Shadow Banking: China's Dual-Track Interest Rate Liberalization

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Shadow banking in China is mainly conducted by commercial banks to evade regulatory restrictions on deposit rate and loan quantity. It essentially constitutes a dual-track pragmatic approach to gradually liberalize the country's repressed interest rate policy. We show in equilibrium that shadow banking improves social surplus given high deposit reserve requirement and inefficient bond market. Full interest rate liberalization leads to additional gain in social surplus. The dual-track approach to interest rate liberalization avoids the potential economic turbulence caused by an otherwise single-track one-step approach.

JEL Classification: E42, E43, E51, G18, G21, G28.
Keywords: Shadow banking, dual-track system, China financial reform, interest rate liberalization, PBoC.

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Abstract

Shadow banking in China is mainly conducted by commercial banks to evade regulatory restrictions on deposit rate and loan quantity. It essentially constitutes a dual-track pragmatic approach to gradually liberalize the country's repressed interest rate policy. We show in equilibrium that shadow banking improves social surplus given high deposit reserve requirement and inefficient bond market. Full interest rate liberalization leads to additional gain in social surplus. The dual-track approach to interest rate liberalization avoids the potential economic turbulence caused by an otherwise single-track one-step approach.

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1 Introduction

Interest rate, as the price of capital, is perhaps the last fundamental price still controlled by government in China, while the prices of most goods and services have been gradually liberalized since the economic reform started in 1979. People's Bank of China (PBoC) imposes binding deposit rate ceiling and loan quota limit on commercial bank credit, which is the dominant financing channel in China. These restrictions, together with inefficient direct equity financing, has lead to imbalance and distortion in the real economy and fostered a rapid growth of shadow banking in recent years (Lin and Zhou, 1993; Zhou, 2009; Wu, 2014).[1]

This paper demonstrates that shadow banking essentially constitutes a dual-track approach to interest rate liberalization in China. Shadow banking in China is primarily carried out by commercial banks and with the tacit endorsement from the government. We develop an equilibrium model to examine the nature of shadow banking in China, its implications for social surplus and financial markets, and its role to facilitate the full interest rate liberalization in the future.

The notion of dual-track interest rate liberalization begins with a plan track—a controlled commercial bank credit track, where the deposit rate and loan quantity are artificially set below their market equilibrium levels (He and Wang, 2012). Then a market track of shadow banking is introduced to allow economic agents to have funding demand and supply determined at market interest rates. The market track typically involves off-balance sheet wealth management products (WMPs) offered by banks to households and trust loans made by banks to firms.

The main advantage of the dual-track approach to interest rate liberalization is that it does not require dismantling and restructuring of existing institutions under the old plan track—commercial bank credit system, which dominates China's social financing and is

[1]The economic structural imbalance and distortions include over-investment, policy-driven business cycle, inefficient state enterprise sector, and high inflation. We present in detail the formation of the rigid interest rate policy, and the problems caused by the policy in Section 2.1.2.

critical for economic growth and financial stability. A "single-track" one-step approach to interest rate liberalization could create efficiency gain but cannot guarantee Pareto improvement—ensure welfare improvement to all agents in the society. In particular, it may create unpredictable systemic risks that endanger financial stability. Shadow banking, as a reform experiment at an early stage, can have least opposition ex ante and minimize the likelihood of reversal ex post.[2] Our main findings are as follows.

First, in the presence of repressive deposit rate ceiling and binding bank loan quota, shadow banking—conducted mainly by commercial banks to evade these regulations—increases household investment return and bank operating profit and provides more financing to the private sector by effectively reducing deposit reserves. Therefore, shadow banking tends to increase social surplus in China. Such a positive impact is more prominent in the presence of high reserve requirement ratio (RRR).

Second, the effects of shadow banking on social surplus depends on bond market efficiency—it is only positive when bond market inefficiency is above a certain threshold. In the presence of a highly efficient bond market, shadow banking can lead to surplus loss—the marginal benefit of diversification falls short of the marginal cost associated with shadow banking. This finding highlights a fundamental difference between shadow banking in a developed country with efficient financial system such as U.S. and shadow banking in a developing country with inefficient financial system such as China.

Furthermore, shadow banking helps to correct the capital mis-pricing and mis-allocation problems caused by interest rate repression and bank credit restriction in China. In particular, inefficient state-owned enterprises (SOEs) enjoy easy access to cheap but scarce bank credit, while more efficient private enterprises struggle for financing (Song, Storesletten, and Zilibotti, 2011). Shadow banking provides private enterprises with urgently needed capital. Higher financing cost associated with shadow banking function as an effective

[2]China has carried out a series of economic reforms since 1979. These reforms largely followed a dual-track approach, which involves introducing a market track in addition to a preexisting plan track to liberalize the market. See Sicular (1988), Byrd (1991), Lin (1992), Lau, Qian, and Roland (2000), Sun and Tong (2003) for discussions on China's dual-track reforms in the agricultural and industrial sectors.

screening mechanism for private enterprises with high productivity.

Finaly, full interest rate liberalization leads to additional gain in social surplus, while Interest rates in general tend to increase. The direction and magnitude of the changes in individual interest rates depend on individual market conditions and interactions. A remarkable advantage of the dual-track interest rate liberalization is that, it allows the repressed bank deposit rate, which anchors the interest rates of all other markets, to gradually converge to its equilibrium market level. Hence significantly reduces the shocks of the reform to the real economy.

This paper is the first one to examine the implications of shadow banking from the perspective of economic reform. Our paper shares the same spirit as Lin (1992) and Lau, Qian, and Roland (2000), who study dual-track reform in agricultural and industrial sectors in China. Gennaioli, Shleifer, and Vishny (2012, 2013) demonstrate that shadow banking improves welfare but is subject to crisis and liquidity dry-ups as banks are more exposed to systemic risks through investment diversification. Our study provides insights on how shadow banking facilitates a transitioning financial system to liberalize its rigid interest rate policy in a practical dual-track approach.

Funke, Mihaylovski, and Zhu (2015) study the interactions among nonstandard monetary policy, the traditional banking sector, and the shadow banking sector in China with a dynamic stochastic general equilibrium (DSGE) model. Dang, Wang, and Yao (2014) develop a behavioral model to show that investors' mis-perception on shadow banking product recovery guarantee incentives "bank-centric" shadow banking in China. Hachem and Song (2015) argue that asymmetric competition within the commercial banking sector gives the rise to shadow banking in China. This paper emphasizes the implications of shadow banking as a practical reform mechanism on social welfare and financial system. The findings are not country-specific and can be applied to other transitioning economies.

The rest of the paper is organized as follows: Section 2 reviews China's interest rate policy, commercial banking sector, and rise of shadow banking. Section 3 introduces the theoretical models. Section 4 analyzes the implications of shadow banking. Section 5

discusses full interest rate liberalization. Section 6 concludes.

2 Institutional Background

This section reviews China's interest rate policy, banking sector, and rise of shadow banking, which are critical for understanding the necessity and practicality of the dual-track approach to interest rate liberalization. Special attention is given to the comparison between shadow banking in China and those in developed economies.

2.1 China's Interest Rate Policy

Interest rates have long been rigidly controlled in China until very recently. Since the banking sector plays a dominant role in the country's financial system, the interest rate control is primarily exercised through the banking regulations, such as deposit rate ceiling, loan quota, and high deposit reserve requirement.

2.1.1 The Formation of the Interest Rate Policy

In China, interest rates have been repressed below the equilibrium levels determined by demand and supply, since the country adopted a planned economy in the 1950s. This interest rate policy was adopted in accordance with China's early economic growth strategy to prioritize the development of the heavy industry (Lin, 1990).[3]

The heavy industry is capital-intensive, yet capital is the scarcest resource in China during the early stage of economic development. It is much more expensive than labor and land. China adopted planned interest rate policy to artificially reduce the relative price of capital. Exchange rates were also repressed, so the heavy industry could import

[3]Reasons for prioritizing the development of the heavy industry are several-folded: (1) China needed to quickly establish a nation-wide defense system for geopolitical considerations after 1949; (2) China's impoverished agricultural economy at the time was unable to provide necessary market conditions for the debut of economic growth; (3) the heavy industry could consume its own outputs and be self-sustained during the initial stage of development. This strategy was also adopted by the former Soviet Union, India, and Eastern European and Latin American countries during the early stage of economic development.

technology and equipment at low cost. Low wage and low raw material price policies were carried out to enable the heavy industry to generate high profit margin and high accumulation rate. Enterprises were nationalized to ensure that profits will be re-invested in the heavy industry as planned. The repressed interest rate, income and material prices inevitably led to resource scarcity and shortage. To solve the problem, a highly centralized planned economy framework was established to secure resource allocation to the heavy industry in priority. A state-controlled purchase and sale system of the agricultural products provided urban citizens with living necessities at the minimum level.

China established a heavy industry system within a short period of time and achieved high-speed economic growth during 1949-1956. However, the strategy of prioritizing heavy industry could not be sustained in the long run. The resources of surplus to support the heavy industry growth were gradually exhausted, since the agriculture and consumer industries experienced almost no growth during the same period of time. On the other hand, the excessive output of the heavy industry could not be consumed by the repressed consumer and agriculture industries.

Economic reforms became inevitable. Since 1979, China has gradually shifted the development strategy from prioritizing heavy industry to exploiting comparative advantage. In particular, state-controlled purchase and sale system of agricultural products was demolished (Lin, 1992). Almost all agricultural products and raw materials are market-priced today. Some SOEs were partially privatized and went public to raise capital (Sun and Tong, 2003). The Split-share Structure Reform granted legitimate trading right to the state-owned shares in the secondary markets, laying down foundation for further privatization (Liao, Liu, and Wang, 2014). Private enterprises in various industries sprout and grew. Rigid official exchange rates were replaced by adjustable bands guided by the PBoC, which fluctuate in greater range over time. Wage also became market-based. However, interest rates, as the price of capital, remain artificially determined and under close regulatory control.

2.1.2 Problems Caused by the Interest Rate Policy

The repressed interest rates underlie structural imbalances and distortions in China's economy. The artificially low interest rates directly lead to excessive investment incentive and capital-intensive technology choice. So capital demand always exceeds capital supply. Interest rates affect the intertemporal elasticity of substitution. In particular, the market-based interest rates will make aggregate demand—investment and consumption—fluctuate in a relatively smooth manner. However, when the interest rates are fixed below the equilibrium levels, the self-adjustment and self-stabilization mechanism of investment and consumption stop functioning, resulting in excessively volatile aggregate demand.

The artificially low real interest rates lead to policy-driven economic cycles in China (Lin and Zhou, 1993). A boom almost always starts with simultaneous increases in investment and consumption, when the government looses control over some administrative policies in approving the capital spending projects. The PBoC expands bank credit to meet the rapidly rising capital demand accordingly. The economy first grows rapidly for two or three years, and then enters into a chaotic regime. Both investment and consumption grow irrationally, primarily fueled by low interest rates and and oversupplied bank credit. Inflation soars as demand for resources, goods, and services, far exceed the limited supply.

