*** (-11.38)
Condominium (-2)	0.8896*** (7.81)	0.8855*** (8.78)	0.8860*** (81.87)
Mortgage (-1)	-0.0920 (-1.42)	-0.0925 (-1.56)	-0.1154*** (-6.07)
Mortgage (-2)	0.1401*** (3.24)	0.1486*** (3.75)	0.1726*** (11.16)
Observations	81	53	53
Wald Chi2 (p -value)	N/A	0.00	0.00
Sargan test (p -value)	N/A	0.00	0.96
AR(1) (p -value)	N/A	N/A	0.10
AR(2) (p -value)	N/A	N/A	0.99
Test of $\beta_1+\beta_2=0$ (p -value)	0.19	0.08	0.00

Note: The condominium price is employed as the representative of average property price. AR(1) and AR(2) are first- and second-order autocorrelation tests. They are only applied to the two-step GMM estimation. The “long-run effect” is tested under the null hypothesis that $\beta_1+\beta_2=0$. Standard errors are reported in Parenthesis, * $p<0.10$, ** $p<0.05$, *** $p<0.01$. Constant terms are not shown in the table.

Table 4: Summary statistics of variables

Variable	Mean	Std. Dev	Min	Max
Income(log)	9.58	0.32	8.60	10.27
Interest (log)	1.65	0.25	0.44	2.14
Population(log)	9.12	1.59	6.81	11.04
Mortgage(log)	10.13	2.17	4.59	13.68
Loan Deposit Ratio(%)	65.73	7.77	46.72	86.31
NIM(%)	2.68	0.52	1.05	4.29
Condominium price(log)	8.31	0.37	7.63	9.53
Residential price(log)	8.26	0.38	7.53	9.49
High grade price(log)	8.91	0.32	8.06	10.00
Economical price(log)	7.58	0.27	6.94	8.38

Table 5: The determinants of Mortgage lending

	(1) mortgage	(2) mortgage	(3) mortgage	(4) mortgage
Condominium price	1.728*** (4.94)	- -	- -	- -
Residencial price	- -	1.817*** (5.76)	- -	- -
High_grade price	- -	- -	0.542** (2.04)	- -
Economical price	- -	- -	- -	-20.12** (-2.14)
Urbanization	4.613** (2.47)	4.085** (2.27)	6.306*** (3.18)	41.22** (2.30)
Intere rate	0.441** (2.29)	0.488*** (2.65)	0.226 (1.10)	0.485 (0.73)
CPI	-1.335 (-0.97)	-1.308 (-0.99)	-2.625* (-1.78)	-20.60** (-2.12)
NIM	0.176 (1.13)	0.237 (1.58)	-0.0139 (-0.09)	1.239 (1.57)
Loan_To_Deposit ratio	0.0895 (0.31)	0.0579 (0.21)	0.0691 (0.22)	-0.241 (-0.24)
Required Reserves	-0.245* (-1.81)	-0.303** (-2.33)	0.0385 (0.28)	1.118* (1.96)
<i>N</i>	78	78	78	73

Note: *t* statistics in parentheses: * p<0.10, ** p<0.05, *** p<0.01

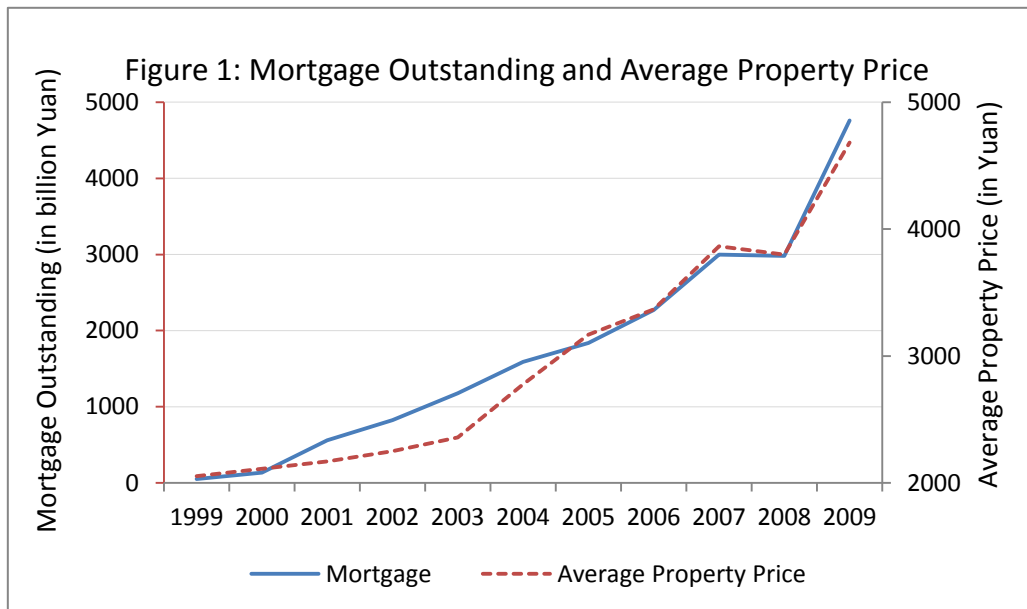
Table 6: Determinants of Housing prices

	(1) Condominium	(2) Residencial	(3) High_Grade	(4) Economical
Mortgage	0.814* (1.92)	0.744** (2.54)	-1.608* (-1.92)	-0.361*** (-3.43)
Income	0.554 (0.97)	0.414 (0.81)	2.154** (2.09)	1.016*** (4.33)
Intere rate	-0.417* (-1.84)	-0.394** (-2.22)	0.602 (1.38)	0.153** (2.25)
CPI	1.085 (0.66)	1.065 (0.79)	-6.148* (-1.88)	-2.812*** (-4.04)
Housing appreciation	0.351 (0.35)	0.120 (0.14)	-2.223 (-1.31)	-1.273* (-1.73)
Required reserves	-0.199 (-0.95)	-0.129 (-0.75)	0.285 (0.80)	-0.0122 (-0.23)
Housing Stock Condominium	-0.469 (-1.35)	-	-	-
Housing Stock Residencial	-	-0.347 (-1.45)	-	-
Housing Stock High_Grade	-	-	0.651 (1.63)	-
Housing Stock Economical	-	-	-	-0.0817 (-1.21)
<i>N</i>	78	78	78	73

Note: *t* statistics in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

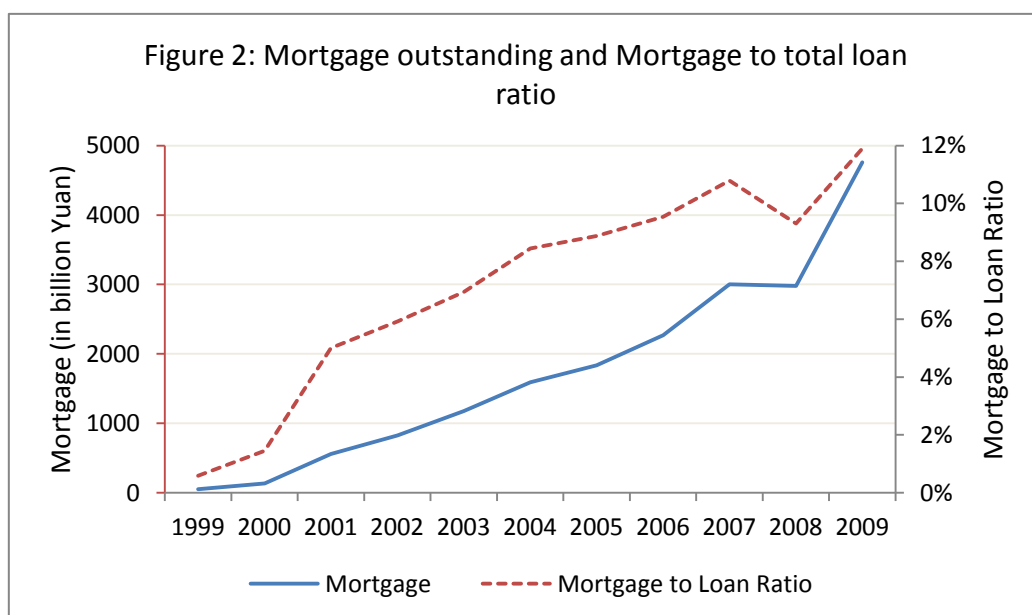
Figures

Figure 1: Mortgage outstanding and Average Property Price



Data source: People's Bank of China and National Bureau of Statistics of China.

Figure 2: Mortgage outstanding and Mortgage to total loan ratio



Data source: People's Bank of China, annual data 1999-2009.

Figure 3: Movements of Required Reserve Ratio and Mortgage Rates

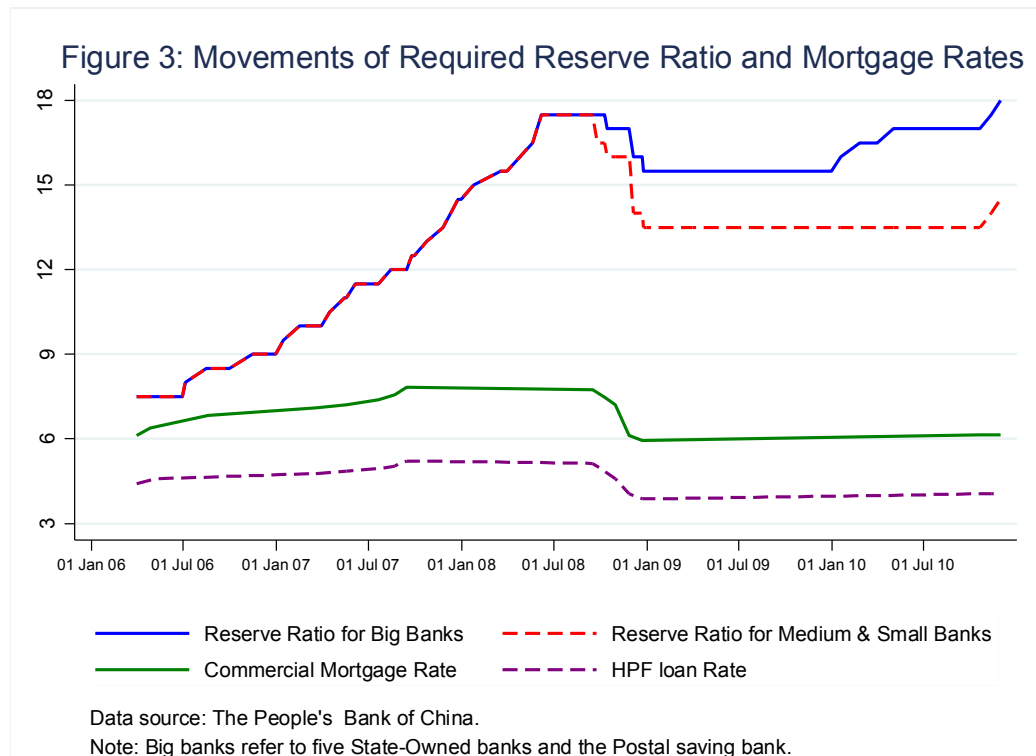
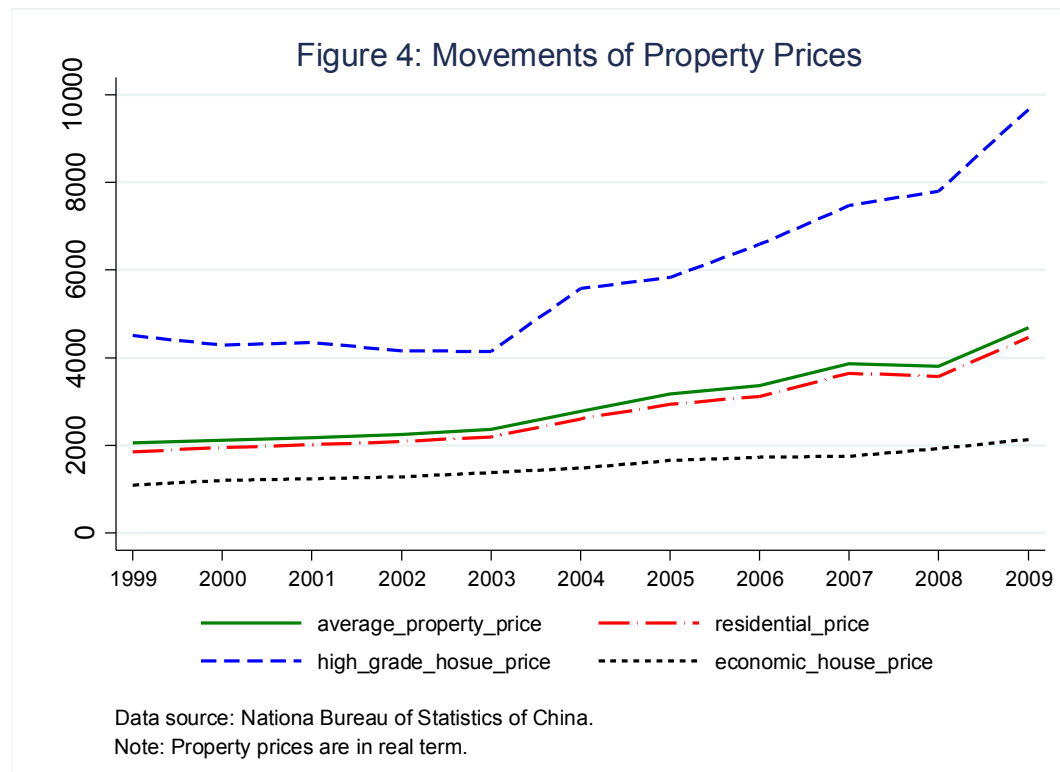


