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

Hao Wang† Honglin Wang‡ Lisheng Wang§ Hao Zhou¶

October 7, 2019

Abstract

We provide a novel interpretation of shadow banking in China from the perspective of dual-track interest rate liberalization. Shadow banking leads to a *Kaldor-Hicks* improvement, if the gains from reducing the capital idleness and financing the more productive private enterprise (PE) outweigh the expected PE default loss. *Pareto* improvement is achieved, because the less productive state-owned enterprise (SOE) participates and gains in shadow banking by transferring bank credit to the PE. In the presence of credit misallocation favoring the SOE, full interest rate liberalization may not guarantee a *Pareto* improvement.

JEL Classification: G21, G23, G28, P21, P31, P34.

Keywords: Shadow banking, interest rate liberalization, dual-track reform, *Kaldor-Hicks* improvement, *Pareto* improvement.

*We would like to thank Vid Adrison (NBER EASE discussant), Chong-En Bai, Loren Brandt, Hui Chen (NBER China discussant), Douglas Gale, Kinda Hachem (NBER EASE discussant), Zhiguo He (Tsinghua Finance Workshop discussant), Takaoshi Ito, Andrew Karolyi, Justin Yifu Lin, Jun Liu (CICF discussant), Zheng Liu, Debbie Lucas, Wenlan Luo (CICM discussant), Min Ouyang, Yingyi Qian, Kang Shi, Michael Zheng Song, Yong Wang, Wei Xiong, Lihong Zhang, Zhen Zhou, Fabrizio Zilibotti, and seminar participants at CICF, CUHK, Federal Reserve Board, Fudan, NBER EASE, NBER China Economy, Institute for New Structural Economics at Peking University, Tsinghua Finance Workshop, and CICM for their comments. All errors remain ours.

†Tsinghua University, School of Economics and Management, 318 Weilun Building, Beijing 100084, China. E-mail: wanghao@sem.tsinghua.edu.cn.

‡Hong Kong Institute for Monetary Research (HKIMR), 55/F, Two International Finance Centre, 8 Finance Street, Central, Hong Kong. Email: wanghonglinmail@yahoo.com.

§The Chinese University of Hong Kong, Department of Economics, Shatin, New Territories, Hong Kong. Email: wanglisheng@link.cuhk.edu.hk.

¶Tsinghua University PBC School of Finance and National Institute of Financial Research, 43 Chengfu Road, Haidian District, Beijing 100083, China. Email: zhouh@pbcsf.tsinghua.edu.cn.

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

Abstract

We provide a novel interpretation of shadow banking in China from the perspective of dual-track interest rate liberalization. Shadow banking leads to a *Kaldor-Hicks* improvement, if the gains from reducing the capital idleness and financing the more productive private enterprise (PE) outweigh the expected PE default loss. *Pareto* improvement is achieved, because the less productive state-owned enterprise (SOE) participates and gains in shadow banking by transferring bank credit to the PE. In the presence of credit misallocation favoring the SOE, full interest rate liberalization may not guarantee a *Pareto* improvement.

JEL Classification: G21, G23, G28, P21, P31, P34.

Keywords: Shadow banking, interest rate liberalization, dual-track reform, *Kaldor-Hicks* improvement, *Pareto* improvement.

1 Introduction

China's interest rate control policy in the past decades has been characterized by effectively binding deposit rate ceiling and bank loan quota. The policy is mainly exercised through banks that dominate the financial system. Due to the misallocation of bank credit in favor of state-owned enterprises (SOEs), which enjoy implicit government guarantee, the rigid interest rate control becomes a root-cause of major economic distortions in the Chinese economy—e.g., over-capacity in capital-intensive industries, investment-driven business cycles, low SOE efficiency, and credit deprivation for private enterprises (PEs).