The low interest rates lead to expectation of high and volatile inflation (Dang, Wang, and Yao, 2014). High inflation expectation and economic overheating tend to reinforce each other in a spiral way. To tame inflation, the government first impose control on agricultural product prices, partially through subsidies to avoid over-repressing the sector. In the meantime, to prevent the economy from being overheated into a maniac regime, which endangers social and economic stability, the government policies are reverted to tighten administrative control over capital investment projects. To facilitate these policies, bank credit supply is dramatically reduced. Both investment and consumption quickly recede, and the economy may take a hard-landing. However, the government's fiscal

budget cannot be balanced when the economic growth is below a certain threshold. Under the pressure of budget constraint, the government starts softening policy restrictions. A new round of policy-driven business cycle begins.

2.2 Banking Sector in China

In the era of planned economy, The PBoC assumed the roles of both central bank and commercial bank to apply the "centralized deposits and credits" method to allocate capital according to economic plans. In 1984, the PBoC began to function exclusively as a central bank. Several large state-owned commercial banks were created to facilitate the PBoC's monetary and financial stability policies. Commercial banks dominate China's financial system.[4]

China has been trying to establish a market-oriented financial system recently, but the banking sector is still tightly controlled by the government. The deposit rate ceiling remains binding, after the non-binding lending rate floor was removed in July 2013. The state effectively controls the loan quantity and lending behaviors of banks through regulations, majority ownership, appointment and dismissal of bank executives, and window guidance.

The lack of fundamental reforms in the banking sector essentially comes from the concern that such reforms may collapse China's financial system, and thus endanger the country's economic and social stability. In particular, (1) since the commercial banks are so used to high profit margin due to repressed deposit rate and under-supplied credit, they have no incentive to reform (Hachem and Song, 2015). As a result, they are not equipped with modern risk management knowledge and techniques and lack of self-discipline in conducting business; (2) borrowers, particularly the SOEs, enjoy stable and cheap bank loans and are lack of the consciousness and knowledge of operating in interest-sensitive environment; (3) in the absence of smoothly-functioned bond markets, monetary policy is more

[4]Deposits mostly flow into large- and medium-sized commercial banks, because there are few alternative investment channels in the presence of underdeveloped bond and equity markets, and closed capital account. Bond financing is also substantially skewed towards commercial banks.

effective through interest rate control, rather than through a market mechanism (Zhou, 2009). These dilemmas highlight the critical importance of formulating pragmatic reform mechanism in liberalizing the rigid interest rate policy and restructuring the inefficient financial system in China.

Table 1 reports the aggregate financing in the whole society in China between 2002 and 2013. It shows that the size of yuan-denominated loans were 8,892 billion yuan in 2013, constituting 51.3% of the aggregate financing in China. The banking sector plays a dominant role in financing in China today, although its relative importance has been decreasing over the past decade.

2.3 Shadow Banking in China

This section introduces shadow banking in China. We discuss the driving forces behind rapid growth of shadow banking and why shadow banking constitutes a market track to provide credit within the dual-track interest rate liberalization framework.

2.3.1 Rise of Shadow Banking

In China, shadow banking started to emerge around 2006 and experienced explosive growth after the 2007-2009 global financial crisis. A major difference between shadow banking in China and in the developed economies, such as the U.S., is that shadow banking in China is primarily carried out by commercial banks, rather than by the nonbank financial institutions. In other words, the Chinese commercial banks assume double roles in both traditional banking and shadow banking.

Similar to what happened in the U.S. in the early 1980s, shadow banking arose in China mainly to evade regulations in the banking sector.[5] However, the Chinese shadow banking emerged to evade explicit controls imposed on deposit rate and bank loan quan-

[5]See, for example, Adrian and Ashycraft (2012) and Gorton and Metrick (2012) for reviews on shadow banking in the U.S. According to Adrian and Ashycraft (2012), there are three intertwined rationales for the existence of shadow banking in the U.S.: (1) innovation in the composition of aggregate money supply; (2) capital, tax, and accounting arbitrage; and (3) agency problems in financial markets.

tity. On the asset side of shadow banking, the banks make trust loans and entrusted loans to circumvent restrictive loan quota imposed by the central bank; on the liability side, the banks develop wealth management products (WMPs) to raise funds from the households bypassing the deposit rate ceiling. Shadow banking-related financial products are also free of multiple macro-prudential regulations on the banking sector, such as deposit reserve requirement, loan-to-deposit ratio, and capital adequacy requirement. Consequently, shadow banking effectively reduces the banks' funding costs and improves their competitiveness.

One may wonder why the Chinese shadow banking is "bank-centric". The Chinese banks have two advantages over the other types of financial institutions. First, the banks are dominant in terms of accessing individual and institutional savings, due to the historical reason that state owned commercial banks are the only allowed deposit institutions. Second, bank deposit receives implicit credit and liquidity guarantee from the state. The scope of the guarantee, however, is vague, leading to a deep-rooted perception that the government will bail out the entire bank in case of financial distress (Dang, Wang, and Yao, 2014).[6] The banks can take advantage of such perception to raise WMPs at low cost. The banks may also enhance the credit quality of WMPs with explicit or implicit guarantee for the full recovery of their principles.

Another natural question is why shadow banking in China only took off in recent years, while these banking controls have been in existence since the birth of the banking industry in the 1980s. The reasons are several-folded. On the bank side, about 100 small and regional banks were established by the end of 2001. The asymmetric competition among large and small banks provided initial incentives for small banks to engage in shadow banking activities and follow-up of large banks (Hachem and Song, 2015). Moreover, the PBoC tripled deposit reserve requirement ratio (RRR) from 7% in 2004 to 21% in 2011, which induced the commercial banks to engage in off-balance sheet financing to bypass the high RRR as a tax.

[6]On May 1, 2015, China announced establishing deposit insurance mechanism and official guarantee of bank deposit up to 500 thousand yuan per account, in preparation for full interest rate liberalization.

Shadow banking in China was also triggered by the global financial crisis. The Chinese government launched a 4-trillion-yuan stimulus package through the commercial banks to avoid potential economic recession in 2008. Two years later, the monetary policy was switched from expansionary to tightening to crack down inflation. The banks dramatically reduced the amount of credit, which is usually rolled over on annual basis, for many government sponsored long-term projects and follow-up investments. To resolve the financing problem of these projects, the government implicitly endorsed shadow banking.

2.3.2 Shadow Banking Products in China

The practice of shadow banking in China involves different financial products compared to its counterparts in the developed economies.[7] The Chinese shadow banking model primarily involves commercial banks "raising capital through WMPs" and subsequently "making entrusted loans or trust loans". Indeed, many trust assets were invested in loans made to finance the government-sponsored infrastructure, real estate, and mining projects (Wu, 2014). Hence, trust loan belongs to shadow banking products based on its practice in China. As of 2013, the trust sector reported total assets of 10.03 trillion yuan, constituting the most prominent driver of shadow banking expansion in China.

Dealer-intermediated finance involves the financial institutions outside the commercial banking sector, including credit intermediation of unlicensed financial conduits, such as on-line finance firms, third-party wealth management entities, micro loans firms, and finance guarantee agencies. In China, few asset management programs of mutual funds and securities companies invest in loans. Moreover, secularization and non-bank shadow banking are of much smaller scale than bank-initiated shadow banking in China.

Table 1 shows that the size of entrusted loans (trust loans) increased from 270 (83) billion yuan in 2006 to 2,547 (1,840) billion yuan in 2013, constituting 6.3% and 1.9% of

[7]For example, Adrian and Ashycraft (2012) and Adrian, Covitz, and Liang (2013) summarize the typical shadow banking activities, institutions, and vehicles in the U.S. The primary instruments include wholesale short term funding that includes asset-backed commercial papers, tri-party repurchase agreements, and money market funds; securitization and new financial products that include various types of asset-backed securities; and dealer-intermediated finance.

the aggregate financing in the economy in 2006, respectively. Their weights rose to 14.7% and 10.6%, respectively, in 2013. In contrast, the sizes of corporate debt and equity were 1,811 and 222 billion yuan in 2013, respectively. Undiscounted bankers' acceptances increased from 2 billion yuan in 2006 to a peak of 2,335 billion yuan in 2010, and then reduced to 776 billion yuan in 2013, because the PBoC cracked down on shadow banking activities that are regarded as especially dangerous over time. In contrast, the ratio of domestic loans to the aggregate financing in the economy fell continuously from 91.9% in 2002 to 51.3% in 2013.

3 Theoretical Analysis

This section develops a parsimonious equilibrium model to investigate whether shadow banking leads to gain in social surplus and the relation between shadow banking and full interest rate liberalization. As illustrated in Figure 1, we develop the model in three scenarios: Model 1 describes a benchmark economy with regulated commercial banking sector in the absence of shadow banking; Model 2 introduces shadow banking to the economy described in Model 1; Model 3 considers an economy with shadow banking after full interest rate liberalization, which demolishes deposit rate ceiling and bank loan quota. We present in detail the models below.

3.1 Model 1: In the Absence of Shadow Banking

Model 1 describes the situations of the Chinese financial system before the rise of shadow banking (1996-2006). This simple benchmark model has four agents: a central bank, a representative commercial bank, a representative household, a representative firm; and four markets: bank deposit market, bank loan market, bond market, and interbank money market. In the model, the household maximizes investment returns through optimal saving allocation between bank deposit and investment in corporate bond. The bank acquires capital through deposit from the household and through liquidity provided by

the central bank. The bank makes loan to the firm or purchases corporate bond issued by the firm. Under the assumption that the firm utilizes capital efficiently, the firm's objective is reduced to minimize funding cost by optimally choosing financing through bank loan or corporate bond.

The role of the central bank is to determine the amount of liquidity provided to the interbank money market for a given policy rate target. The banking sector is restrictively regulated with deposit rate ceiling and bank loan quota, reflecting the nature of rigid interest rate policy in China before 2006.[8] We introduce the objective functions of the representative bank, firm, and household, respectively, followed by deriving market equilibrium conditions.

3.1.1 Bank's Function

We presume that the commercial banking sector is competitive.[9] The bank takes deposit from the household and borrows central bank fund from money market to raise capital. It makes loan to the firm in the loan market, and purchases corporate bond issued by the firm in the bond market. Part of the bank's assets are reserved in the central bank to satisfy deposit reserve requirement. Subject to balance sheet constrain, the bank maximizes the following objective function:

$$\Pi_b = \max_{L,B_b,D} \{r_l L + r_r \alpha D + r_b B_b - r_d D - r_p CBF - C(L,D)\} \tag{1}$$

$$s.t. \quad L + B_b \leq CBF + (1-\alpha)D,$$

where r_l denotes the bank loan rate, and D denotes the size of deposit; r_r denotes the deposit reserve rate, and α denotes the deposit reserve requirement ratio set by the central bank; r_b denotes the bond interest rate and B_b denotes the size of corporate bond issued to

[8] There were loan interest rate floors imposed by the central bank before 2006, but in most times those floors were not binding.