Figure 4: Movements of Property Prices



Reference

Abreu M. and V. Mendes. 2002. "Commercial bank interest margins and Profitability: evidence from EU countries". *Porto working paper series*.

Arellano, M. and S. Bond. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *Review of Economic Studies*, Vol. 58, pp. 277-297

Annett, A. (2005): "House prices and monetary policy in the euro area", Chapter III in Euro area policies: selected issues. *IMF Country Report No. 05/266*.

Ayuso, J. and F. Restoy (2006): House prices and rents: An equilibrium asset pricing approach. *Journal of Empirical Finance*. Vol. 13, pp.371-388.

Blundell, R. and S. Bond. (1998): Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, Vol. 87, Issue 1, pp. 115-143.

Capozza, D., P. Hendershott, C. Mack, and C. Mayer (2002): Determinants of Real House Price Dynamics. *NBER Working Paper No. W9262*.

Casu, B. and C. Girardone (2009): Testing the relationship between competition and efficiency in banking: A panel data analysis. *Economics Letters*, Vol. 105, Issue 1, pp. 134-137.

Carbo-Valverde, S. and F. Francisco-Rodriguez (2010): The Relationship between Mortgage Markets and House Prices: Does Financial Instability Make the Difference? *CenFIS Working Paper 10-02*.

Crone, T and R., Voith (1992): Estimating house price appreciation: A comparison of methods. *Journal of Housing Economics*. Vol. 2, pp. 324-338.

Davis, E.P. and H., Zhu (2009): Commercial property prices and bank performance. *The Quarterly Review of Economics and Finance*, Vol. 49, Issue 4, pp. 1341-1359.

Davis, E.P. and H., Zhu (2010): Bank lending and commercial property cycles: Some cross-country evidence. *Journal of International Money and Finance*. Vol. 30, Issue 1, pp. 1 – 21.

Deng, Y. H., D., Zheng and C. Ling (2005): An Early Assessment of Residential Mortgage Performance in China. *The Journal of Real Estate Finance and Economics*, Vol. 31, pp. 117-136.

Deng, Y. H. and P., Fei (2008): The Emerging Mortgage Markets in China. In D. Ben-Shaher, C. K. Y. Leung & S. E. Ong (Eds.), *Mortgage Market Worldwide*. pp. 1-33

Dougherty, A. and R., Order (1982): Inflation, Housing Costs, and the Consumer Price Index. *The American Economic Review*, Vol. 72, pp. 154-164.

Égert, B. and D. Mihaljek (2007): Determinants of House Prices in Central and Eastern Europe. *Comparative Economic Studies*. Vol 49, pp.367–388.

Fitzpatrick, T. and K. McQuinn (2007): House prices and mortgage credit: Empirical evidence for Ireland. *Manchester School*, Vol. 75, Issue 1, pp. 82-103.

Hanweck, G. and L., Ryu (2005): The Sensitivity of Bank Net Interest Margins and Profitability to Credit, Interest-Rate, and Term-Structure Shocks Across Bank Product Specializations. *FDIC Working Paper* No. 05-02.

Hartwig, J. (2010): Is health capital formation good for long-term economic growth? – Panel Granger-causality evidence for OECD countries. *Journal of Macroeconomics*, Vol. 32, Issue 1, pp. 314-325.

Holtz-Eakin, D., N., Whitney and R., Harvey (1988): Estimating Vector Autoregressions with Panel Data. *Econometrica*, Vol. 56, Issue 6, pp. 1371-95.

Gerlach, S. and W., Peng (2005): Bank lending and property prices in Hong Kong. *Journal of Banking & Finance*, Vol. 29, Issue 2, pp. 461-481.

Gimeno, R. and C., Martinez-Carrascal (2006): The Interaction between House Prices and Loans for House Purchase: The Spanish Case. *Banco de Espana Research Paper* No. WP-0605.

Goodhart, C. and B., Hofmann (2004): Deflation, Credit and Asset Prices. *HKIMR Working Paper* No. 13/2003.

Goodhart, C. and B., Hofmann (2008): House prices, money, credit, and the macroeconomy. *Oxford Review of Economic Policy*, Vol. 24, pp.180–205.

Green, J. and J., Shoven (1986): The Effects of Interest Rates on Mortgage Prepayments. *Journal of Money, Credit and Banking*, Vol. 18, pp. 41-59.

Hill, R. J. and Q., Gan (2008): A New Perspective on the Relationship Between House Prices and Income. *UNSW Australian School of Business Research Paper* No. 2008 ECON 13.

Hofmann, B. (2003): Bank Lending and Property Prices: Some International Evidence. *HKIMR Working Paper* No. 22/2003.

Kearl, J.R. (1979): Inflation, Mortgage, and Housing. *The Journal of Political Economy*, Vol. 87, pp. 1115-1138.

King, A., and M., Lenox (2002): Exploring the Locus of Profitable Pollution Reduction. *Management Science*, Vol.48, Issue 2, pp. 289-299

Lacoviello, M. and R., Minetti (2008): The credit channel of monetary policy: Evidence from the housing market. *Journal of Macroeconomics*, Vol. 30, pp. 69-96.

Liang, Q. and H., Cao (2007): Property prices and bank lending in China. *Journal of Asian Economics*, Vol. 18, Issue 1, pp. 63-75.

Lütkepohl, H. and F., Xu (2012): The role of the log transformation in forecasting economic variables. *Empirical Economics*, Vol. 42, Issue 3, pp 619-638.

Matthews, K. (2009): Bank Productivity in China 1997-2007: An Exercise in Measurement. *HKIMR Working Paper* No.25/2009.

McQuinn, K. and G., O'Reilly (2007): A Model of Cross-Country House Prices. *Research Technical Papers from Central Bank & Financial Services Authority of Ireland (CBFSAI)*, No 5/RT/07.

Meen, G. (2002): The time series behavior of house prices: A transatlantic divide? *Journal of Housing Economics*, Vol. 11, pp.1-23.

Miles, D. and V., Pillonca (2008): Financial Innovation and European Housing and Mortgage Markets. *Oxford Review of Economic Policy*, Vol. 24, Issue 1, pp. 145-175.

Muellbauer, J. and A., Murphy (1997): Booms and Busts in the UK Housing Market. *The Economic Journal*, Vol. 107, pp. 1701-1727.

Podrecca, E. and G., Carmeci (2001): Fixed investment and economic growth: new results on causality, *Applied Economics*, Vol. 33, Issue. 2, pp. 177-182

Quigley, J. and S. Raphael (2005): Regulation and the High Cost of Housing in California. *The American Economic Review*. Vol. 95, pp. 323-328.

Tsatsaronis, K. and H. Zhu (2004): What drives housing price dynamics: cross country evidence. *BIS Quarterly Review*.

Wolswijk, G. (2006): Determinants of Mortgage Debt Growth in EU Countries. *European Journal of Housing Policy*, Vol. 6, Issue 2, pp. 131-149.

Wooldridge, J. M. (2005): Fixed-Effects and Related Estimators for Correlated Random-Coefficient and Treatment-Effect Panel Data Models, *The Review of Economics and Statistics*, Vol. 87, Issue 2, pp. 385–390.

Yeung, S. and R., Howes (2006): The role of the housing provident fund in financing affordable housing development in China. *Habitat International*, Vol. 30, Issue 2, pp. 343-356.

Yuan, Z. G. and X. Y. Fan (2003): An Analysis of Rational Bubbles in the Real Asset Market. *Economic Research Journal*, Issue. 3, pp. 34 – 43. (in Chinese)

Zhang, X. Q. (2000): The Restructuring of the Housing Finance System in Urban China. *Cities*, Vol. 17, Issue 5, pp. 339-348.

Zheng, L., Q. Huang, T. Lu , W. Zhou (2007): The Process and Problems of Industrialization and Urbanization in China: The Status of the Tenth Five-Year Plan and Recommendations for the Eleventh Five-Year Plan. *Chinese Economy*, Volume 40, pp. 6-30.

Zhou, J. K. (2006): Forming and Evolvement of Real Estate Bubble --- An Explanation of Hypothesis Financial Supportive Excess. *Finance & Trade Economics*, Issue. 05, pp. 3-10. (in Chinese)

Zhu, H. (2006): The Structure of Housing Finance Markets and House Prices in Asia. *BIS Quarterly Review*, 55-70.

Chapter 3: The impact of deregulation trends on the Chinese banks' interest margins

Chapter 3: The impact of deregulation trends on the Chinese banks' interest margins ²⁰

Abstract

In this paper, we examine the impact of deregulation trends and foreign bank entry on the net interest margins of China's banking sector. By comparing the banks' net interest margins before and after the banking liberalization, we investigate the impact of the financial deregulation and the presence of foreign banks on the profitability of Chinese banks. The number of foreign banks has strong negative effects on the profitability of domestic banks. The credit risk is the major factor to enhance the profitability of the Chinese domestic banks. On the other hand, the banks require high interest margins to compensate for the liquid, default and credit risk exposures. After the banking liberalization, domestic banks do not keep as many liquid assets and loan loss provisions as before.

²⁰ This chapter is the result of joint work with Prof. Santiago Carbó Valverde and Prof. Francisco Rodríguez Fernández.