[9] This assumption is in line with the actual situation of the commercial banking sector in China. There are five large national banks and several hundred regional banks in China. Within these large banks, the performance of each provincial branch is evaluated on individual basis. In the presence of close monitoring, the commercial banks cannot manipulate credit prices in China.

the bank; r_d denotes the deposit rate; r_p denotes the policy interest rate, or alternatively, a short-term interest rate in the interbank money market; CBF denotes the size of liquidity in the money market provided by the central bank. The central bank employs r_p and CBF as monetary policy instruments, which is consistent with the practice of open market operation in China.

The last term $C(L, D)$ represents the bank's operating cost in the loan and deposit markets. Because we need the cost function $C(L, D)$ to be strictly convex and twice continuously differentiable, the following cost function form is assigned to simplify the discussion below:[10]

$$C(L, D) = \frac{1}{2}(\delta_L L^2 + \delta_D D^2), \tag{2}$$

where δ_L and δ_D denote the marginal costs of engaging in the loan and deposit markets, respectively. Solving the first-order conditions of commercial banks (see the Appendix for detailed mathematical derivation), we have the supply function of bank loan as

$$L^s = \frac{r_l - r_b}{\delta_L};^{11} \tag{3}$$

and the banks' demand function of deposit as

$$D^d = \frac{\alpha r_r + (1-\alpha) r_b - r_d}{\delta_D}. \tag{4}$$

Based on the balance sheet constraint, the banks' demand of bond is

$$\begin{aligned} B_b^d =& CBF + (1-\alpha)D - L \\ =& CBF + \frac{(1-\alpha)\left[\alpha r_r + (1-\alpha) r_b - r_d\right]}{\delta_D} - \frac{r_l - r_b}{\delta_L}. \end{aligned} \tag{5}$$

[10] We in this paper use the bond cost as the benchmark cost. So the costs of the other financial assets are expressed as marginal costs with respect to the cost of bond.

[11] Throughout the paper, we use the superscript "s" to denote supply function, and the superscript "d" to denote demand function.

3.1.2 Firm's Function

The representative firms employs a production function that is linear in capital input[12]. We assume that the firm has zero capital endowment, and entirely relies on external financing from two sources, i.e., bond financing from the bank and the household, and loan financing from the bank. The firm's objective function is to maximize its profit:

$$\Pi_f = \max_{L,B} \left\{ \varphi_F(L+B) - r_l L - r_b B - \frac{1}{2}\left(\delta_{FL}L^2 + \delta_{FB}B^2\right) \right\}, \tag{6}$$

where φ_F denotes marginal return on assets (ROA, or marginal return to capital) of the firm. Capital raised from the loan market and from the bond market is the same in the sense of ROA, but at different costs: the parameter δ_{FL} and δ_{FB} denote the firm's marginal costs of loan financing and bond financing, respectively. Solving the FOCs of the representative firm, we have the demand function of bank loan as

$$L^d = \frac{\varphi_F - r_l}{\delta_{FL}}; \tag{7}$$

and the supply function of corporate bond as

$$B^s = \frac{\varphi_F - r_b}{\delta_{FB}}. \tag{8}$$

3.1.3 Household's Function

The optimization problem to the representative household is to allocate investment into bank deposit and corporate bond to maximize investment return. Assuming exogenous households' wealth, the objective function of the household is expressed as

$$\Pi_h = \max_{D,B_h} \left\{ r_d D + r_b B_h - \frac{1}{2}\varphi_{HB} B_h^2 \right\} \tag{9}$$

$$s.t. \quad D + B_h \leq W, \tag{10}$$

[12]The labor input is normalized to be 1, so does not appear in the production function.

where φ_{HB} denotes the marginal risk adjustment cost for the household to hold corporate bond; parameter W denotes household wealth. The households need to determine the optimal allocation of wealth into investment in deposit and bond, Solving the FOCs, we have the household's demand function of bond as

$$B_h^d = \frac{r_b - r_d}{\varphi_{HB}}; \tag{11}$$

and the household's supply function of bank deposit as

$$D^s = \begin{cases} W - \dfrac{r_b - r_d}{\varphi_{HB}} & \text{if } r_d \geq 0; \\ 0 & \text{if } r_d < 0, \end{cases}$$

If the deposit interest rate is negative, households would hold cash instead of deposit their money into the bank and the deposit market would fail. Therefore, the deposit interest rate is always positive in the model..

3.1.4 Deposit Rate Ceiling and Loan Quota

Since in our model, agents—firms, commercial banks and households—are homogenous, the loan quota is the same to each bank. In Model 1, bank loan quota strictly constrains the amount of loan supply from the bank to the firm. The supply function of bank loan is reduced to the following form:

$$L^s = \bar{L},$$

where $\bar{L} = k_1 * L^*$; and L^* denotes the equilibrium loan size in an otherwise quota-free economy; parameter $k_1 \in [0, 1]$ denotes the ratio of loan quota to quota-free equilibrium loan size, which measures the tightness of the loan quota. In addition, the deposit rate ceiling is expressed as

$$r_d = \bar{r_d},$$

where $\bar{r_d} = k_2 * r_d^*$; and r_d^* denotes the equilibrium deposit rate in an otherwise control-free economy; parameter $k_2 \in [0, 1]$ denotes the ratio of deposit rate ceiling to the ceiling-free

equilibrium deposit rate, which captures the magnitude of deposit interest rate repression.

In the presence of binding deposit rate ceiling, the size of bank deposit is entirely determined by deposit supply from the household, because the household is less willing to supply deposit under a repressed interest rate, in which part of the household's investment shifts from bank deposit to corporate bond. The deposit size in this regulated banking sector is

$$\bar{D^*} = D^s|_{r_d=\bar{r_d}} = W - \frac{r_b - \bar{r_d}}{\varphi_{HB}}. \tag{12}$$

In the same vine, the equilibrium size of bank loan in the presence of binding loan quota is

$$\bar{L^*} = L^s = \bar{L}. \tag{13}$$

The market clearing conditions for the loan market and the deposit market are distorted by these binding restrictions. On the other hand, the bond market is fully liberalized. As a result, the size of the bond market is greater than its counterpart without bank credit control (see the Appendix for proof).

3.1.5 Social Surplus

One central theme of the paper is to examine how shadow banking affects social surplus. Within our model setting, social surplus consists of household surplus (HS), firm surplus (FS), and bank surplus (BS). Further, we denote with the subscripts of "D", "L", and "B" the sources of the surpluses from the deposit, loan, and bond markets, respectively. For example, BS_L denotes the bank's surplus from the bank loan market. Further, an asterisk mark denotes market equilibrium. We analyze the surpluses in each market. Social surplus is then computed as

$$SW = FS + HS + BS, \tag{14}$$

where $FS = FS_L + FS_B$; $HS = HS_D + HS_B$; and $BS = BS_L + BS_D + BS_B$. The bank surplus from the deposit markets, BS_D, and the household surplus from the deposite

market, HS_D, are

$$\begin{aligned} BS_D &= \frac{\bar{D}^*}{2}\left[2\left(\alpha r_r + (1-\alpha)r_b^* - \bar{r_d}\right) - \delta_D \bar{D}^*\right]; \\ HS_D &= \frac{\bar{D}^*}{2}\left[\bar{r_d} - (r_b^* - \varphi_{HB} W)\right]. \end{aligned}$$

In equilibrium, firm surplus generated from the loan market, FS_L, and bank surplus from the loan market, BS_L, are

$$\begin{aligned} FS_L &= \frac{\bar{L}}{2}\left(\varphi_F - \bar{r_l^*}\right); \\ BS_L &= \frac{\bar{L}}{2}\left[2\left(\bar{r_l^*} - r_b^*\right) - \delta_L \bar{L}\right]. \end{aligned}$$

In the bond market, firm surplus, FS_B, bank surplus, BS_B, and household surplus, HS_B, are

$$\begin{aligned} FS_B &= \frac{B^*}{2}\left(\varphi_F - r_b^*\right); \\ HS_B &= \frac{1}{2\varphi_{HB}}\left(r_b^* - \bar{r_d}\right)^2; \\ BS_B &= \left(B^* - \frac{r_b^* - \bar{r_d}}{\varphi_{HB}}\right)\left[r_b^* - \frac{\delta_L \bar{r_l^*} - \delta_L(1-\alpha)(\alpha r_r - \bar{r_d}) - \delta_L \delta_D CBF}{\delta_D + (1-\alpha)^2 \delta_L}\right]. \end{aligned}$$

3.2 Model 2: Introducing Shadow Banking

In Model 2, we introduce shadow banking into the economy described in Model 1. Indeed, Model 2 resembles the current financial system of China (2006-present), which involves a controlled commercial banking sector and "bank-centric" shadow banking. In particular, shadow banking arises to evade the restrictions imposed on the bank and become a funding source parallel to commercial banking and bond market. In this paper, for sake of brevity, the practice of "bank-centric" shadow banking involves: (1) the bank selling WMPs to the household; and (2) the bank making trust loan to the firm.[13] Compared to the financial

[13]Of course, we are aware that there are many other products in the shadow banking industry in China such as entrust loans, banker's bill etc. But the nature of those shadow banking products is similar, for sake of simplicity, we choose the WMP and trust loan as representative products in this model.

system in Model 1, the financial system in Model 2 contains two more markets: the WMP market and the trust loan market. In addition to the existing four markets in Model 1, we primarily investigate the trust loan market and the WMP market in new equilibrium.

3.2.1 Bank's Function

In the presence of shadow banking, the objective function of the bank is expressed as

$$\begin{aligned}\Pi_b = \max_{L,TL,B_b,D,WMP} \{&r_l L + r_r \alpha D + r_b B_b + r_{tl} TL - r_d D - r_{wmp} WMP - r_p CBF \\ &- C\left(L, TL, D, WMP\right)\}, \\ s.t. \quad &L + TL + B_b \leq CBF + (1-\alpha)D + WMP,\end{aligned} \tag{15}$$

where r_{tl} and r_{wmp} denote the interest rates of trust loan and WMP, respectively. Similar to Model 1, the bank's operation cost in these markets is modeled as a quadratic function of the sizes of loan, trust loan, deposit, and WMP:

$$C(L, TL, D, WMP) = \frac{1}{2}(\delta_L L^2 + \delta_{TL} TL^2 + \delta_D D^2 + \delta_{WMP} WMP^2), \tag{16}$$

where δ_{TL} and δ_{WMP} denote the marginal costs of trust loan and WMP for the bank, respectively. Since the loan quota is still binding, we have the banks' loan supply function as

$$L^s = \bar{L}; \tag{17}$$

Solving the FOCs, the banks' supply function of trust loan as

$$TL^s = \frac{r_{tl} - r_b}{\delta_{TL}}. \tag{18}$$

Since the deposit rate ceiling remains binding as $r_d = \bar{r_d}$, the size of deposit is still determined by the household deposit supply, which falls short of the deposit demand. The size of deposit in equilibrium is given by

$$D^d = D^s = W - \frac{r_b - \bar{r_d}}{\varphi_{HB}} - \frac{r_{wmp} - \bar{r_d}}{\varphi_{HWMP}}. \tag{19}$$

The bank's supply function of WMP is

$$WMP^s = \frac{r_b - r_{wmp}}{\delta_{WMP}}. \tag{20}$$

3.2.2 Firm's Function

In the presence of shadow banking, the firm can raise capital through (1) issuing bond to the bank and the household; (2) borrowing bank loan; and (3) borrowing trust loan from the bank. The firm's objective function is to maximize profit, and can be expressed as

$$\Pi_f = \max_{L,B} \left\{ \varphi_F(L + B + TL) - r_l L - r_b B - r_{tl} TL - \frac{1}{2}\left(\delta_{FL} L^2 + \delta_{FB} B^2 + \delta_{FTL} TL^2\right) \right\}, \tag{21}$$

where δ_{FTL} denotes the firm's marginal cost of borrowing trust loan. The firm decides jointly and simultaneously its demand for loan and trust loan and it supply of bond. Solving the FOCs, we have the firm's demand function of trust loan as

$$TL^d = \frac{\varphi_F - r_{tl}}{\delta_{FTL}}. \tag{22}$$

3.2.3 Household's Function

The household allocates investment into three assets, i.e., deposit, bond, and WMP, to maximize investment return. Given exogenous wealth endowment, the household has the following objective function:

$$\Pi_h = \max_{D,B_h,WMP} \left\{ \bar{r_d} D + r_b B_h + r_{wmp} WMP - \frac{1}{2}\varphi_{HB} {B_h}^2 - \frac{1}{2}\varphi_{HWMP} WMP^2 \right\} \tag{23}$$

$$s.t. \quad D + B_h + WMP \leq W,$$

where φ_{HB} and φ_{HWMP} denote the marginal costs for the household to invest in bond and WMP, respectively. The household select the optimal amount of investment in deposit, bond, and WMP under its binding budget constraint. Solving the FOCs, we have the

household's supply function of deposit as

$$D^s = W - \frac{r_b - \bar{r_d}}{\varphi_{HB}} - \frac{r_{wmp} - \bar{r_d}}{\varphi_{HWMP}}; \tag{24}$$

$$\tag{25}$$

and the household's demand functions of bond and WMP as

$$B_h^d = \frac{r_b - \bar{r_d}}{\varphi_{HB}}; \tag{26}$$

$$WMP^d = \frac{r_{wmp} - \bar{r_d}}{\varphi_{HWMP}}. \tag{27}$$

For brevity, we present the market clearing conditions and the computation of social surplus in the Appendix. The mathematical derivations follow the same logic as the derivations in Model 1. The only difference is that there exist two shadow banking markets (trust loan and WMP) in Model 2. Compared with the market clearing conditions in Model 1, we add two new market clearing conditions for the trust loan market and the WMP market.

3.3 Model 3: Full Interest Rate Liberalization

Model 3 describes an economy after full interest rate liberalization. In particular, binding bank loan quota and deposit rate ceiling are removed. Shadow banking is allowed to exist in the new economy. On the other hand, commercial banks are still subject to deposit reserve requirement, which would affect how the shadow banking performs after interest rate liberalization.

In this model, the prices and quantities of all financial products are market-determined by demand and supply in equilibrium. In other words, the size of deposit is not only determined by the supply side, but also by demand side. Similarly, the loan supply is no longer determined by loan quota, instead, loan demand from the firm and loan supply from the bank would reach an equilibrium to jointly pin down the size and price in loan market. For brevity, we present the agents' demand and supply functions of various

financial products, market clearing conditions, and the computation of social surplus in the Appendix.

4 Comparative Analysis

This section presents comparative analyses of model simulations, and analyzes the effects of shadow banking on the interest rates of various financial markets and social surplus, followed by examining roles of shadow banking after full interest rate liberalization in Section 5.

4.1 Benchmark Parameter Values

This section introduces our calibration strategy and model parameter value selection. Model 2 is the most complex among the three models and describes the current financial system in China. So we use Model 2 as the benchmark to illustrate our calibration strategy. As shown in Table 2, the parameters are classified into four sets by agent types.

We select the benchmark parameter values based on their observed values if available in 2013. In particular, we set the RRR, α, to be 20%; the interest rates of deposit reserve and the open market operation (or, central bank fund, CBF) to be 1.5% and 2%, respectively. Following Bai, Hsieh, and Qian (2006), we set the firm's gross return on asset, ϕ_F, to be 20%. For the parameters whose values cannot be observed, we set their values to enable the models to generate interest rates and market features that are consistent with empirical pattern in the real world. For example, desirable parameter values should lead to a robust ranking of the interest rates as $r_{tl} > r_l > r_b > r_{wmp} > r_d$. Accordingly, Model 2 yields trust loan rate of 15.9%, bank loan rate of 15.1%, bond rate of 7.7%, WMP rate of 6.4%, and deposit rate of 3.0%. These interest rates are also close to the observed rates in recent years.

In our model, the key parameters are various marginal costs for the bank, firm and household, which can not be easily measured in practice. Therefore, instead of concen-

trating on the absolute numbers of those costs, we focus on the relative values of those parameters as follows: to the bank, the marginal cost of deposit ($\delta_D = 0.01$) should be lower than the cost of making loans ($\delta_L = 0.02$) since making loans needs a lot of risk management and surveillance before and after loan making. On the other hand, comparing with traditional banking, the cost of shadow banking is higher because it is new and not transparent as its counterpart in the traditional banking. Therefore, we set the cost of WMP twice larger than the deposit cost ($\delta_{WMP} = 0.02$) and the cost of trust loan much high than regular banking loan ($\delta_{TL} = 0.10$), to imitate high costs in trust loan industry due to severe misperceptions between investors and banks (Dang, Wang, and Yao, 2014).

To the firm, there are three ways to obtain financing: regular bank loans, issuing bonds, and borrowing from shadow banking. Since the entry to bond market in China is still quite difficult to most firms, we set the marginal cost of issuing bond higher than borrowing loan from the bank ($\delta_{FB} = 0.10$ verse $\delta_{FL} = 0.02$). Similarly, borrowing trust loan ($\delta_{FTL} = 0.05$) is more costly compared to regular bank loan, but less difficult than issuing bond.

The household has three ways to allocate wealth: deposit, bonds and WMP. Investing in deposits is easy and almost risk-free in China now, for simplicity, we assume investing deposit is cost-free for household. On the one hand, buying bond is costly and risky, so we set $\delta_{HB} = 0.02$.[14] On the other hand, purchasing WMP is relatively less risky, but is still subject to some risk, so we set $\delta_{HWMP} = 0.05$. We conduct sensitivity analysis with different cost parameter values, and find that our conclusions are consistent and robust.

In our model, we assume that the firm's capital eventually comes from either the household's wealth or the central bank fund. The ratio of central bank fund to the aggregate output was roughly 4.4% in China in 2013. So we set the household's endowed wealth $W = 5$ and the central bank fund $CBF = 0.3$, respectively. The aggregate output is 6.36 ($5.3 \times (1 + 20\%) = 6.36$, where the firm's return on capital is 20%). Therefore, we

[14]Based on our model setting, the marginal operation cost for commercial banks to hold corporate bond equals zero. Hence, compared with commercial banks, it is more costly for households to hold corporate bond, as shown by $\delta_{HB} > \delta_B$, if we denote commercial banks' marginal operation cost for bond by δ_B.

have $CBF = 6.36 \times 0.044 \approx 0.3$.

Without loss of generality, we set the benchmark loan quota, k_1, and deposit rate ceiling, k_2, at 90% and 80% of the control-free equilibrium levels, respectively.[15] In robustness analysis, we find that our results and conclusions are not sensitive to the reasonably selected values of k_1 and k_2. Further, we set the marginal costs of engaging in the shadow banking market higher than the marginal costs of engaging in the commercial banking market, which is in principle consistent with intuition and the empirical observations.

4.2 Interest Rates and Capital Allocation

This dynamic model enables us to analyze the effects of shadow banking on interest rates, capital allocation, and composition of the aggregate social surplus gain or loss in different scenarios. The analysis provides insights on how the agents collectively respond to the rise of shadow banking and how the economy reaches new equilibria with or without credit restrictions.

Table 3 reports that after introducing shadow banking to the economy, the deposit interest rate, r_d, sharply increases from 1.3% to 3.0% with the deposit rate ceiling remaining at 80% of the regulation-free level. The result suggests that if the central bank aims to maintain the relative degree of deposit rate ceiling, the deposit rate will significantly increases after shadow banking emerges, ceteris paribus.[16] On the other hand, the interest rate of WMP is 6.4%, which is significantly higher than the deposit rate. The size-weighted average return of WMP and deposit is 3.4%, substantially higher than the deposit rate of 1.3% prior to the rise of shadow banking, suggesting that the household benefits from higher deposit rate and even higher WMP return within shadow banking.

[15] We set the deposit rate ceiling and bank loan quantity quota as relative restrictions to their market-determined levels, rather than at fixed levels. This practice is consistent with the notion that in China, loan quota and deposit rate ceiling are periodically adjusted to meet capital demand. Robustness check indicates that assuming fixed levels of loan quota and deposit rate ceiling does not change our results and conclusions in a qualitative manner.

[16] The size of deposit can shrink more if the level of deposit rate ceiling is otherwise fixed, because such practice will repress the deposit rate in a stronger way.

The interest rates of the financial products are inter-dependent. After the rise of shadow banking, the bank loan interest rate, r_l, increases from 14.3% to 15.1%. The trust loan interest rate is 15.9%, leading the size-weighted average interest rate of bank loan products to 15.3%. Since the trust loan has higher interest rate than the bond, the bank shifts capital from bond investment to trust loan lending. Reduction in bank bond investment leads to rising bond interest rate, r_b, from 4.7% to 7.7%. The repressed deposit rate substantially shapes the interest rates of the other financial products in equilibrium, although the latters are effectively market-determined.

After introducing the shadow banking, more funding resource deviates from the traditional banking, as a result, the size of deposit reserve decreases, leading to less idolized capital in the economy. Table 4 shows that the size of deposit reserve decreases from 0.97 to 0.82 after introducing shadow banking. The result shows that shadow banking not only liberalizes interest rate, but also can increase the amount of disposable capital of commercial banks.

The shadow banking has two ways to shrink the size of deposit: first, more capital is invested by the household from deposit to WMP; second, the shadow banking enables the total amount of funding in the system to increase, which allows the bank to less depend on deposit to finance their lending.

The size of bank loan shrinks from 2.80 to 2.44 after the rise of shadow banking. Trust loan leads the sum of bank loan and trust loan quantity to 3.25, exceeding the size of loan prior to the rise of shadow banking. The bank engages in trust loan, which yields an interest rate higher than those of loan and bond. The bond interest rate increases as the bank reduces bond demand, which encourages the household to allocate more investment in the bond market. Reduction in the bank's demand of bond outweighs the increase in the household's demand of bond. As a result, the size of the bond market shrinks from 1.53 to 1.23.

Shadow banking has two effects on the bank's profit: the *price effect* associated with the interest rates of loan, trust loan, and bond; the *scale effect* related to the amount of

capital available to the bank. Table 4 shows that the bank's capital outflows (inflows) before and after the rise of shadow banking are 4.16 (5.13) and 4.25 (5.06), respectively.[17] Presence of shadow banking leads to an increase in bank interest rate margin from 9.9% to 10.1%. Both the price effect and the scale effect contribute positively to the bank's profit, which increases from 0.22 to 0.24.