3.1 Introduction

The bank, which functions as an intermediary in channeling funds, plays a key role in the economic growth. The basic financial intermediation function is based on deposit-taking and granting loans and the main illustration on the performance of banks in such traditional intermediation activities in the net interest margin. The net interest margin (NIM) is defined as the ratio of net interest spread to total assets. It is an important measure of not only the bank profitability but also the social cost of financial intermediations. The lower interest margin which means: the more people prefer to borrow from banks, and consequently the lower social cost of financial institutes. (Demirguc-Kunt and Huizinga 1999; Maudos and Fernandez de Guevara 2004) Higher interest margins bring about a higher profitability and a better stability for the banking sector, especially for a non well-functioning economy. The increasing annual bank interest margins during the period of 2000 – 2009 were accompanied by increased market competition, as shown in Table 1. However, according to the (World Trade Organization) WTO accession agreement, China began to open the domestic banking market in November 2006. A full line of banking businesses in both foreign and local currencies was then opened to foreign subsidiary banks and branches, without any restriction on geographical or business scopes. Foreign subsidiary banks were allowed to receive deposits

from the public without a special permission or license.²¹ Both foreign and domestic banks were then supervised by the same regulatory standards. Therefore, the period after 2007 is denoted as the post-liberalization period. The presence of foreign banks contributed to the improvement of competition in the banking sector and reduced the interest margins of domestic banks. (Claessens et al. 2001; Williams 2003; Claeys and Vennet 2008) Xu (2010) investigated the impact of foreign banks entry on the Chinese banking sector, and suggested that the presence of foreign banks generated a higher competition and improved the bank efficiency in China. The main objective of our paper is to investigate the determinants of the net interest margins of the Chinese banks while taking into account the presence of foreign banks.

The remainder of the paper is organized as follows. Section 2 gives a brief review of relevant literature on the determinants of banks' interest margins. The empirical framework is presented in section 3. Section 4 describes the samples and the variables. Section 5 presents the major empirical results. Finally, we conclude the analyses with a summary of the results in section 6.

²¹ In 2006, the China Banking Regulatory Commission (CBRC) issued the *Regulations for the Administration of Foreign Funded Banks*. Within this framework, the requirements and obligations of foreign banks were set forth.

3.2 Literature review

Ho and Saunders (1981) propose the pioneering model, in which the bank is regarded as a risk-averse dealer, and the spread relies on the intermediation activities. This dealership model is a reference framework for many subsequent empirical analyses. Allen (1988) extends the Ho-Saunders model by including alternative products in the loan portfolio, which leads to the diversification of financial intermediaries. Carbó-Valverde and Rodríguez-Fernández (2007) consider the loan heterogeneity and involve the non-traditional assets into the multi-output model. They use a data of 19,322 European banks to examine the interest margins between 1994 and 2001. Their findings indicate that the low bank interest margin, which is a result of a stronger competition, could be compensated by the revenue of non-traditional businesses. Similarly, Wong (1997) proposes a firm model in a static setting. He analyzes multiple risk measures and suggested an ambiguous effect of the interest risk on the interbank market.

Among other empirical works, Angbazo (1997) studies different risk measures and concludes that the default risk, rather than the interest rate risk, has a greater impact on the interest margin of large banks. Demirguc-Kunt and Huizinga (1999) use a sample of banks' interest margins in 80 countries during the period of 1988 – 1995. They find higher interest margins of foreign banks than that of domestic banks in developing countries, while the opposite result

exists for developed countries. Saunders and Schumacher (2000) suggest a trade-off between the solvency risk and the net interest margins, by using a sample of European and US banks. Maudos and Fernandez de Guevara (2004) extend the empirical framework by including operating costs and market power. They find that falling operating costs and credit risks contribute to the reduction of bank interest margins. The cases of transition economies and developing countries are also investigated by Drakos (2003) and Claeys and Vennet (2008). They investigate the case of Central and Eastern European Countries (CEEC) and find a decreased interest margin and a better efficiency in CEEC banks. In addition, the decline of domestic banks' interest margins has been associated with the presence of foreign banks in transition economies. Kasman et al. (2010) compares the determinants of NIM between the new and existing EU member countries. They conclude that the difference of interest margins between the two groups still exists and the M&A needs to be promoted in order to increase the scale efficiency. As for the developing countries, Doliente (2005) investigates the banks in four Southeast Asian countries, and finds the bank interest margins are sensitive to the short-term interest rate. Following Ho-Saunders dealership model, Zhou and Wong (2008) examines the determinants of net interest margins of the Chinese commercial banks during the period of 1996 - 2003. They confirm the impact of several conventional factors, including market concentration, size and risk aversion etc., on the net interest margins. The main contribution of our paper is to use

a comprehensive data to study the effect of banking liberalization in China.²² By comparing the banks' net interest margins before and after the banking liberalization, we attempt to scrutinize the impact of financial deregulation and the presence of foreign banks on the profitability of Chinese banking sector.

3.3 Empirical approach

We investigate the determinants of net interest margins of Chinese banks in the context of Ho and Saunders (1981). There are two empirical approaches in the literature to estimate the determinants of net interest margins. The first is a two-stage process, which is used by Ho and Saunders (1981), Saunders and Schumacher (2000) and Doliente (2005). In the first stage, a cross-sectional regression is run to obtain a measure of the "pure spread", which is defined as the spread between the interest revenue on bank assets and interest expense on bank liabilities as a proportion of average bank assets. In the second stage, the "pure spread" is regressed against the volatility of interest rates. However, a long time series is required for the second stage estimation. On the other hand, McShane and Sharpe (1985) and Angbazo (1997) propose an alternative single-stage approach, which includes both bank-specific characteristics and country-specific macroeconomic conditions as explanatory variables.²³ Since our sample covers annual accounting data between the

²² Differing from Zhou and Wong (2008), we involve not only the commercial banks but also cooperative credit into our sample for the investigation.

²³ The single-stage approach is also used by Maudos and Fernandez de Guevara (2004), Claeys and Vennet (2008),

years 2000-2009, we employ the single-step estimation approach for the estimation. In addition, the presence of foreign banks is found to be negatively related to the NIM. (Claessen et al. 2001; Drakos 2003; Claey's & Vennet 2008) We also study the impact of foreign banks entry on the interest margins of Chinese domestic banks. In model **I** we use a single-step approach and include bank specific variables and market concentration index for the estimation. In model **II**, the number of foreign banks is involved in the framework in order to capture the effect of foreign banks' presence. Our empirical framework is specified as follows:

Model I:

$$NIM_{it} = \beta_0 + \beta_1 HHI_t + \beta_2 Size_{it} + \beta_3 Opportunity_{it} + \beta_4 Inefficiency_{it} + \beta_5 Risk_Aversion_{it} + \beta_6 Liquid_Risk_{it} + \beta_7 Default_Risk_{it} + \beta_8 Credit_Risk_{it} + \varepsilon_{it}$$

Model II:

$$NIM_{it} = \beta_0 + \beta_1 HHI_t + \beta_2 Size_{it} + \beta_3 Opportunity_{it} + \beta_4 Inefficiency_{it} + \beta_5 Risk_Aversion_{it} + \beta_6 Liquid_Risk_{it} + \beta_7 Default_Risk_{it} + \beta_8 Credit_Risk_{it} + \beta_9 Foreign_i + \varepsilon_{it}$$

We first estimate the results using a fixed effect method, which controls for all individual characteristics of banks.²⁴ Since the interest margins are explained by quantities, the estimations are challenged by potential endogeneity biases. For example, García-Herrero et al. (2009) indicate that the more profitable

Kasman et. al. (2010)

²⁴ Maudos and Fernandez de Guevara (2004) have used fixed effects method to investigate the case of European banking sector.

banks increase their equity capital and size more easily. To address this problem, Arellano and Bover (1995), Blundell and Bond (1998) introduce the Generalized Method of Moments (GMM), known as the system GMM estimator, to alleviate endogeneity concerns. The lagged dependent and explanatory variables in both levels and differences are employed as instrumental variables. In addition, the system GMM estimator also accounts for the unobserved heterogeneity across banks. (García-Herrero et al. 2009; Dietrich and G. Wanzenrie 2011) The results of Hansen test of over identification and autocorrelation tests for consistency are reported.²⁵

3.4 Data and the description of the sample

We use a sample of 116 Chinese domestic banks, which consists of State-Owned Banks (SOBs); Joint Stock Banks (JSBs); City Commercial Banks(CCBs) and Credit Cooperatives. All bank-level data in the sample are obtained from the Bureau Van Dijk's BankScope database. The total number of foreign banks is from the annual report of China Banking Regulatory Commission. The sample includes 1,113 observations over the period of 2000-2009. Table 2 illustrates a summary statistics of the variables.

²⁵ Both first- and second-order autocorrelation tests are reported. If the second-order autocorrelation is observed, the system GMM estimator is then inconsistent.

The annual mean values of the variables are shown in Panel I of Table 1. The net interest margins of domestic banks had increased until 2008, when the influence of financial crisis affected China. In terms of the market concentration, the Herfindahl-Hirschman Index is observed to be decreasing from 2000 to 2006, and then it began to increase slowly.²⁶ The opportunity costs of all financial intermediaries were declining smoothly until 2007 and then probe a sharp spike in 2008 and 2009. It can be largely attributed to the soaring liquid reserves of CCBs & credit cooperative, which are more risk-averse and prefer to leave aside more liquid assets to resist the financial risk. Finally, the presence of foreign banks kept growing during the entire period. Panel II shows the mean values before and after the banking liberalization. We find that the net interest margins after 2007 was higher than before. It means that the domestic banks did not suffer from the financial market openness in 2007. Instead, the presence of foreign banks forced domestic banks to improve their efficiency and performance. In addition, the opportunity costs of bank reserves had increased substantially after 2007 - from 0.7% to 4%. The average interest margin of Chinese banks during the period of 2000 - 2009 was 2.7%. It is similar to European banks, in spite of a lower volatility. The loan size of the full sample is lower than that of European banks. Furthermore, we find a similar Credit Risk level, a lower Liquid Risk and a lower default risk of Chinese banking sector than that of European banks.

²⁶ The Herfindahl-Hirschman Indices after 2001 are below than 1000. According to the regulation of American Department of Justice (1992), it can be classified as a high competitive market.

(Kasman et al. 2010; Carbó-Valverde and Rodríguez-Fernández 2007)

According to the econometric approach in section 3, we include the following variables in the estimation. The definitions, expected signs and summary statistics of all variables are summarized in Table 2.

(1) **HHI**: we use the Herfindahl-Hirschmann Index (HHI) to capture the market concentration. It is defined as the sum of the squares of the market shares of each bank. (Maudos and Fernandez de Guevara 2004) In spite of some evidence of positive impact of *HHI* on the interest margin (Maudos and Fernandez de Guevara 2004; Carbó-Valverde and Rodríguez-Fernández 2007), Cetorelli and Gambera (2002) argue that the bank concentration can also impose a depressing impact on growth.

(2) **Size**: The log of total loan is used as a proxy of the size of individual banks. Maudos and Fernandez de Guevara (2004) suggest a positive relationship between the bank interest spread and the average size of operations.²⁷ Therefore a positive sign of *size* is expected.

(3) **Opportunity**: We use the ratio of liquid reserves, which are the sum of cash and due from banks, to total assets, to proxy the opportunity costs. The higher liquidity ratio of banks' asset, the higher opportunity costs for banks. Then a greater volume of interest margins is required to cover the cost. Therefore, a positive sign of *opportunity* is expected.

²⁷ However in the empirical results, the negative impacts of loan size on the NIM for France and Italy are reported.