The aggregate financing to the firm is 4.33 and 4.48 in Models 1 and 2, respectively, implying that shadow banking increases financing to the private sector by effectively reducing capital idolization. The result further suggests that when capital is efficiently used, shadow banking tends to increase aggregate output.[18] Based on the above discussions, we have the following proposition:

Proposition 1. *In the presence of repressive deposit rate ceiling and binding bank loan quota, "bank-centric" shadow banking, as dual-track interest rate liberalization, increases household investment return and bank profit, and provides more capital to the private sector by reducing deposit reserve.*

4.3 Social Surplus

A central debate about shadow banking is whether it adds or subtracts social surplus. Table 5 shows that the share of bank loan in the aggregate financing decreases from 64.7% to 54.5%, while the newly emerged shadow banking occupies 18.1% of the aggregate social financing. The percentage of the aggregate financing in the bond market also drops from 35.5% to 27.5%. These trends suggest that shadow banking is going to take a significantly larger portion of social financing in China.

We measure social surplus gain by introducing shadow banking as the difference be-

[17] For the bank, capital outflow=$L+B_b$ and capital inflow=$D+CBF$ in Model 1; capital outflow=$L+TL+B_b$ and capital inflow=$D+WMP+CBF$ in Models 2 and 3. Accordingly, bank profit=$r_l*L+r_r*\alpha*D+r_b*B_b-r_d*D-r_p*CBF-C(L,D)$ in Model 1; bank profit=$r_l*L+r_r*\alpha*D+r_b*B_b+r_{tl}*TL-r_d*D-r_{wmp}*WMP-r_p*CBF-C(L,TL,D,WMP)$ in Models 2 and 3.

[18] We assume that capital is efficiently used in production. It is interesting to investigate how the firm, bank, and household respond to shadow banking when shadow banking leads to capital oversupply and inefficient usage. We leave it to future research.

tween the aggregate social surpluses of Model 1 and Model 2. Table 6 shows that given our model settings, the aggregate social surplus increases from 0.40 to 0.46 after the rise of shadow banking. Shadow banking reduces the size of deposit reserve through discouraging the household's investment in bank deposit. Consequently, more capital enters into the firm's production and generates more output. Shadow banking provides additional investment channels and risk management tools, which also positively affects social surplus.

In greater detail, the household's surplus increases from 0.07 to 0.13, as the household can invest in WMP for a higher return and as the deposit interest rate increases. The bank's surplus increases from 0.13 to 0.18. Capital raised through the shadow banking channel evades deposit reserve requirement. The bank can also evade loan quantity restriction to make trust loan to the firm. The firm's surplus, however, decreases from 0.20 to 0.15. The reason is that before the rise of shadow banking, the firm indirectly benefits from the repressed interest rate. Hence, shadow banking can help to partially correct capital mis-pricing problem.

Capital mis-pricing and mis-allocation lead to fundamental structural imbalance in the Chinese economy. Inefficient SOEs enjoy easy access to cheap bank credit, while more efficient private enterprises struggle for financing. Bank credit, the dominant financing resource, is extremely skewed towards SOEs. Shadow banking, as dual-track interest rate liberalization, facilitates the correction of capital mis-allocation. In particular, shadow banking provides private enterprises with really needed capital. The high cost associated with shadow banking virtually functions as an effective screening mechanism to allow efficient private enterprises to prosper. On the other hand, it helps to eliminate enterprises with low productivity. Based on the above discussions, we have the following proposition:

Proposition 2. *Shadow banking increases social surplus, and helps to correct the capital mis-pricing and mis-allocation problems induced by interest rate repression and bank credit restriction in China.*

Intuitively, shadow banking competes against commercial banking and bond financing in attracting households' investment. The more distorted or fractioned the other two markets are, the more significant role shadow banking can play in terms of improving financial system efficiency. The distortions associated with the Chinese banking sector are binding deposit rate ceiling and loan quota, and high deposit reserve requirement. These practices substantially reduce the efficiency of the Chinese banks as financial intermediary.

We investigate how shadow banking-induced social surplus gain is related to the degree of deposit rate repression, the degree of bank loan restriction, deposit reserve requirement, and bond market inefficiency. The degree of deposit rate repression is measured with the percentage of deposit rate ceiling to market-determined deposit rate, k_1; the degree of bank loan restriction is measured with the ratio of loan quota to market equilibrium loan size, k_2; deposit reserve requirement is the percentage of deposit for capital reserve, α; bond market inefficiency is proxied by the firm's operation cost in the bond market, δ_{FB}.

Figure 2 shows that social surplus gain from shadow banking is positively related to the degree of deposit rate repression $(1 - k_1)$ and the degree of bank loan quantity restriction $(1 - k_2)$. The results are consistent to our prior that the more distorted the bank financing channel, the greater social value can shadow banking creates. The results also indicate that social surplus gain derived from introducing shadow banking can be negative if deposit rate repression is not substantial.

Social surplus gain is negatively and convexly related to deposit reserve requirement. On the one hand, shadow banking helps to reduce capital idolization due to high deposit reserve requirement, leading to a greater increase in social surplus. On the other hand, high deposit reserve requirement ex ante discourages deposit before the rise of shadow banking, and, thus, leads to less social surplus gain from shadow banking. The second effect appears to dominate the first effect in our setting. In addition, the marginal effect of shadow banking on social surplus gain decreases with deposit reserve requirement increasing.

The corporate bond markets are underdeveloped in China. Its market size is small.

As of 2007, the ratio of outstanding corporate bonds to GDP was 1.5% for China, in comparison to 125.7% and 38.9% for the US and Japan, respectively (China Securities Regulatory Commission, 2008). Bond issuance process is complicated and costly, subject to high qualification standards and lengthy approval of segmented regulators. Private enterprises, especially small and medium enterprises, virtually have no access to the bond markets. Hence, shadow banking should achieve greater social surplus gain when the bond market is less efficient in our model.

We find that the impact of shadow banking on social surplus crucially depends on bond market efficiency. The lower-right graph in Figure 2 shows that shadow banking-induced surplus gain is only positive when the bond market inefficiency is above a certain threshold. In the presence of a highly efficient market, shadow banking can lead to surplus loss. A highly efficient bond market constitutes an almost perfect substitute for the commercial banking channel, more costly shadow banking competes against the efficient bond market for capital. The marginal benefit of diversification may fall short of the marginal cost associated with shadow banking, leading to social surplus loss. This result highlights one fundamental difference between shadow banking in a developed financial system with efficient bond markets, such as the U.S., and shadow banking in a developing and transitioning financial system with inefficient bond markets, such as China. We have the following proposition:

Proposition 3. *The amount of social surplus gain induced by shadow banking is positively related to the degree of interest rate repression and the degree of loan quantity restriction; negatively related to deposit reserve requirement. Shadow banking leads to social surplus gain (loss) when bond market is inefficient (efficient).*

5 Full Interest Rate Liberalization

China sets full interest rate liberalization as one ultimate goal of the on-going financial reforms. The bank loan quota and deposit rate ceiling will eventually be demolished.

Deposit reserve requirement will remain exist to distinguish commercial banks with other nonbank financial institutions, but the level of the reserve requirement might depend on the flexibility of the RMB exchange rate and the amount of foreign reserve inflows or outflows in the future. This section analyzes how full interest rate liberalization affects interest rates, social surplus, and shadow banking.

5.1 Interest Rates

A question often asked by regulators, academics, and practitioners on full interest rate liberation in China, is whether it will lead to disruptive increase in interest rates and significant turbulences to the economy. We address the question by contrasting the interest rates of various markets in Model 2 and Model 3.

Table 3 shows that the deposit rate increases from 3.0% to 3.7% after full liberalization, reflecting the removal of deposit rate ceiling. The interest rate of WMP increases from 6.4% to 7.6%, greater than the increase in the deposit rate. The difference reflects the higher risk and higher costs associated with WMP. The rate of bank loan decreases from 15.1% to 14.6% after full liberalization. Rising loan supply due to the removal of loan quantity restriction leads to cheaper bank loan. In contrast, the interest rate of trust loan increases from 15.9% to 16.4%, partially driven by the rising WMP rate. The interest rate of bond increases from 7.7% to 9.2%, partially driven by the rising rates of bank capital. The results suggest that interest rates will in general increase after full interest rate liberalization, but not all interest rates will change in the same way. The direction and extent of the changes in these interest rates depend on individual market conditions as well as the interaction among the markets.

The differences between the interest rates in Model 3 and Model 1 can be viewed as the changes in interest rates if a dramatic "single-track" interest rate liberalization is carried out, whereas the differences between the interest rates in Model 3 and Model 2 can be regarded as the results of a gradual "dual-track" liberalization. The differences in interest rates between Models 1 and 3 are greater than the differences between Models 2 and

3, suggesting that the "dual-track" liberalization approach can substantially reduce the magnitude of interest rate turbulence and allow for a smoother transition from a financial system dominated by controlled interest rate to a market-oriented financial system.

Full interest rate liberalization affects the economic agents differently. Table 4 shows that the household directly benefits from full interest rate liberalization, as her investment return increases from 3.6% in Model 2 to 4.6% in Model 3. After full liberalization, the bank's weighted average profit margin decreases from 10.1% to 9.7%. Full interest rate liberalization allows for more capital inputs into the firm's production. The firm's profit margin, however, decreases from 6.8% to 6.4%, because the overall cost of capital increases due to the removal of deposit rate ceiling.

Table 4 shows that the amount of deposit reserve decreases after full interest rate liberalization. This phenomenon seems counter-intuitive at a first glance, but actually is due to the mixed effects of the removal of loan quota and deposit interest rate ceiling. In particular, the bank expands the size of loan, which increases the bank's demand for deposit. On the other hand, the removal of deposit rate ceiling lifts up the deposit rate to its repression-free level, which discourages bank deposit holdings. For the household, the removal of loan quota affects her asset allocation indirectly through the bond market, that is, the removal of loan quota encourages the bank to shift some capital from the bond market to the loan market, leading to a decrease in the aggregate bond demand. As a result, the bond interest rate increases. The household purchases more bond, leading to a reduction in deposit supply, whereas the removal of deposit rate ceiling helps to increase deposit supply. The two effects tend to offset each other, resulting in a decrease in the size of bank deposit in our setting. However, it is important to note that the impact of full interest rate liberalization on bank deposit is market-dependent, and can go in either direction.

These results have policy implications for the fundamental structural imbalance and in China's economy. Interest rate liberation can effectively reduce households' subsidy to firms, particularly SOEs, and discipline investment in sectors of over capacity and low

efficiency, e.g., steel industry that caused inflated imported iron ore prices before 2010.

5.2 Social Surplus

Table 5 shows that a greater amount of capital flows through the bank to the firm as restrictive deposit rate ceiling is removed. The share of bank financing in the aggregate financing increases from 54.5% to 60%. As a result, the percentage of the aggregate financing in shadow banking (bond market) decreases from 18.1% (27.5%) to 16.0% (24.00%). It is intuitive that the restoration of the deposit rate to its market equilibrium level attracts more household investment in deposit. The bank can shift some capital from the trust loan market to the loan market to reduce operation cost.