- (4) ***Inefficiency***: This variable is measured by the cost to income ratio. Since the interest margin is undermined by high costs, a negative sign of *Inefficiency* is expected.
- (5) ***Risk_Aversion***: In the context of Ho-Saunders Model (1981), the commercial banks are assumed to be risk-averse dealers. Therefore, we explore to what extent risk-aversion can affect banks' interest margins. Following McShane and Sharpe (1985), Maudos and Fernandez de Guevara (2004), this variable is proxied by the ratio of total equity to total assets. Since the higher interest margin is favored by those banks, which are more risk averse, a positive sign is expected.
- (6) ***Liquid_Risk***: Following Angbazo (1997), we use the ratio of liquid assets to total liabilities to proxy the liquid risk. A positive sign is expected.
- (7) ***Credit_Risk***: We use the loan to assets ratio to proxy the credit risk. (Maudos and Fernandez de Guevara 2004, Kasman et al. 2010) Since the higher volume of loans granted is associated with higher credit risk exposure, we assume it has a positive impact on the interest margins.
- (8) ***Default_Risk***: Following Kasman et al. 2010, we use the ratio of loan loss provisions to total loans to proxy the default risk. Since the banks require extra interest margins to compensate for higher default risk, a positive sign is expected.
- (9) ***Foreign***: we employ the number of foreign banks to proxy the impact of foreign banks on Chinese domestic banking market. Since the financial

market openness and increased presence of foreign banks can bring about higher competition to the domestic banking sector and improved welfare for customers, we argue that foreign banks' presence has a negative impact on the interest margin of banking sector. (Claessen et al. 2001; Claey's & Vennet 2008)

3.5 Empirical results

We estimate the determinants of Net Interest Margins using both Fixed Effect and GMM methods. The results without the influence of foreign banks are shown in Table 3. Column (1) reports the estimation under fixed effect model for all banks between 2000 and 2009. Column (2) reflects the results of the sub-period before 2007 under the fixed effect method. The results after the banking liberalization in 2007 with fixed effect model are presented in Column (3). Column (4) – (6) report the results for the whole sample, sub-period before and after the liberalization with system GMM method respectively.

In general, we find overall that the explanatory variables achieve the predicted signs. The fixed effect estimations of the coefficients of loan size and inefficiency are negative, which are not consistent with the GMM estimators. Since the fixed effect estimation tends to be biased due to the endogeneity

problem, the GMM estimator seems to be more reliable.²⁸ We do not notice a significant effect of neither loans nor inefficiency on the interest margins in GMM estimation, except for the period before 2007. The positive and significant impact of loan size on the interest margins before 2007 is not in line with the results of Zhou and Wong (2008).²⁹ Before the banking liberalization, the foreign banks' business was subject to severe limitations and strict supervisions. The margins of domestic banks come from the high interest rate spread which was established by the government. Therefore, the higher was the volume of loan granted, the higher the interest margins they could earn. Since the interest rate policy is to a large extent controlled by the supervisor, loan expansion was the principal way to earn interest margins before 2007. The entry of foreign banks has challenged the monopolistic power of domestic banks and made the loan expansion a statistically less relevant variable in explaining profitability after the banking liberalization. The opportunity cost measured by the ratio of liquid reserves to total assets has a significant and positive impact on the net interest margins the fact which confirms the findings of Maudos and Fernandez de Guevara (2004). This result implies that the high interest margins are underpinned by liquidity reserves. This effect is particularly significant after the banking liberalization.

²⁸ As García-Herrero et al. (2009) said, more banks with higher interest margins have more advantage to increase the size, which contributes to the bank's profitability

²⁹ Our estimation differs with Zhou and Wong (2008) in two aspects: first, we use a more recent time series between 2000 and 2007 and system GMM method to control for the possible endogeneity problem. However, Zhou and Wong (2008) employ the data between 1996 and 2003 and only fixed effect method.

Almost all the risk factors have implied significant and positive effects on the interest margins, except for the risk aversion. A high financial risk is associated with large non-performing loan ratios of the Chinese domestic banks. Therefore, they require high interest margins to compensate for defaults and credit risk exposures. After the banking liberalization, the market openness forced domestic banks to improve their profitability to overcome high risk exposures. The findings are in line with Maudos and Fernandez de Guevara (2004), Hawtrey and Liang (2008) and Kasman et al (2010) for other international experiences.

In Table 4 we include the number of foreign banks to proxy the influence of foreign bank presence. The presence of foreign banks has a significant and negative impact on the domestic banking sector. This result is consistent with the findings of Claessens et al. (2001) and Claeys & Vennet (2008). The entry of foreign banks reduced the banks' profitability particularly after the banking liberalization. This implies that the presence of foreign banks forced the domestic bank market to be more competitive and therefore to reduce the bank's net interest margins. Another result that deserves our attention is that only the credit risk variable seemed to contribute to the increase of interest margins after 2007. This may be explained by the risk taking behavior of the Chinese banks. In particular, after the banking liberalization, the domestic banks became more profit-driven and risk averse. They tend to keep lower

liquidity assets and loan loss provisions than before. On the other hand, the positive effect of credit risk indicates that the loan expansion is also the most important way to earn interest margins in the Chinese banking market.

3.6. Conclusions and policy implications

In this paper, we examine the impact of deregulation trends and foreign bank entry on the net interest margins of China's banking sector. The banking liberalization brings about higher competition and narrowed net interest margins. The loan expansion is found to be the main way to earn interest margins during our research period. In terms of the risk parameter, the credit risk is documented as the major factor to enhance the profitability of Chinese domestic banks. A high financial risk is associated with a high non-performing loan ratio of the Chinese domestic banks. Therefore, they require high interest margins to compensate for the liquid, default and credit risk exposures. The risk taking behavior of the Chinese banks is also influenced by the entry of foreign banks. The foreign bank presence forced domestic banks to be more competitive and to reduce the bank's net interest margins. After the banking liberalization, domestic banks did not keep as many liquid assets and loan loss provisions as before. Furthermore, we find a substantial and negative impact of foreign bank presence on the profitability of domestic banks.

Appendix

Table 1: Mean value of variables

Panel I: The annual mean value of variables in the estimation										
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
NIM (%)	1.88	2.12	2.02	2.01	2.31	2.64	2.83	3.22	3.40	2.81
HHI	5247	1756	1505	1350	1267	1229	1196	1128	1090	1097
Size	8.02	8.57	8.40	8.46	8.29	8.12	7.90	8.13	8.82	9.21
Opportunity (%)	1.29	1.07	0.75	0.68	0.60	0.58	0.69	0.96	5.25	7.36
Inefficiency (%)	66.81	60.47	56.43	53.19	51.63	44.76	42.23	36.70	35.52	40.16
Risk_Aversion (%)	4.97	4.69	3.82	3.56	3.70	4.30	5.28	5.58	6.03	6.07
Liquidity_Risk (%)	23.69	18.53	17.26	16.60	18.03	20.10	20.04	22.77	23.63	22.31
Default_Risk (%)	0.52	0.55	0.75	0.75	0.85	1.10	1.04	0.84	1.19	0.68
Credit_Risk (%)	48.64	53.87	52.02	53.92	55.63	54.74	55.69	53.55	52.26	52.25
Foreign banks	191	190	181	192	188	207	224	274	311	338

Panel II: The mean value of variables before and after the banking liberalization

	Sample before the banking liberalization		Sample after the banking liberalization	
	Mean	Std. dev	Mean	Std. dev
NIM (%)	2.426	0.847	3.164	0.990
HHI	1935	1364	1093	3.497
Size	8.201	1.922	8.655	1.043
Opportunity (%)	0.7	0.007	4	0.070
Inefficiency (%)	49.4	0.169	37.3	0.102
Risk_Aversion (%)	4.3	0.025	5.9	0.024
Liquidity_Risk (%)	18.8	0.085	24.1	0.089
Default_Risk (%)	0.9	0.006	0.9	0.008
Credit_Risk (%)	54.5	0.096	52.8	0.081
Foreign banks	196	13.511	308	26.260

Table 2: Summary statistics for the full sample

Variable	Definition	Expected Sign	Mean	Std. dev	Minimum	Maximum
Dependent Variable						
NIM (%)	Difference between the interest revenue and interest expense, in logarithms		2.717	0.975	0.420	6.680
Explanatory Variables						
HHI	The sum of the squares of the market shares	+/-	310.905	424.034	101.595	1570.146
Size	Total volume of loans, in logarithms	-	8.377	1.903	4.872	13.463
Opportunity	The ratio of liquid reserves to total assets	+	0.019	0.045	0.000	0.298
Inefficiency	The cost to income ratio as a measure of inefficiency (the quality of management)	-	0.446	0.158	0.040	1.699
Risk_Aversion	The ratio of total equity to total assets	+	0.049	0.026	-0.137	0.313
Liquid_Risk	The ratio of liquid assets to total liabilities	+	0.210	0.090	0.012	0.971
Default_Risk	The ratio of loan loss provisions to total loans	+	0.009	0.007	-0.006	0.042
Credit_Risk	The ratio of total loans to total assets	+	0.539	0.091	0.186	0.885
Foreign	The number of foreign banks in mainland China.	-	229.708	54.294	181	338

Note: The liquid reserves refer to the sum of cash and due from banks.

Table 3: Regression results for Net Interest Margins (NIM)

	Fixed Effect			System GMM		
	(1)	(2)	(3)	(4)	(5)	(6)
HHI	-7.98E-5 (-0.90)	-2.54E-5 (-0.31)	-9.22E-4 (-0.36)	-2.37E-4 (-0.22)	-2.17E-3 (-1.57)	1.42E-2*** (2.94)
Size	-0.108 (-1.53)	-0.273** (-2.27)	-0.418** (-2.26)	0.026 (0.48)	0.172*** (2.05)	0.084 (1.16)
Opportunity	5.096*** (8.95)	2.544 (0.48)	4.130*** (4.66)	6.486*** (2.02)	24.51 (0.32)	7.991*** (2.99)
Inefficiency	-3.374*** (-9.28)	-3.670*** (-7.30)	-3.317*** (-3.06)	2.566 (1.39)	2.012 (1.06)	-0.356 (-0.15)
Risk_aversion	4.531*** (3.85)	3.901 (2.52)	3.375 (1.61)	19.87 (1.43)	22.23 (1.17)	20.69 (1.29)
Liquid_risk	1.302** (2.50)	-0.205 (-0.26)	0.285 (0.30)	6.475*** (2.91)	6.581*** (2.18)	6.617* (1.90)
Default_risk	15.05*** (3.30)	18.13*** (2.67)	17.83*** (2.20)	89.62*** (3.61)	123.6*** (3.24)	79.29*** (3.83)
Credit_risk	1.919*** (3.77)	1.235 (1.63)	4.146*** (3.60)	6.204*** (4.36)	3.443** (2.02)	8.372*** (4.65)
Constant	3.445*** (4.45)	5.484*** (4.63)	6.313 (1.63)	-4.735* (-1.88)	-2.471 (-0.79)	-21.21*** (-2.91)
Observations	515	303	212	291	133	158
Number of Groups	103	99	97	73	46	68
AR(1)	N/A	N/A	N/A	0.003	0.054	0.002
AR(2)	N/A	N/A	N/A	0.210	0.225	0.147
Hansen	N/A	N/A	N/A	0.140	0.322	0.470

Notes: Variables are instrumented through GMM procedure following Arellano and Bover (1995), Blundell and Bond (1998). AR(1), AR(2) refer to the *p-value* of first- and second-order Arellano-Bond test for autocorrelation. Hansen is the *p-value* of Hansen test for over-identification. t statistics in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: Regression results with the presence of foreign banks.

	Fixed Effect			System GMM		
	(1)	(2)	(3)	(4)	(5)	(6)
HHI	-9.11E-5 (-1.04)	-5.51E-5 (-0.69)	-1.45E-2*** (-3.96)	-5.00E-3*** (-2.82)	-4.26E-3 (-3.44)	-1.49E-2 (-2.30)
Size	-0.429*** (-4.01)	-0.626*** (-4.04)	0.320 (1.40)	0.050 (0.71)	0.159* (1.82)	-0.021 (-0.27)
Opportunity	4.158*** (6.84)	0.344 (0.07)	4.797*** (5.85)	4.839 (1.52)	82.13 (1.19)	6.627* (1.72)
Inefficiency	-3.238*** (-9.02)	-3.277*** (-6.53)	-2.377** (-2.36)	2.321 (1.21)	1.516 (0.74)	0.654 (0.19)
Risk_aversion	3.555*** (3.01)	2.445 (1.57)	3.656* (1.91)	25.49* (1.83)	19.00 (1.25)	20.34 (1.17)
Liquid_risk	0.843 (1.61)	-0.515 (-0.66)	0.012 (0.01)	8.370*** (3.09)	5.720*** (2.00)	4.535 (1.30)
Default_risk	17.15*** (3.80)	18.82*** (2.85)	9.665 (1.28)	74.96*** (3.02)	94.54*** (2.70)	39.00 (1.43)
Credit_risk	2.655*** (4.97)	1.780** (2.37)	3.140*** (2.94)	6.300*** (3.91)	3.603* (1.70)	7.418*** (3.45)
Foreign	0.0040*** (3.94)	0.0107*** (3.49)	-0.0150*** (-4.80)	-0.0096*** (-2.68)	-0.0103 (-1.50)	-0.0161** (-2.51)
Constant	4.910*** (5.80)	5.960*** (5.13)	19.76*** (4.38)	2.744 (0.84)	2.750 (0.88)	17.86** (2.15)
AR(1)	N/A	N/A	N/A	0.011	0.031	0.006
AR(2)	N/A	N/A	N/A	0.181	0.135	0.146
Hansen	N/A	N/A	N/A	0.051	0.241	0.025

Notes: Variables are instrumented through GMM procedure following Arellano and Bover (1995), Blundell and Bond (1998). AR(1), AR(2) refer to the *p-value* of first- and second-order Arellano-Bond test for autocorrelation. Hansen is the *p-value* of Hansen test for over-identification. t statistics in parentheses * p<0.10, ** p<0.05, *** p<0.01.

References:

Allen, L (1988): The determinants of bank interest margins: A note, *Journal of Financial and Quantitative Analysis*, pp. 231–235.

Angbazo, L (1997): Commercial bank net interest margins, default risk, interest rate risk and off balance sheet activities, *Journal of Banking and Finance* , pp. 55–87.

Arellano, M. and O. Bover, (1995): Another look at the instrumental variable estimation of error-components models, *Journal of Econometrics*, Vol. 68, pp. 29-51.

Blundell, R. and S. Bond (1998): Initial conditions and moment restrictions in dynamic panel data models, *Journal of Econometrics*, Vol. 87, pp. 115-143.

Carbó-Valverde S. and F. Rodriguez-Fernandez (2007): The determinants of bank margins in European banking. *Journal of Banking & Finance*, Vol. 31, pp. 2043-2063

Cetorelli, N. and M. Gambera (2002): Banking Market Structure, Financial Dependence and Growth: International Evidence from Industry Data. *The Journal of Finance*. Vol.2, pp. 617 – 648.

Claessens, S.; A. Demirguc-Kunt and H. Huizinga (2001): How does foreign entry affect domestic banking markets? *Journal of Banking and Finance*, Vol.25, pp. 891-911.

Claeys S. and R. V. Vennet (2008): Determinants of bank interest margins in Central and Eastern Europe: A comparison with the West. *Economic Systems*, Vol. 32, pp. 197-216.

Demirguc-Kunt, A. and H. Huizinga (1999): Determinants of Commercial Bank Interest Margins and Profitability: Some International Evidence. *World Bank Economic Review*, Vol. 13, pp 379-408.

Dietrich, A. and G. Wanzenrie (2011): Determinants of bank profitability before and during the crisis: Evidence from Switzerland, *Journal of International Financial Markets, Institutions and Money*, Vol. 21, pp. 307 - 327

Doliente, J.S. (2005): Determinants of bank net interest margins in Southeast Asia. *Applied Financial Economics Letters*, Vol. 1, pp. 53 – 57

Drakos, K.(2003): Assessing the success of reform in transition banking 10 years later: an interest margins analysis. *Journal of Policy Modeling*, Vol. 25, pp.309-317.

Ferri, G. (2009): Are New Tigers supplanting Old Mammoths in China's banking system? Evidence from a sample of city commercial banks. *Journal of Banking & Finance*, Vol. 33, pp. 131 – 140.

Fu, X. and S. Heffernan (2009): The effects of reform on China's bank structure and performance. *Journal of Banking & Finance*, Vol. 33, pp. 39 – 52.

García-Herrero, A., S. Gavila and D. Santabárbara (2009): What explains the low profitability of Chinese Banks? *Journal of Banking & Finance*, Vol.33, pp. 2080-2092.

Hawtrey, K. and H. Liang (2008): Bank interest margins in OECD countries, *The North American Journal of Economics and Finance*. Vol. 19, pp. 249 – 260.

Ho, T. and A. Saunders (1981): The determinants of bank interest margins: Theory and empirical evidence, *Journal of Financial and Quantitative Analysis* , pp. 581–600.

Kasman, A.; G. Tunc; G. Vardar and B. Okan (2010): Consolidation and commercial bank net interest margins: Evidence from the old and new European Union members and candidate countries. *Economic Modelling*, Vol. 27, pp. 648-655

Kostas, D. (2003): Assessing the success of reform in transition banking 10 years later: an interest margins analysis, *Journal of Policy Modeling*, Vol.25, pp. 309-317,

Levine, R. and Z. Sara (1998): Stock Markets, Banks, and Economic Growth. *American Economic Review*, Vol. 88, pp. 537-558,

Maudos, J. and J. Fernandez de Guevara (2008): Factors explaining the interest margin in the banking sectors of the European Union, *Journal of Banking and Finance*, Vol. 28, pp. 2259–2281.

Saunders, A. and L. Schumacher (2000): The determinants of bank interest rate margins: An international study, *Journal of International Money and Finance*, Vol. 19, pp. 813–832.

Williams, B. (2003): Domestic and international determinants of bank profits: Foreign banks in Australia. *Journal of Banking & Finance*, Vol. 27, pp. 1185 – 1210.

Wong, K.P. (1997): On the determinants of bank interest margins under credit and interest rate risk, *Journal of Banking and Finance*, Vol.21, pp. 251–271.

Xu, Y. (2010): Towards a more accurate measure of foreign bank entry and its impact on domestic banking performance: The case of China. *Journal of Banking & Finance*, Vol.35, pp. 886 – 901.

Zhou, K. and M. C. S. Wong (2008): The Determinants of Net Interest Margins of Commercial Banks in Mainland China. *Emerging Markets Finance and Trade*, Vol. 44, pp. 41-53

Chapter 4: The diffusion pattern of non-cash payments: Evidence from China

Chapter 4: The diffusion pattern of non-cash payments: Evidence from China³⁰

Abstract

Exploiting an original data of non-cash payments during the period between 1996 and 2005, this paper analyzes the diffusion patterns of non-cash payments in China. Based on both exponential and Gompertz curves, the POS terminal has shown a higher diffusion rate than that of ATM. This result is also robust when a time trend is interacted with rival's precedence, network effects and market concentration. The diffusion rates of both ATM and POS terminals have accelerated after 2002, when *UnionPay* was established in China. The diffusion rate of ATM is found to be mainly driven by rival's adoptions. The market concentration boosts the diffusion of POS terminals. In spite of the rising number of POS terminals and merchants, the volume of POS transactions is low. The diffusion rate of POS is, however, negatively affected by interchange fees.

³⁰ This chapter is the result of joint work with Prof. Santiago Carbó Valverde and Prof. Francisco Rodríguez Fernández.

4.1 Introduction

The proliferation of bankcards and non-cash payment technologies, such as Automated Teller Machine (ATM) and Point of Sale (POS) terminals, has been one of the most relevant innovations in payment systems over the past decades. The usage of electronic cards has reduced transaction costs and has also enhanced economic efficiency. Comparing with cash, non-cash payments have several advantages, such as convenience and security. If all paper-based payments are replaced by alternative electronic instruments within a country, around 1% GDP could be saved annually. (Shy and Tarkka 2002; Humphrey et al. 2003)

Global non-cash payment transactions have kept on growing at an average rate of 6.8% in 2001 - 2009. After a decline during the financial crisis, it began to pick up again in 2010 at an estimated annual growth rate of 7.8%.³¹ The emerging and mature Asian-Pacific markets have dearly contributed to the recovery of non-cash payments.

After the first credit card was introduced by Bank of China in 1985, the Chinese non-cash payment market has witnessed a steady growth. Figure 1 illustrates the infrastructure situation of non-cash payment instruments in

³¹ The data is released by the World Payment Report from Capgemini, The Royal Bank of Scotland (RBS), and the European financial marketing association (EFMA). Before the financial crisis (2001 - 2007), the annual growth rate is 7.2%.

China. We observe that the number of payment cards has grown far more rapidly than both ATM and POS terminals. The number of POS terminals and merchants recruited increased more quickly than ATM machines. Apart from the infrastructure improvement, figure 2 illustrates that the rise of non-cash transactions has gone through two stages. Before 1998, the non-cash payment market maintained very low transaction values. The fast-track development of non-cash payment transactions was shown after 2002, when the national organization – China *UnionPay* - was established. The transfer and withdrawal values continue to grow more rapidly than POS figures. This phenomenon implies, in spite of the relative fewer ATMs than POS terminals, the Chinese customers prefer the convenient cash withdrawal to the POS transactions. The promotion of “*UnionPay*” brand has enhanced the adoption of bankcard usage. At the end of 2005, China ranked the second largest market around the globe in terms of the issuance of plastic cards. Until 2009, the annual growth of card usage in China is 20.8%, which is higher than the average growth of non-cash transactions globally (World payment report; Worthington and Lu 2007). By exploiting a dataset of bankcard and non-cash payment instruments³², this paper investigates the diffusion pattern of non-cash payment instruments in the Chinese market.

³² Other than the developed countries, the Chinese payment card market has long been dominated by debit cards and quasi-credit cards, instead of credit cards. Therefore, the terminology of “Bankcard” seems more appropriate than others in terms of the Chinese non-cash payment system.

The paper is organized as follows. Section 2 reviews the literature on the diffusion of payment cards and highlights the major contributions of our work. Section 3 describes the data, empirical approach and variables employed in the estimation. The empirical results are presented in section 4. Section 5 concludes this paper.

4.2 Literature Review

Most theoretical studies of non-cash payments focus on the two-sided nature and network externality of the payment market, such as Rochet and Tirole (2002, 2006), Wright (2003, 2004) and Guthrie and Wright (2007). They explained how the interchange fees can affect merchants' acceptance and consumers' usage of the payment cards. Qi and Yang (2003) propose a neural network model to predict the adoption behavior of credit cardholders. Using nonlinear utility function and variable Marginal Rate of Substitution (MRS), they find consumers' adoption of credit card is likely to follow a nonlinear utility function and they do not make linear tradeoffs between card attributes. Masters and Rodríguez-Reye (2005) investigated the credit card acceptance in the context of heterogeneous sellers. They provided an explanation of how the credit cardholders in different countries use the cards in different ways and then argued that the retailers' adoption of credit cards is not affected by other sellers' decisions.