Table 6 shows that the aggregate social surplus increases from 0.46 in Model 2 to 0.48 in Model 3, suggesting that full interest rate liberalization achieves additional gain in social surplus. Full liberalization enables capital to be allocated in a more efficient manner. By agent, the household and the bank experience surplus gain as they directly benefit from the removal of the restrictions imposed on deposit rate and loan quantity. The firm experiences surplus loss since its overall financing cost increases after full liberalization. That amount of loss, however, is less than that of a loss incurred in a transition without shadow banking. The result highlights a remarkable advantage of the dual-track interest rate liberalization mechanism, which allows the controlled bank deposit rate, which anchors the interest rates of the other markets, to gradually converge to its market level before full liberalization. Thus, it can significantly alleviate the shocks of full liberalization to the real economy.

5.3 Post-Liberalization Shadow Banking

We address what role shadow banking will play after full interest rate liberalization. Table 5 shows that shadow banking remains as a significant part of the aggregate social financing, but its share decreases. Full interest rate liberalization will not completely crowd out shadow banking because shadow banking constitutes an effective channel to

evade high capital reserve requirement. From the social welfare perspective, shadow banking has advantage over commercial banking in terms of reducing capital idolization. In addition, shadow banking provides the firm with an alternative financing channel in alleviating high frictions of and inaccessibility to the bond market. On the other hand, the costs associated with shadow banking, partially due to embedded opaqueness and information asymmetry, tend to reduce the importance of shadow banking in the fully liberalized financial system. In summary, the validity of shadow banking depends not only on its own evolution, but also the development of the commercial banking sector and the direct financing markets. Based on the above discussions, we have the following proposition:

Proposition 4. *Full interest rate liberalization achieves additional gain in social surplus. Interest rates in general tend to increase after full interest rate liberalization, but the direction and magnitude of the changes in individual interest rates depend on individual market conditions and market interaction. Shadow banking, as a dual-track interest rate reform mechanism, helps to alleviate the shocks of interest rate liberalization to the real economy.*

6 Conclusions

Shadow banking provides a pragmatic dual-track reform solution to China's rigid interest rate policy, which was formed in the era of planned economy and underlies the structural imbalance and distortions of China's economy. Different from its counterparts in the developed economies, shadow banking in China was developed by commercial banks with the tacit endorsement of the government to evade interest rate and credit quantity restrictions. Hence, shadow banking in China essentially constitutes an effort of covert interest rate liberalization.

Using a parsimonious equilibrium model, we show that the dual track liberalization approach of introducing the shadow bank track by the side of the controlled commercial

banking track leads to efficiency gain in credit allocation and social surplus. Full interest rate liberalization leads to additional gain in social surplus. Importantly, the dual-track interest rate liberalization approach allows the repressed bank deposit rate, which anchors the interest rates of the other markets, to gradually converge to its market level before full liberalization takes place. It can significantly alleviate the economic turbulences caused by an otherwise single-track, one-step interest rate liberalization.

China has set full interest rate liberalization as an ultimate goal of its on-going financial reforms, for which market-oriented monetary policy and regulatory framework need to be established. The shadow banking track nevertheless prepares the central bank and the other economic agents for such a transition, while the preexisting controlled commercial banking track provides safeguard against disruptive shocks in an early stage. The two tracks will be gradually converging in the coming years.

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Appendix

A.1 Optimization Problems of the Agents

We elaborate the procedures to solve optimization problems for each sector and clearing conditions for each market, using Model 1 as an example.

A.1.1 Banks' Function

Assuming operation cost of loans and bonds to be quadratic form, the optimization problem of the representative commercial bank is given by

$$\Pi_b = \max_{L,B,D} \left\{ r_l L + r_r \alpha D + r_b B - r_d D - r_p CBF - \frac{1}{2}(\delta_L L^2 + \delta_D D^2) \right\} \tag{A-1}$$

$$s.t. \quad L + B_b \leq CBF + (1-\alpha)D$$

It is obvious that firms' optimal external financing bundle requires the budget constraint to be binding. Plugging the binding budget constraint into banks' objective function, we re-arrange their optimization problem,

$$\Pi_b = r_l L + r_r \alpha D + r_b \left[CBF + (1-\alpha)D - L \right] - r_d D - r_p CBF - \frac{1}{2}(\delta_L L^2 + \delta_D D^2), \tag{A-2}$$

The first-order condition (FOC) with respect to L,

$$\frac{\partial \Pi_b}{\partial L} = r_l - r_b - \delta_L L = 0$$

Hence,

$$L^s = \frac{r_l - r_b}{\delta_L}$$

Similarly, FOCs with respect to D can be derived as follows.

$$D^d = \frac{\alpha r_r + (1-\alpha) r_b - r_d}{\delta_D}$$

Regarding $r_b > r_p$ as given, commercial banks will have infinite demand on the central bank fund (CBF). However, the CBF size is strictly controlled as a quantity instrument by the central bank. From the eyes of commercial bankers, both CBF and r_p are exogenously given.

Substituting the loan supply and deposit demand into banks' budget constraint, we

can further pin down their bond demand,

$$B_b^d = CBF + \frac{(1-\alpha)\left[\alpha r_r + (1-\alpha) r_b - r_d\right]}{\delta_D} - \frac{r_l - r_b}{\delta_L}$$

A.1.2 Firms' Function

Firms' capital for production all come from external financing. Their objective is to maximize their profits without budget constraint.

$$\Pi_f = \max_{L,B} \left\{ \varphi_F(L+B) - r_l L - r_b B - \frac{1}{2}\left(\delta_{FL} L^2 + \delta_{FB} B^2\right) \right\}, \tag{A-3}$$

The first-order condition (FOC) with respect to L,

$$\frac{\partial \Pi_f}{\partial L} = \varphi_F - r_l - \delta_{FL} L = 0,$$

hence,

$$L^d = \frac{\varphi_F - r_l}{\delta_{FL}};$$

Similarly, we derive firms' bond demand using their FOC with respect to B,

$$B^s = \frac{\varphi_F - r_b}{\delta_{FB}}.$$

Given a production function with constant marginal efficiency of capital, firms choose a optimal external financing bundle to minimize their aggregate cost.[19] Firms' capital demand allocation between loans and bonds are jointly determined by their marginal operation costs and equilibrium interest rates for loans and bonds.

A.1.3 Household's Function

The maximization problem for households is

$$\Pi_h = \max_{D,B} \left\{ r_d D + r_b B - \frac{1}{2}\varphi_{HB} B^2 \right\},$$

$$s.t. \quad D + B \leq W.$$

[19] Under our model settings, Firms' profit maximization problem is equivalent with their cost minimization problem given a target output level.

Plugging the binding budget constraint into households' investment income function,

$$\Pi_h = \max_{B_h} \left\{ r_d(W - B_h) + r_b B_h - \frac{1}{2}\varphi_{HB} B_h^2 \right\},$$

The FOC with respect to B_h,

$$\frac{\partial \Pi_h}{\partial B_h} = -r_d + r_b - \varphi_{HB} B_h = 0,$$

hence, households' bond demand function is given by

$$B_h^d = \frac{r_b - r_d}{\varphi_{HB}}.$$

Correspondingly, their deposit supply function is

$$D^s = W - \frac{r_b - r_d}{\varphi_{HB}}.$$

Following a similar approach, we derive the optimization conditions for each agent in Model 2 and Model 3.

A.2 Market Clearing Conditions

A.2.1 Model 1: In the Absence of Shadow Banking

For a frictionless economy, all markets are fully liberalized and the equilibrium is directly derived by the market supply and demand. We list the market clearing conditions for the frictionless economy as follows.

$$\begin{aligned}
\frac{r_l - r_b}{\delta_L} &= \frac{\varphi_F - r_l}{\delta_{FL}}; \\
\frac{\alpha r_r + (1-\alpha) r_b - r_d}{\delta_D} &= W - \frac{r_b - r_d}{\varphi_{HB}}; \\
CBF + \frac{(1-\alpha)\left[\alpha r_r + (1-\alpha) r_b - r_d\right]}{\delta_D} - \frac{r_l - r_b}{\delta_L} + \frac{r_b - r_d}{\varphi_{HB}} &= \frac{\varphi_F - r_b}{\delta_{FB}}.
\end{aligned}$$

However, for our Model 1 with financial frictions, the market clearing conditions for loan market and deposit market are twisted by the binding constraints on loan size and deposit

interest rate. The market clearing conditions for Model 1 is given by

$$\begin{aligned} \bar{L} &= \frac{\varphi_F - r_l}{\delta_{FL}}; \\ r_d &= \bar{r_d}; \\ CBF + (1-\alpha)\left(W - \frac{r_b - r_d}{\varphi_{HB}}\right) - \bar{L} + \frac{r_b - r_d}{\varphi_{HB}} &= \frac{\varphi_F - r_b}{\delta_{FB}}. \end{aligned}$$

In the simultaneous equations, the first equation and second equation represent the market clearing conditions for loan market and bond market, respectively. In this case, Loan quota leads to the reallocation of a certain amount of commercial banks' capital from loans to bonds. Similarly, deposit interest rate ceiling leads to the reallocation of a certain amount of households' capital from deposit to bonds. The loan market shrinks under these financial frictions. Meanwhile, the capital that firms obtain from other sectors shrinks as well, leading to a drop in the aggregate output level.

A.2.2 Model 2: In the Presence of Shadow Banking

The settings of loan quota and interest rate ceiling of deposit are the same as that described in Model 1. Since there are five liberalized markets (loan market, bond market, trust loan market, deposit market, and wealth management product market), the market clearing conditions are listed below.

$$\begin{aligned} \bar{L} &= \frac{\varphi_F - r_l}{\delta_{FL}}; \\ r_d &= \bar{r_d}; \\ CBF + (1-\alpha)\left(W - \frac{r_b - r_d}{\varphi_{HB}} - \frac{r_{wmp} - r_d}{\varphi_{HWMP}}\right) + \frac{r_b - r_{wmp}}{\delta_{WMP}} & \\ - \bar{L} - \frac{r_{tl} - r_b}{\delta_{TL}} + \frac{r_b - r_d}{\varphi_{HB}} &= \frac{\varphi_F - r_b}{\delta_{FB}}; \\ \frac{r_{tl} - r_b}{\delta_{TL}} &= \frac{\varphi_F - r_{tl}}{\delta_{FTL}}; \\ \frac{r_b - r_{wmp}}{\delta_{WMP}} &= \frac{r_{wmp} - r_d}{\varphi_{HWMP}}. \end{aligned}$$

Hence, there are five equations to pin down five endogenous variables (r_l, r_d, r_b, r_{tl}, r_{wmp}).