In terms of the empirical studies, Hannan and McDowell (1984) examined the relationship between market structure and ATM adoption level. They found a positive impact of market concentration on the diffusion of ATM in the banking industry. A higher proportion of firms tend to accept ATMs in a relatively concentrated market. Antonides et al. (1998) used a wide range of secondary data and S-shape curves to estimate the adoption pattern of ATM and bankcards. The results implied a higher adoption level of bankcards than that of ATM machines. Social learning was considered as the main driver of this process. The determinants of ATM and POS diffusions were examined by Carbó-Valverde and Rodríguez-Fernández (2008). They used the data of Spanish payment market and found that supply factors are the driving components of both ATM and POS diffusions. The growth rate of ATM and POS transactions are negatively correlated, which could be explained by a kind of “horse race”.

The study of the Chinese non-cash payments is, nonetheless, limited in the international literature. Worthington (2003, 2005) makes an exploratory study of the Chinese non-cash payment market, and concludes that the Chinese payment card market is quite unique. Worthington et al. (2007, 2011) explored the holding and usage of credit cards of urban-affluent and early adopters. Their findings suggested that credit cards are more easily adopted by young and urban-affluent consumers in China. On the other hand, in spite of the

respondents' appreciation of the convenience of credit cards, the "infrastructure" level and a fear of loss of financial control may be the barrier of credit card diffusion.

Almost all the previous studies focused on the adoption of payment cards in China from the perspective of the cultural environment, rather than the payment instruments. Our paper contributes to the literature by investigating the diffusion pattern of non-cash payments in China from the perspective of network effects, infrastructure level and market concentration.

4.3 Empirical methodology

We employ a discrete model, proposed by Mansfield (1968), to investigate the diffusion pattern of innovation. We assume the diffusion rate of a payment instrument at time $t+1$ is a function of the diffusion at time t . Following this assumption, both Exponential and Gompertz curves used to employed to estimate the diffusion rates of ATM and POS over time. The expression for the exponential curve is as follows:

$$y(t) = y_0(1 + r)^t \quad (1)$$

where $y(t)$ is the adoption level of an innovation – ATM or POS - in this framework. y_0 stands for the initial adoption level of ATM (or POS), and the growth rate is denoted as r . Then we take Log linear transformation of the exponential curve as follows:

$$\log y(t) = \log y_0 + t \cdot \log(1 + r) \quad (2)$$

An alternative method to estimate the diffusion rate of an innovation is a Gompertz growth curve. It was initially proposed by Benjamin Gompertz in 1825 to forecast the fertility distributions. Then it was widely used to estimate the telephone, automobile and the ATM adoption. (Migon and Gamerman 1993; Dargay and Gately 1997) The Gompertz curve expression is as follows:

$$y(t) = S \cdot \exp[-\alpha \cdot \exp(-\beta \cdot t)] \quad (3)$$

Where $y(t)$ is the adoption level of an innovation, S stands for the saturation level of the adoption. The parameter α determines the flatness of the curve. The diffusion speed of ATM (or POS) is measured by β . Since the saturation level of ATM or POS adoption is difficult to observe, we use the first difference log transformation to fit the Gompertz curve (Franses 1994). First, we take the log transformation of equation (3). Then, we take first difference of $\log[y(t)]$ to remove the saturation level, as shown in (5). Finally, after the log transformation of equation (5), we get a linear function of time-variable, as shown in equation (6).

$$\log[y(t)] = \log S - \alpha \cdot \exp(-\beta \cdot t) \quad (4)$$

$$\Delta \log[y(t)] = \exp(-\beta \cdot t) \cdot (-\alpha + \alpha \exp \beta) \quad (5)$$

$$\log[\Delta \log y(t)] = -\beta \cdot t + \log(\alpha \exp \beta - \alpha) \quad (6)$$

Based on the models above, we propose the following empirical methods of both exponential and Gompertz curves to estimate the diffusion of ATM and POS in the Chinese market. The panel-data approach with fixed effects is implemented to control for unobservable cross-sectional individual differences.

$$\log y_{it} = \alpha + \beta \cdot t_i + \varepsilon_{it} \quad (7)$$

$$\log[\Delta \log y_{it}] = \alpha - \beta \cdot t_i + \varepsilon_{it} \quad (8)$$

Following Hannan and McDowell (1984), we adopt a two-step strategy to investigate the determinants of ATM and POS diffusion rates. In the first step, we use the Gompertz curve to estimate the ATM and POS diffusion rate of each individual bank, which is measured by coefficient β . In the second step, we use the bank level β as the dependent variable and an OLS method to estimate the determinants of diffusion rates. The mean values of rivals' precedence, market concentration, network effect, the growth of ATM (or POS) and other control variables for all banks are employed as explanatory variables.

4.4 Data and variables

An unbalanced panel of the annual number of ATM and POS terminals is applied in the estimation. Our sample consists of State-Owned-Banks (SOBs), Joint-Stock-Banks (JSBs), major City-Commercial-Banks (CCBs) and other Credit Cooperatives. All the data are collected from ALMANAC OF CHINA'S FINANCE AND BANKING, which is the official publication of People's Bank of China. We use the total number of ATM machines (or POS terminals) to proxy the adoption level of ATM (and POS) in the market. They are the dependent variables in the estimation.

As for the determinants of non-cash payment diffusions, there are several explanatory variables involved in the empirical framework: rival's precedence, network effects, and market concentration. The definitions of these variables are described as follows:

Rival's precedence

One period lag of other banks' adoption of ATM (and POS) is used to proxy the rival's precedence. Since the rival's adoption of a new innovation may affect the marketing strategies of its counterparts in the industry, a positive sign is expected. Log transformation is used to reduce heteroscedasticity concerns.

Network effects

We employ the product of (*card growth × own ATMs*) and (*card growth × own POSs*) to proxy the direct ATM and POS network effects. It reflects the bank's own non-cash payment infrastructure level. On the other hand, the product of (*own card growth × competitor's ATMs*) and (*own card growth × competitor's POSs*) are used to proxy the indirect ATM and POS network effects. It reflects other banks' infrastructural level. After the initial investment in non-cash payment infrastructure, the bank tends to take returns and slacken the efforts to improve the existing network. On the other hand, a better payment environment of the counterparts may force a bank to improve its own payment network. Therefore, we expect negative signs for the direct network variables and positive signs for indirect network variables respectively.

Market Concentration

We use the Hirfindahl-Hirschman Index (HHI) to proxy the market concentration in both ATM and POS markets. According to the industrial organization theory, the financial institutions with higher market share have more advantages to reduce the variable costs, and then promote the diffusion of an innovation. Hence, a concentrated market structure is beneficial for the diffusion. Therefore a positive sign for market concentration is expected.

Control variables:

Finally, we carefully select control variables so as to ensure the estimation is

robust to omitted variables. *Cards* is the total number of annual bank cards issued; *Merchants* is the total number of merchants-recruited which provide POS service to customers; *Branches* is the number of individual bank's branches; *Balance* is the volume of bank card balance. In addition, we use log transformation of variables to reduce heteroscedasticity. The growth of ATMs (or POSs) is the annual growth rate of ATM machines (and POS terminals) in the market. It reflects the infrastructure improvement of the non-cash payment network.

4.5 Results

4.5.1 The diffusion rates of ATM and POS transactions

The diffusion patterns of ATMs and POS in the Chinese market are shown in Table 3. Using both exponential and Gompertz curves, the ATM and POS diffusion rates are measured by the coefficient β . The results imply, in general, the POS terminals have shown a higher diffusion rate than that of ATM.³³ Compared with the ATM machine, a POS terminal needs a relatively lower installation and maintenance expense. Therefore, it is more accessible and easily accepted by acquiring banks and merchants. It also accounts for the higher growth rate of POS terminals than ATM machines, as shown in Figure

³³ The results of exponential and Gompertz curves are not consistent. The Gompertz model has more advantages in estimating the innovation adoption at different speed. It is more flexible than the linear-transformed logistic curve because it is asymmetric and allows for different curvatures in different phases.(Snellman et al. 2000) Therefore, we tend to accept the results using Gompertz curve.

1.³⁴ This result is also robust when a time trend is interacted with four other variables, which are rival precedence, own effects, indirect effects and market concentration (HHI). In addition, the interactive variables are found to have lower diffusion rates than the original time effect for both ATM and POS terminals during our research period.

China *UnionPay* is the nation's largest electronic payment network and bankcard association, with the obligation to expand and enhance the non-cash payments in China. The results of ATM and POS diffusion patterns after 2002, when *UnionPay* was established, are shown in Table 4. It is not surprising that, the diffusion rates of both ATM and POS transactions after 2002 became higher than the average level. This result is also consistent when the interactive variables are taken into account. By means of better infrastructure and countrywide switching network and service centers, *UnionPay* promotes the inter-regional and inter-bank usage of payment cards.³⁵ Meanwhile, a unified brand has improved the acceptance of both merchants and customers. Consequently, we argue that the foundation of *UnionPay* has promoted the adoption and diffusion level of non-cash payment instruments. Next, same as the previous evidence, POS has shown a higher diffusion rate than ATM machines. It is robust when the interactive variables of rival precedence and

³⁴ However, the adoption of POS payments is impeded by complex interchange fee mechanism. The actual utilization rate of POS is far lower than that of ATM machines. It also accounts for the higher transaction volume of ATM withdrawal than the consumption with POS, as shown in Figure 2.

³⁵ It aims at enabling the cardholders to withdraw cash from any bank's ATM machine in any city. Another objective of uniformed payment brand is to compete with foreign banks and card organizations under the WTO agreement. (Worthington 2003 & 2005)

indirect effects are considered. In addition, the gap of diffusion rate between the ATM and POS transaction values became smaller. It implies the growth pattern of ATM and POS seems to converge to each other. ATM machines increase faster than that of POS terminals after the establishment of *UnionPay* in 2002. The latter could be explained by the improvement of inter-regional and inter-bank withdrawal functions of the ATM network. On the other hand, the business quarrel for the interchange fee among merchants, card issuing and acquiring banks has impeded further diffusion of POS terminals.

4.5.2 The determinants of ATM and POS diffusions

Table 5 shows the determinants of ATM and POS diffusion rates. The bank-level β from Gompertz curve is employed as the dependent variable. The explanatory variables are also the mean values of each individual bank. Our results suggest that the diffusion rate of ATM is mainly driven by rival's adoption and the card payments' infrastructure. The rival's precedence has also promoted the adoption level of ATM machines. This result is consistent with the previous work on mature payment market. (Carbó-Valverde and Rodríguez-Fernández 2008) Next, the growths of both ATM and POS terminals have boosted the ATM diffusion rate. The improvement of the infrastructure situation is a significant factor to drive the adoption of ATM and POS in the growth stage of non-cash payment market. We find some interesting results

for the diffusion rate of POS terminals. The direct POS network has a positive and significant effect in the diffusion rate of POS terminals. However, the POS diffusion reacted negatively to the direct ATM network effect. The latter implies a strong substitution effect of ATM withdrawals on the POS payments. The card payment on POS terminals is still dominated by the cash payment in the Chinese market. On the other hand, the majority of payment cards in China are debit cards, rather than credit cards.³⁶ Worthington (2005) explained the higher growth rate of debit cards than credit cards on both supply and demand factors, and put this phenomenon down to the culture of saving and spending. In addition, the fast diffusion rate of debit cards is also attributed to the little risk for banks, since no credit is attached to the transaction. Customers prefer to pay with their account balance instead of a credit line.³⁷ Therefore, higher balance levels account for the significant effect of *balance* on the POS diffusion rate.

The Herfindahl–Hirschman Index exerted a positive impact on the POS diffusion. It suggests that the market concentration promotes the diffusion rate of POS terminals. This result is consistent with the view that a concentrated market can facilitate the diffusion of a new technology (Hannan and McDowell 1984). However, both ATM and POS markets in China have

³⁶ The People's bank of China has reported that, until the end of 2011, the accumulated number of credit card issuance is 285 million, which accounts for only 9.66 percent of total payment cards in Chinese market. The ratio of debit to credit card is 9.33:1.

³⁷ Worthington (2005) also points out that the informal channel of borrowing with low or even no interest is more accepted by Chinese consumers. The credit line is, however, not preferred by Chinese people.

experienced a change from concentrated to moderately concentrated markets between 1996 and 2005 (see Table 2), and the diffusion rate of POS is slowing down during this period. Carbó-Valverde and Rodríguez-Fernández (2008) use the Lerner Index to measure the market power. They find that the market power has negative effect on the ATM diffusion but a positive impact on the POS diffusion rate. They argue that the increasing margins of ATMs will increase the annual fees of cardholders, but it seems not true for POS transactions. This result is confirmed by the effect of recruited merchant as well. However, it is inconsistent with the traditional innovation theory which says that the acceptance of merchants and customers is the main drivers to promote the improvement of infrastructure during the expansion stage. This result could be explained by the interchange fee barrier, which is the major bottleneck for the diffusion of POS terminals in the Chinese payment market.³⁸ POS payments are not preferred by merchants because of their higher transactions costs. It also accounts for the negative impact of merchants on the diffusion of POS terminals.

4.6 Conclusions and policy implications

In this paper we study the diffusion patterns of non-cash payments in the

³⁸ Many recruited merchants in Shanghai, Guangzhou and other major cities have complained about the higher interchange fee of POS. Some merchants even stopped the POS payment service.

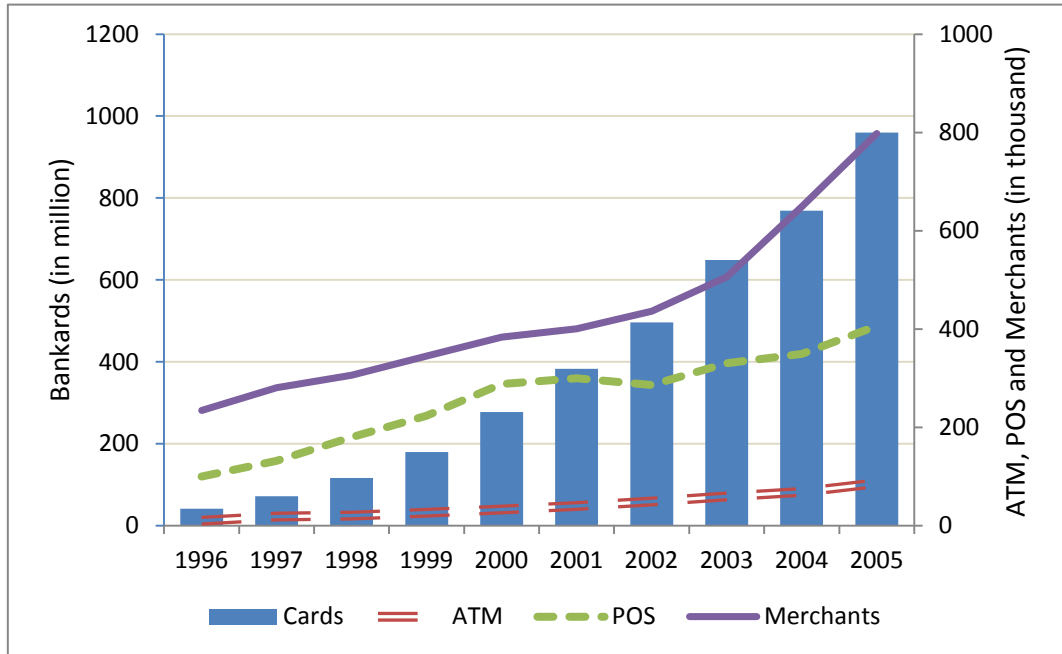
Chinese market. Based on both exponential and Gompertz curves, we find the POS terminals have shown a higher diffusion rate than that of ATMs. This result is also robust when a time trend is interacted with rival's precedence, own effects, indirect effects and market concentration. The diffusion rates of both ATM and POS transactions have accelerated after 2002, when China *UnionPay* was established. Therefore we argue that the establishment of China *UnionPay* has promoted the expansion of non-cash payments. The diffusion rate of ATM is mainly driven by the rival's adoption and the infrastructure situation. The market concentration, infrastructure development, direct network effects and balance promote the diffusion rate of POS terminals. We find a negative impact of direct ATM network on the POS diffusion. It implies a substitution effect of ATM withdrawals on POS payments. Interestingly, we document a negative impact of merchants-recruited, who provide POS transaction service, on the diffusion of POS terminals. It implies that, in spite of the increasing number of POS terminals, the diffusion rate of POS is somehow impeded by the interchange fee mechanism.

Our investigations have also policy implications which are twofold. The current problem of non-cash payment system in China is, first, the lagging development of credit cards rather than that of debit cards. The potential financial defaults of cardholders have impeded the adoption and diffusion of card payments. (Worthington et al. 2011) Then it is necessary to establish an

effective Personal Credit Management mechanism in order to generate a good screening tool and a safer payment environment for credit cards. Second, considering the high and the inelastic interchange fee, the merchants are reluctant to adopt the innovation of non-cash payments instruments. Hence, the regulator should formulate an efficient pricing mechanism to attract more merchants into the payment network. It contributes to the sustainable development of the whole non-cash payment industry.

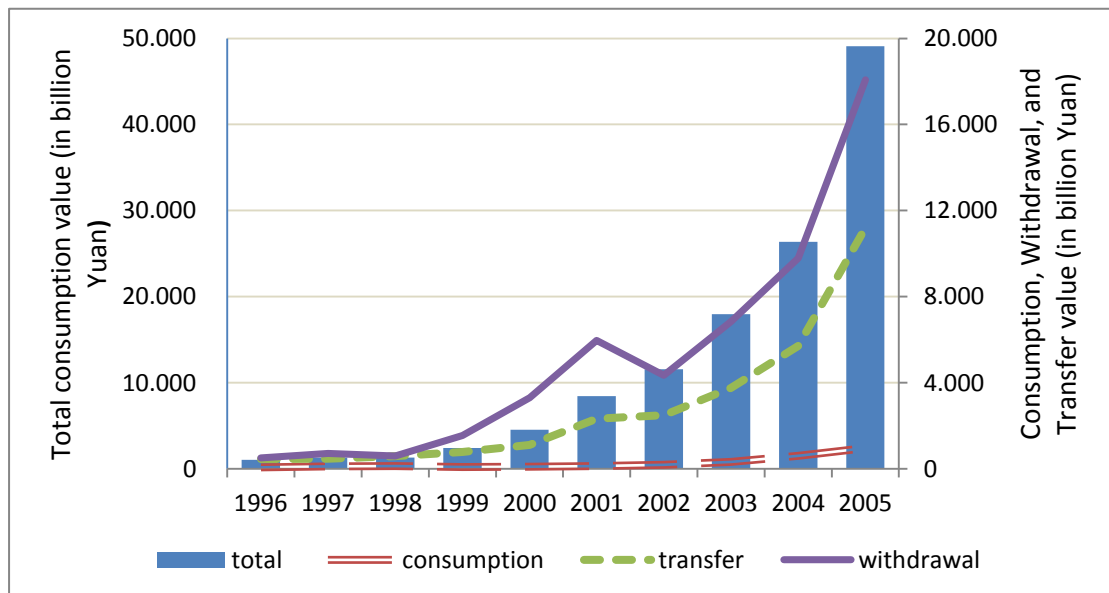
Appendix

Figure 1: The infrastructure situation of non-cash payments



Data source: Almanac of China's Finance and Banking.

Figure 2: The transaction value of non-cash payments



Data source: Almanac of China's Finance and Banking.

Table 1: Summary statistics of variables

Variable	Mean	Std. Dev	Min	Max
Cards (log)	13.68	2.44	3.33	19.20
Consumption (log)	9.93	3.07	1.10	16.97
Withdrawal (log)	13.25	2.75	0.69	20.47
Transfer (log)	11.97	3.79	1.44	19.95
ATM (log)	4.79	2.18	0.69	11.97
POS (log)	5.97	2.61	1.10	11.51
Merchants (log)	5.84	3.01	0.69	11.97
Balance (log)	11.85	2.39	0.69	17.80
Branches(log)	5.57	2.10	2.56	10.66

Table 2: Yearly Hirfindahl-Hirschman Indices (HHI) in both ATM and POS markets

Year	HHI	
	ATM	POS
1996	2817	2425
1997	2523	2802
1998	2123	2266
1999	1922	1851
2000	1811	1677
2001	1619	1416
2002	1454	1652
2003	1358	1602
2004	1280	1616
2005	1295	1674

Table 3: The diffusion pattern of ATM and POS terminals.

	Diffusion ATM		Diffusion POS	
	Logistic	Gompertz	Logistic	Gompertz
α	2.1445*** (18.14)	-0.3599 (-1.41)	3.8309*** (20.51)	0.3498 (0.38)
β (Time)	0.2987*** (19.70)	0.1232*** (3.84)	0.2553*** (10.58)	0.1857*** (4.32)
Number of Observations	433	276	370	180
α	3.1810*** (22.71)	-0.0437 (-0.15)	4.5513*** (16.35)	0.6600 (1.50)
β (Time * rival precedence)	0.0507*** (02.29)	0.0385*** (4.49)	0.0392*** (6.26)	0.0400*** (3.98)
Number of Observations	319	276	273	180
α	3.4662*** (64.54)	-0.7292*** (-3.99)	4.5810*** (33.63)	-0.1585 (-0.62)
β (Time * Own effect)	0.1186*** (26.21)	0.0499*** (3.37)	0.1176*** (11.82)	0.0664*** (3.72)
Number of Observations	331	276	289	180
α	2.4459*** (24.08)	-0.4999** (-2.28)	4.1115*** (24.90)	0.1298 (0.45)
β (Time * Indirect effects)	0.0313*** (20.05)	0.0126*** (3.84)	0.0261*** (10.32)	0.0187*** (4.24)
Number of Observations	433	276	370	180
α	1.0969*** (6.04)	0.1742*** (14.07)	3.8253*** (18.57)	0.3240 (0.90)
β (Time * HHI)	0.00031*** (18.49)	0.00014*** (3.72)	0.00016*** (9.59)	0.00011*** (3.93)
Number of Observations	433	276	370	180

Note: Panel-data approach with fixed effects is employed for estimation.

t statistics in parentheses * p<0.10, ** p<0.05, *** p<0.01.

Table 4: The diffusion pattern of ATM and POS terminals after the foundation of ChinaUnionPay(CUP) in 2002.