A.2.3 Model 3: Full Interest Rate Liberalization

As an ideal case of Model 3, we list the market clearing conditions in Model 3, capturing the features of China's future after financial liberalization.

$$\begin{aligned}
\frac{r_l - r_b}{\delta_L} &= \frac{\varphi_F - r_l}{\delta_{FL}};\\
\frac{\alpha r_r + (1-\alpha) r_b - r_d}{\delta_D} &= W - \frac{r_b - r_d}{\varphi_{HB}} - \frac{r_{wmp} - r_d}{\varphi_{HWMP}};\\
CBF + \frac{(1-\alpha)\left[\alpha r_r + (1-\alpha) r_b - r_d\right]}{\delta_D} &+ \frac{r_b - r_{wmp}}{\delta_{WMP}}\\
- \frac{r_l - r_b}{\delta_L} - \frac{r_{tl} - r_b}{\delta_{TL}} + \frac{r_b - r_d}{\varphi_{HB}} &= \frac{\varphi_F - r_b}{\delta_{FB}};\\
\frac{r_{tl} - r_b}{\delta_{TL}} &= \frac{\varphi_F - r_{tl}}{\delta_{FTL}};\\
\frac{r_b - r_{wmp}}{\delta_{WMP}} &= \frac{r_{wmp} - r_d}{\varphi_{HWMP}}.
\end{aligned}$$

In this new equilibrium, neither deposit interest rate ceiling nor loan quota exists, which makes the five markets fully liberalized.

A.3 Computing Social Surplus

A.3.1 Model 2: In the Presence of Shadow Banking

Based on the settings of Model 2, we calculate the surplus of each sector in each market. In the equilibrium of deposit market,

$$\begin{aligned}
BS_D &= \frac{\bar{D^*}}{2}\left[2\left(\alpha r_r + (1-\alpha) r_b^* - \bar{r_d}\right) - \delta_D \bar{D^*}\right];\\
HS_D &= \frac{\bar{D^*}}{2}\left[\bar{r_d} - \left(\frac{\varphi_{HWMP} r_b^* + \varphi_{HB} r_w^* - \varphi_{HB}\varphi_{HWMP} W}{\varphi_{HB} + \varphi_{HWMP}}\right)\right],
\end{aligned}$$

where $\bar{D^*} = W - \frac{r_b - \bar{r}_d}{\delta_{HB}} - \frac{r_{wmp} - \bar{r}_d}{\delta_{HWMP}}$, implying that the equilibrium deposit size in the deposit market with interest rate ceiling is lower than that in a frictionless economy.

In the equilibrium loan market, we calculate FS and BS as

$$\begin{aligned}
FS_L &= \frac{\bar{L}}{2}\left(\varphi_F - \bar{r_l^*}\right);\\
BS_L &= \frac{\bar{L}}{2}\left[2\left(\bar{r_l^*} - r_b^*\right) - \delta_L \bar{L}\right],
\end{aligned}$$

where $\bar{r_l^*} = \varphi_F - \delta_{FL}\bar{L}$, suggesting that with bank loan quota, the interest rate of loan is

higher than that in an economy without bank loan quota.

In the equilibrium of bond market,

$$\begin{aligned} FS_B &= \frac{B^*}{2}\left(\varphi_F - r_b^*\right) \\ HS_B &= \frac{1}{2\varphi_{HB}}\left(r_b^* - \bar{r_d}\right)^2 \\ BS_B &= \left(B^* - \frac{r_b^* - \bar{r_d}}{\varphi_{HB}}\right)\left[r_b^* - \frac{\delta_L r_l^* - \delta_L(1-\alpha)(\alpha r_r - \bar{r_d}) - \delta_L\delta_D CBF}{\delta_D + (1-\alpha)^2\delta_L}\right] \end{aligned}$$

In the equilibrium of trust loan market,

$$\begin{aligned} FS_{TL} &= \frac{TL^*}{2}\left(\varphi_F - r_{tl}^*\right) \\ BS_{TL} &= \frac{TL^*}{2}\left(r_{tl}^* - r_b^*\right) \end{aligned}$$

In the equilibrium of wealth management product market,

$$\begin{aligned} BS_{WMP} &= \frac{WMP^*}{2}\left(r_b^* - r_{wmp}^*\right) \\ HS_{WMP} &= \frac{WMP^*}{2}\left(r_{wmp}^* - r_d^*\right). \end{aligned}$$

By aggregation within each sector, we can derive the aggregate surplus for each sector in all markets and the aggregate social surplus.

$$\begin{aligned} FS &= FS_L + FS_{TL} + FS_B; \\ HS &= HS_D + HS_{WMP} + HS_B; \\ BS &= BS_L + BS_{TL} + BS_D + BS_{WMP} + BS_B; \\ SW &= FS + HS + BS. \end{aligned}$$

A.3.2 Model 3: Full Interest Rate Liberalization

We calculate the surplus of each agent. In the equilibrium of deposit market,

$$\begin{aligned} BS_D &= \frac{D^*}{2}\left[\alpha r_r + (1-\alpha)r_b^* - r_d^*\right] \\ HS_D &= \frac{D^*}{2}\left[r_d^* - \left(\frac{\varphi_{HWMP} r_b^* + \varphi_{HB} r_w^* - \varphi_{HB}\varphi_{HWMP} W}{\varphi_{HB} + \varphi_{HWMP}}\right)\right] \end{aligned}$$

In the equilibrium of loan market,

$$\begin{aligned} FS_L &= \frac{L^*}{2}\left(\varphi_F - r_l^*\right) \\ BS_L &= \frac{L^*}{2}\left(r_l^* - r_b^*\right) \end{aligned}$$

In the equilibrium of bond market,

$$\begin{aligned} FS_B &= \frac{B^*}{2}\left(\varphi_F - r_b^*\right) \\ HS_B &= \frac{1}{2\varphi_{HB}}\left(r_b^* - r_d^*\right)^2 \\ BS_B &= \left(B^* - \frac{r_b^* - r_d^*}{\varphi_{HB}}\right)\left[r_b^* - \frac{\delta_L r_l^* - \delta_L(1-\alpha)(\alpha r_r - r_d^*) - \delta_L\delta_D CBF}{\delta_D + (1-\alpha)^2\delta_L}\right] \end{aligned}$$

In the equilibrium of trust loan market,

$$\begin{aligned} FS_{TL} &= \frac{TL^*}{2}\left(\varphi_F - r_{tl}^*\right) \\ BS_{TL} &= \frac{TL^*}{2}\left(r_{tl}^* - r_b^*\right) \end{aligned}$$

In the equilibrium of wealth management product market,

$$\begin{aligned} BS_{WMP} &= \frac{WMP^*}{2}\left(r_b^* - r_{wmp}^*\right) \\ HS_{WMP} &= \frac{WMP^*}{2}\left(r_{wmp}^* - r_d^*\right) \end{aligned}$$

Similarly to Model 2, by aggregation within each sector, we can derive the aggregate surplus for each sector in all markets and the aggregate social surplus.

$$\begin{aligned} FS &= FS_L + FS_{TL} + FS_B \\ HS &= HS_D + HS_{WMP} + HS_B \\ BS &= BS_L + BS_{TL} + BS_D + BS_{WMP} + BS_B \\ SW &= FS + HS + BS. \end{aligned}$$

Table 1: **Aggregate Financing to the Real Economy in China**

This table reports the aggregate financing to the real economy in China between 2002 and 2013. AFRE denotes the total volume of financing provided by the financial system to the real economy within a year. It is a flow measure. RMBL denotes RMB-denominated loans. FL denotes foreign currency-denominated loans (RMB equivalent). EL denotes entrusted loans. TL denotes trust loans. UBA denotes undiscounted bankers' acceptances. CB denotes net financing of corporate bonds. EQ denotes equity financing on domestic stock market by non-financial enterprises. Sources of data: PBC, National Development and Reform Commission (NDRC), China Securities Regulatory Commission (CSRC), China Insurance Regulatory Commission (CIRC), China Government Securities Depository Trust & Clearing Co. Ltd. (CDC), and National Association of Financial Market Institutional Investors (NAFMII).

Panel A: Loan Size (in billion RMBs)

Year	AFRE	RMBL	FL	ETL	TL	UBA	CB	EQ
2002	2011	1848	73	18		-70	37	63
2003	3411	2765	229	60		201	50	56
2004	2863	2267	138	312		-29	47	67
2005	3001	2354	142	196		2	201	34
2006	4270	3152	146	270	83	150	231	154
2007	5966	3632	386	337	170	670	228	433
2008	6980	4904	195	426	314	106	552	332
2009	13910	9594	927	678	436	461	1237	335
2010	14019	7945	486	875	387	2335	1106	579
2011	12829	7472	571	1296	203	1027	1366	438
2012	15763	8204	916	1284	1285	1050	2255	251
2013	17317	8892	585	2547	1840	776	1811	222

Panel B: In Percentage to AFRE

Year	AFRE	RMBL	FL	ETL	TL	UBA	CB	EQ
2002	100	91.9	3.6	0.9		-3.5	1.8	3.1
2003	100	81.1	6.7	1.8		5.9	1.5	1.6
2004	100	79.2	4.8	10.9		-1.0	1.6	2.4
2005	100	78.5	4.7	6.5		0.1	6.7	1.1
2006	100	73.8	3.4	6.3	1.9	3.5	5.4	3.6
2007	100	60.9	6.5	5.7	2.9	11.2	3.8	7.3
2008	100	70.3	2.8	6.1	4.5	1.5	7.9	4.8
2009	100	69.0	6.7	4.9	3.1	3.3	8.9	2.4
2010	100	56.7	3.5	6.2	2.8	16.7	7.9	4.1
2011	100	58.2	4.5	10.1	1.6	8.0	10.6	3.4
2012	100	52.0	5.8	8.1	8.1	6.7	14.3	1.6
2013	100	51.3	3.4	14.7	10.6	4.5	10.5	1.3

Table 2: **Benchmark Parameter Values**

This table reports the benchmark parameter values. The values are consistent with the observed values or those reported in previous literature. Parameters, r_r, r_p, α and the ratio of CBF to W are selected based on the data obtained the National Bureau of Statistics of China. The value of φ_F is from Bai et al (2006). The values of the unobservable parameters are selected to enable the models to generate interests rates and the composition of assets that are intuitive and roughly match the observed interest rates and financial asset features.

Parameter	Definition	Value
Parameters in the Household's Function		
φ_{HB}	Marginal Cost of Bond Investment	0.20
φ_{HWMP}	Marginal cost of WMP Investment	0.05
W	Household Wealth Endowment	5
Parameters in the Firm's Function		
φ_F	Marginal Productivity	0.20
δ_{FL}	Marginal Cost of Borrowing Bank Loan	0.02
δ_{FB}	Marginal Cost of Issuing Bond	0.10
δ_{FTL}	Marginal Cost of Borrowing Trust Loan	0.05
Parameters in the Bank's Function		
δ_L	Marginal Cost of Loan	0.02
δ_D	Marginal Cost of Deposit	0.01
δ_{WMP}	Marginal Cost of WMP	0.02
δ_{TL}	Marginal Cost of Trust Loan	0.10
Parameters in the Central Bank Policy		
α	Deposit Reserve Requirement Ratio	20%
r_r	Deposit Reserve Rate	1.5%
r_p	Central Bank Fund Rate	2%
CBF	Size of Central Bank Fund (CBF)	0.3
k_1	Degree of Loan Restriction (Loan Quota)	90%
k_2	Degree of Deposit Rate Repression (Rate Ceiling)	80%

Table 3: **Interest Rates and Market Sizes**

This table presents the equilibrium interest rates and sizes of the financial assets in Models 1, 2, and 3. The models have $\delta_{FB} = 0.05$ and $k_1 = k_2 = 0.8$. The variables r_l, r_{tl}, r_b, r_d, and r_{wmp} denote the interest rates of the loan, trust loan, bond, deposit, and WMP, respectively. The size-weighted average rate of loan products is measured by $\frac{L}{L+TL}r_l + \frac{TL}{L+TL}r_{tl}$. The size-weighted average rate of bank financing products measured by $\frac{D}{D+WMP}r_d + \frac{WMP}{D+WMP}r_{wmp}$. The variables, L, TL, B, D, and WMP denote the sizes of the loan, trust loan, bond, deposit, and WMP, respectively. The summed sizes of bank loan products and bank financing assets are denoted by $L + TL$ and $D + WMP$, respectively.

Variable	Model 1	Model 2	Model 3
Asset Interest Rate			
r_l	14.3%	15.1%	14.6%
r_{tl}	-	15.9%	16.4%
$\frac{L}{L+TL}r_l + \frac{TL}{L+TL}r_{tl}$	14.3%	15.3%	15.0%
r_b	4.7%	7.7%	9.2%
r_d	1.3%	3.0%	3.7%
r_{wmp}	-	6.4%	7.6%
$\frac{D}{D+WMP}r_d + \frac{WMP}{D+WMP}r_{wmp}$	1.3%	3.4%	4.3%
Asset Size			
L	2.80	2.44	2.71
TL	-	0.81	0.72
$L + TL$	2.80	3.25	3.43
B	1.53	1.23	1.08
D	4.83	4.08	3.94
WMP	-	0.68	0.78
$D + WMP$	4.83	4.76	4.73
αD	0.97	0.82	0.79

Table 4: **Returns, Capital Flows, and Profits**

This table presents the interest rates, capital flows, and profits of each agent. The firm's financing cost=$r_l * \frac{L}{L+B} + r_b * \frac{B}{L+B}$; in Models 2 and 3, financing cost=$r_l * \frac{L}{L+TL+B} + r_{tl} * \frac{TL}{L+TL+B} + r_b * \frac{B}{L+TL+B}$. Profit margin denotes the difference between return on capital and financing cost. The bank's rate of return is calculated using the weighted average interest rate o capital inflow. In Model 1, the rate of return=$r_l * \frac{L}{L+B_b} + r_b * \frac{L}{L+B_b}$; in Models 2 and 3, the rate of return=$r_l * \frac{L}{L+TL+B_b} + r_{tl} * \frac{TL}{L+TL+B_b} + r_b * \frac{L}{L+TL+B_b}$. Financing cost measures the weighted average cost rate among banks' different external financing approaches, i.e., in Model 1, financing cost rate=$r_d * \frac{D}{D+CBF} + r_p * \frac{CBF}{D+CBF}$; $r_d * \frac{D}{D+WMP+CBF} + r_{wmp} * \frac{WMP}{D+WMP+CBF} + r_p * \frac{CBF}{D+WMP+CBF}$ in Models 2 and 3. Capital outflow (inflow) is measured as $L+B_b$ $(D+CBF)$ and $L+TL+B_b$ $(D+WMP+CBF)$ in Models 2 and 3. Rate of return for the household is measured as $r_d * \frac{D}{D+B_h} + r_b * \frac{B_h}{D+B_h}$ in Model 1; $r_d * \frac{D}{D+B_h+WMP} + r_b * \frac{B_h}{D+B_h+WMP} + r_{wmp} * \frac{WMP}{D+B_h+WMP}$ in Models 2 and 3.

Variables	Model 1	Model 2	Model 3
Firm			
Return on Capital	20.0%	20.0%	20.0%
Financing Cost	11.0%	13.2%	13.6%
Profit Margin	9.0%	6.8%	6.4%
Capital Inflow	4.33	4.48	4.51
Financial Market Operation Cost	0.20	0.15	0.13
Profit	0.20	0.15	0.16
Bank			
Rate of Return	11.2%	13.5%	13.9%
Financing Cost	1.3%	3.4%	4.2%
Interest Rate Margin	9.9%	10.1%	9.7%
Capital Outflow	4.16	4.25	4.24
Capital Inflow	5.13	5.06	5.03
Deposit Reserve	0.97	0.82	0.79
Operation Cost	0.20	0.18	0.18
Profit	0.22	0.24	0.20
Household			
Rate of Return	1.4%	3.6%	4.6%
Asset Size	5.0	5.0	5.0
Cost of Investment	0.00	0.02	0.02
Profit	0.07	0.17	0.21

Table 5: **Social Financing Decomposition**

This table decomposes the aggregate social financing into three channels commercial banking, shadow banking, and bond financing, and presents the percentage of social financing in each channel in the financial systems in Models 1, 2, and 3. Capital flow share is measured as the ratio of the capital outflow in a financing channel to the aggregate capital flow.

Financing Channel	Model 1	Model 2	Model 3
Banking	64.7%	54.5%	60%
Shadow Banking	-	18.1%	16.0%
Bond Financing	35.3%	27.5%	24.0%

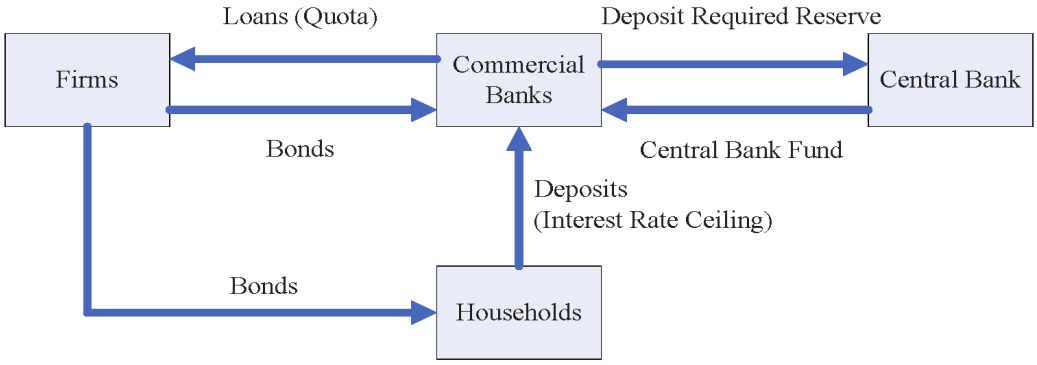
Table 6: **Social Surplus**

This table presents the decomposition of social surplus by agent and by market, respectively. Aggreage social surplus consists of household surplus (HS), firm surplus (FS), and bank surplus (BS).

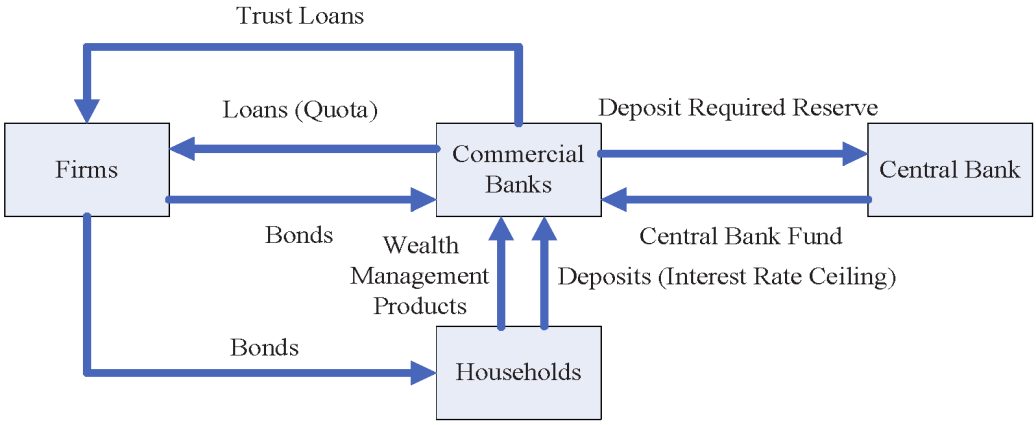
	Model 1	Model 2	Model 3
Aggregate Social Surplus			
Aggregate Social Surplus	0.40	0.46	0.48
Social Surplus by Agent			
Firm Surplus FS	0.20	0.15	0.14
Bank Surplus BS	0.13	0.18	0.19
Household Surplus HS	0.07	0.13	0.15
Social Surplus by Market			
Loan Market	0.31	0.21	0.15
Trust Loan Market	-	0.05	0.04
Loan & Trust Loan Markets	0.31	0.26	0.19
Bond Market	0.01	0.01	0.07
Deposit Market	0.08	0.17	0.21
WMP Market	-	0.02	0.02
Deposit & WMP Markets	0.08	0.19	0.23

Figure 1: **Financial System Structures**

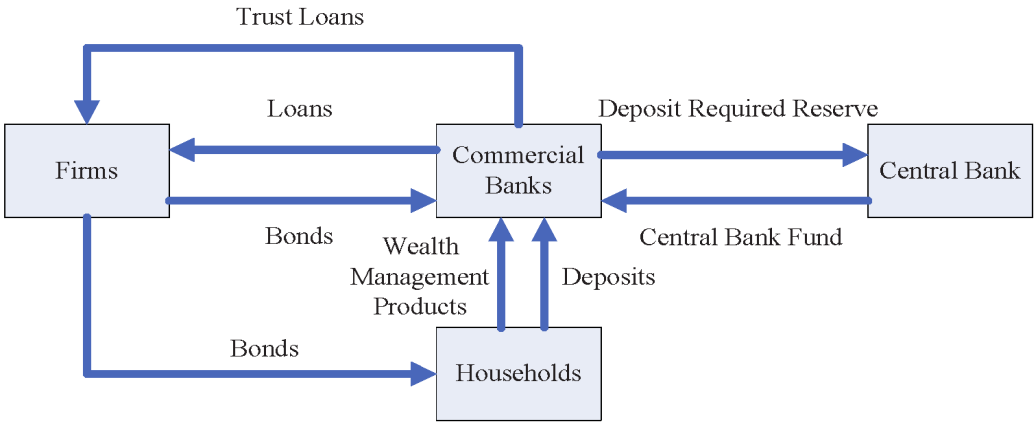
This figure illustrates the financial system structures and the interactions among the representative agents in Models 1, 2, and 3, respectively. The arrow represents the direction of capital flow.



(A) The Structure of Model 1



(B) The Structure of Model 2



(C) The Structure of Model 3

Figure 2: **Social Surplus and Market Frictions**

This figure reports the interactions between social surplus gain contributed by shadow banking and the degree of deposit rate repression, the degree of bank loan restriction, deposit reserve requirement, and bond market inefficiency. Social surplus gain is measured by the difference between the aggregate social surpluses of Model 1 and Model 2; the degree of deposit rate repression is proxied by the percentage of deposit rate ceiling to market-determined deposit rate, k_1; the degree of bank loan restriction is proxied by the ratio of loan quota to market equilibrium loan size, k_2; deposit reserve requirement is the percentage of deposit used as capital reserve at the central bank, α; bond market inefficiency is proxied by the firm's bond issuance cost, δ_{FB}.