	Diffusion ATM		Diffusion POS	
	Logistic	Gompertz	Logistic	Gompertz
α	1.4422*** (5.43)	1.0164*** (1.15)	3.2637*** (6.53)	1.6402 (1.42)
β (Time)	0.3071*** (10.41)	0.2585** (2.62)	0.2248*** (4.08)	0.2992** (2.34)
Number of Observations	263	191	221	116
α	2.8261*** (17.02)	0.0719 (0.14)	4.5660*** (10.98)	1.1357 (1.19)
β (Time * rival precedence)	0.0440*** (9.31)	0.0393*** (2.68)	0.0219** (2.48)	0.0469** (2.30)
Number of Observations	227	191	184	116
α	2.3485*** (25.00)	-0.7672 (-1.36)	2.8497*** (13.66)	-0.2611 (-0.35)
β (Time * Own effect)	0.1592*** (20.96)	0.0407 (0.95)	0.1783*** (12.54)	0.0515 (1.09)
Number of Observations	238	191	198	116
α	1.5635*** (6.40)	0.9699 (1.19)	3.5341*** (7.93)	1.3737*** (53.63)
β (Time * Indirect effects)	0.0347*** (10.81)	0.0301*** (2.76)	0.0228*** (3.97)	0.0315** (2.37)
Number of Observations	263	191	221	116
α	0.9301*** (2.70)	1.0877 (0.97)	3.6031*** (8.66)	1.0711 (1.11)
β (Time * HHI)	0.00028*** (9.51)	0.00020** (2.13)	0.00011*** (4.09)	0.000144** (2.22)
Number of Observations	263	191	221	116

Note: Panel-data approach with fixed effects is employed for estimation.

t statistics in parentheses * p<0.10, ** p<0.05, *** p<0.01.

Table 5: The determinants of the ATM and POS diffusions.

	<i>Beta_ATM</i>	<i>Beta_POS</i>
Rival's ATM adoption _{t-1}	2.111** (2.03)	- -
Rival's POS adoption _{t-1}	- -	0.0394 (0.04)
HHI ATM network	0.00024 (0.08)	-
HHI POS network	- -	0.0059* (1.84)
Log[card growth* own ATMs]	-0.192 (-1.21)	-0.322** (-1.85)
Log[card growth* own POSs]	-0.432 (-0.72)	1.920** (2.36)
Log[Own card* Competitor's ATMs]	0.002 (1.65)	0.0021 (0.79)
Log[Own card* Competitor's POSs]	8.91E-5 (0.12)	-3.36E-5 (0.21)
Growth of ATMs	1.882*** (3.34)	1.636** (2.74)
Growth of POSs	0.822* (1.99)	0.189 (0.38)
Balance	0.117 (0.97)	0.271* (1.96)
Branches	0.086 (0.60)	- -
Merchants		-0.341** (-2.19)
<i>Constant</i>	-18.74*** (-3.53)	-11.91* (-1.74)
<i>N</i>	52	42
F-test	3.38***	1.86*
<i>R-sq</i>	0.45	0.37

Note: The Beta is estimated for each individual bank in the sample. All explanatory variables are the mean values of each individual bank as well. The *t*-statistic in parentheses * p<0.10, ** p<0.05, *** p<0.01

References

Antonides, G.; H. B. Amesz and I. C. Hulscher (1999) "Adoption of payment systems in ten countries – a case study of diffusion of innovations", *European Journal of Marketing*, Vol. 33, pp.1123 – 1135.

Blackman, A. W., Jr. (1971) "The Rate of Innovation in the Commercial Aircraft Jet Engine Market", *Technological Forecasting and Social Change*, Vol. 2, pp. 269-276.

----- (1972) "A Mathematical Model for Trend Forecasts" *Technological Forecasting and Social Change*, Vol. 3, pp. 441-452.

Carbó-Valverde, S. and F., Rodríguez-Fernández (2008) "ATMs vs. POS Terminals: A Horse Race?", *21st Australasian Finance and Banking Conference 2008 Paper*.

Dargay, J. and D. Gately (1997) "Vehicle ownership to 2015: Implications for energy use and emissions", *Energy Policy*, Volume 25, pp. 1121-1127.

Franses, P. H. (1994) "Fitting a Gompertz curve", *Journal of the Operational Research Society*, Vol. 45, pp. 109-113

Guthrie, G. and J. Wright (2007): Competing Payment Schemes, *The Journal of Industrial Economics*, Vol. 55, pp. 37-67.

Hannan, T. H. and J. M. McDowell (1984) "Market Concentration and the Diffusion of New Technology in the Banking Industry", *The Review of Economics and Statistics*, Vol. 66, pp. 686-691.

Humphrey, D.; M. Willeson; T. Lindblomand; G. Bergendahl (2003) "What does it Cost to Make a Payment", *Review of Network Economics*, Vol.2, pp. 159-174.

Mansfield, E. (1968) "Technological Change and the Rate of Imitation", *Econometrica* Vol. 29, pp. 741-766.

Markose, S. M., and Y. J. Loke (2003) "Network Effects on Cash-Card Substitution in Transactions and Low Interest Rate Regimes", *The Economic Journal*, Vol. 113, pp. 456-476.

Masters, A. and L. R. Rodríguez-Reyes (2005) "Endogenous credit-card acceptance in a model of precautionary demand for money", *Oxford Economic Papers*, Vol. 57, pp. 157-168.

Meade N. and T. Islam (1995) "Forecasting with growth curves: An empirical comparison", *International Journal of Forecasting*, Vol. 11, pp. 199-215.

Migon, H. S. and Gamerman, D. (1993) "Generalized exponential growth models a bayesian approach", *Journal of Forecasting*, Vol.12, pp.573–584.

Qi, M. and S. Yang (2003): Forecasting consumer credit card adoption: what can we learn about the utility function? *International Journal of Forecasting*, Vol. 19, pp. 71 – 85.

Rochet, J-C. and J. Tirole (2002): Cooperation among Competitors: Some Economics of Payment Card Associations, *The RAND Journal of Economics*, Vol. 33, pp. 549-570

----- (2006): Externalities and Regulation in Card Payment Systems, *Review of Network Economics*. Vol. 5, pp. 1-14.

Scholnick, B.; N. Massoud; A. Saunders; S. Carbo-Valverde; F. Rodríguez-Fernández (2008) "The economics of credit cards, debit cards and ATMs: A survey and some new evidence", *Journal of Banking & Finance*, Vol. 32(8), pp. 1468-1483.

Shy, O. and J. Tarkka (2002) "The Market for Electronic Cash Cards", *Journal of Money, Credit and Banking*, Vol. 34, pp. 299-314.

Scherer, F. M. (1984) "Innovation and growth: Schumpeterian perspectives." Cambridge, MA: MIT Press.

Snellman J.; V. Jukka; D. Humphrey (2000) "Substitution of noncash payment instruments for cash in Europe", *Journal of Financial Services Research*, Vol. 19, pp. 131-145.

Snellman J., H. and M. Virén (2009) "ATM networks and cash usage", *Applied Financial Economics*, Vol. 19, pp. 841-851.

Wright, J. (2003): Optimal card payment systems, *European Economic Review*, Vol. 47, pp. 587-612.

Wright, J. (2004): The Determinants of Optimal Interchange Fees in Payment Systems, *The Journal of Industrial Economics*, Vol. 52, pp. 1-26.

World payment report 2011, Capgemini, the Royal Bank of Scotland, and European Financial Management Association (EFMA).

Worthington, S. (2003) "The Chinese payment card market: an exploratory study", *International Journal of Bank Marketing*, Vol. 21, pp.324 – 334.

----- (2005) "Entering the market for financial services in transitional economies: A case study of credit cards in China", *International Journal of Bank Marketing*, Vol. 23, pp.381 – 396.

Worthington, S.; D. Stewart, X. Lu (2007) "The adoption and usage of credit cards by urban-affluent consumers in China", *International Journal of Bank Marketing*, Vol. 25, pp. 238 – 252.

Worthington, S.; F. M. Thompson; D. B. Stewart (2011) "Credit cards in a Chinese cultural context—The young, affluent Chinese as early adopters", *Journal of Retailing and Consumer Services*, Vol. 18, pp. 534-541.

Chapter 5: Conclusions

Chapter 5: Conclusions

This thesis aims at shedding light on the great changes that have taken place in the Chinese banking, property and non-cash payment markets during the past two decades. In Chapter 2 we find a reverse causality relationship between housing prices and mortgage credit using Granger tests and a Two-Stage Least Squared/Instrumental Variable approach. The urbanization process is proved to have positive impact on the growth of mortgage lending. In terms of monetary policy, we find negative effects of the required reserves on the change of mortgage credit and the interest rate on property prices, but not the opposite.

In Chapter 3, we examine to what extent the financial deregulation and foreign bank presence can affect banks' profitability. The results reveal that banking liberalization brought about higher competition and narrowed the net interest margin. Credit risk is found to be the major factor in enhancing the profitability of the Chinese domestic banks. The foreign bank presence forced domestic banks to be more competitive and therefore reduce banks' net interest margins.

In Chapter 4, we investigate the diffusion pattern of non-cash payments in China. Based on both exponential and Gompertz curves, we find that the POS

terminals have achieved a higher diffusion rate than that of ATMs. The diffusion rate of ATM was mainly driven by rival's adoption and the situation of the payment infrastructure. Market concentration, infrastructure development, direct network effects and balance promote the diffusion rate of POS terminals. Finally, we find that the establishment of China *UnionPay* (CUP) has promoted the expansion of non-cash payments.

All the above mentioned findings provide a comprehensive understanding of the Chinese banking system under the circumstances of the financial reforms in China.

Capítulo 5: Conclusiones

Esta tesis doctoral trata de arrojar luz sobre los grandes cambios que han tenido lugar en los mercados bancarios chinos, los mercados de propiedad y los mercados de pagos no basados en el efectivo durante las dos últimas décadas. En el capítulo 2 se descubre una relación de causalidad inversa entre el precio de la vivienda y el crédito hipotecario utilizando el contraste de Granger y el enfoque de mínimos cuadrados bietápicos con variables instrumentales. Se ha probado que el proceso de urbanización ha tenido un impacto positivo sobre el crecimiento del crédito hipotecario. En términos de política monetaria, se descubren los efectos negativos de las reservas obligatorias sobre la variación en el crédito hipotecario y el tipo de interés sobre los precios de la propiedad, aunque no en sentido inverso.

En el capítulo 3, se examina la extensión de hasta donde puede afectar la desregulación financiera y la presencia de bancos extranjeros sobre la rentabilidad de los bancos. Los resultados demuestran que la liberalización bancaria ha traído consigo una mayor competencia y ha ampliado el margen de intermediación. Se ha descubierto que el riesgo de crédito es el principal factor que incrementa la rentabilidad de los bancos nacionales chinos. La presencia de bancos extranjeros ha presionado a los bancos nacionales a ser más competitivos y, por tanto, a reducir el margen de intermediación del

banco.

En el capítulo 4, se investiga el patrón de difusión de los pagos no basados en el efectivo en China. Basado tanto en la curva exponencial como en la curva de Gomperts, se descubre que las terminales de punto de venta han mostrado una mayor tasa de difusión que la de los cajeros automáticos. La tasa de difusión de los cajeros automáticos ha sido conducida principalmente por adopción del rival y la situación de la infraestructura de pagos. La concentración del mercado, el desarrollo de infraestructuras, los efectos directos de red y el balance impulsan la tasa de difusión de los terminales de punto de venta. Finalmente, se descubre que el establecimiento de la ChinaUnionPay (CUP) ha promovido la expansión de los pagos no basados en el efectivo. Todos estos descubrimientos presentados anteriormente proveen un entendimiento comprensivo del sistema bancario de China bajo las circunstancias de la reforma financiera en China.