Oppositions to interest rate reform or liberalization mainly come from SOEs and banks, who fear to lose their privileged positions of artificially low financing cost and guaranteed interest rate spread, respectively. Policy makers also worry that premature interest rate liberalization could expose the vulnerability of banks and SOEs, causing financial panic and economic turmoil. How to formulate a pragmatic reform strategy for interest rate liberalization, with the broadest societal support and the least economic disruption, presents a great challenge for China's policy makers.

Shadow banking in China has experienced exponential growth in the past decade—mainly in the forms of wealth management products (WMPs) on the liability side, and trust loans and entrusted loans on the asset side, of shadow banking balance sheet. This essentially serves as a dual-track reform mechanism to gradually liberalize the rigid control of interest rates. That is, alongside the preexisting controlled track of banking credit favoring SOEs, a new market track of shadow banking is established to channel credit to PEs at the market-determined interest rates. We provide novel economic interpretations of China's shadow banking in this paper by addressing the following questions: Can shadow banking generate a *Kaldor-Hicks* improvement (aggregate profit gain)? Can shadow banking help to achieve a *Pareto* improvement (reform without losers)? Will full interest rate liberalization alone lead to additional profit gain or further *Pareto* improvement?

We examine a market equilibrium model of the Chinese credit system. There are four

representative agents in economy—the household, the SOE, the PE, and the bank—who maximize their respective objective functions, based on which the market equilibrium is then established. This setting deviates from the classic general equilibrium models that usually allocate entire profits to the household and focus on examining the household's optimization problem (see, e.g., Diamond and Dybvig, 1983; Allen and Gale, 2000). The difference stems from the unique features of China's transitioning economy, in particular, not all SOEs', banks', or even PEs' profits eventually flow to households, due to the developing embryonic nature of the property right or ownership right system (Qian and Roland, 1998; Lin, Cai, and Li, 1998; Lin and Tan, 1999; Lau, Qian, and Roland, 2000). Consequently, our approach to understand shadow banking in China—as a practical reform mechanism of dual-track interest rate liberalization—purposely aims to resolve or mitigate the conflicting interests among various reform stake holders.

Our model shows that shadow banking in China affects the aggregate profit through three channels. First, the *"capital"* channel: shadow banking attracts funds away from bank deposit, which is subject to ultra-high reserve requirement ratio (RRR), putting more capital into production and reducing capital idleness. Second, the *"productivity"* channel: shadow banking channels bank credit toward the previously capital-deprived, high-productivity PE, which generates greater profit than SOE. Third, the *"risk"* channel: the PE default loss reduces profit. China's dual-track interest rate liberalization via shadow banking leads to *Kaldor-Hicks* improvement, if the gains from reducing capital idleness and from financing more efficient PE outweigh the expected PE default loss.

Pareto improvement can be achieved under the dual-track interest rate liberalization with specific, yet reasonable conditions. The household and PE are unconditionally better off from the dual-track interest rate liberalization, because they are given the options to participate in shadow banking for potential gains or to stay out of it without being worse off. The PE can afford to borrow at a higher market interest rate than the controlled bank loan rate, due to its higher productivity than the SOE's. As a result, the bank can offer a more attractive WMP rate to the household than the controlled deposit rate, after

adjusting for the PE's expected default loss. The bank earns zero or fixed profit and is guaranteed not to suffer any reform loss.[1]

More importantly, the SOE can avoid being worse off during the dual-track interest rate reform, by participating in shadow banking—transferring bank credit to the more productive PE and sharing the profit gain. The aggregate gain from the dual-track interest rate reform increases with the PE's productivity. Since the PE's default loss has an upper limit, then, there exists a lower bound of the PE's productivity that generates sufficiently high profit gain to fully compensate the SOE's loss during the dual-track interest rate reform. Because the profit distributions among the agents are determined by the equilibrium interest rates, which in turn are anchored by the binding deposit rate ceiling and bank loan quota, the government can adjust these two controls to make *Pareto* improvement feasible or achievable during the reform.

Full interest rate liberalization removes the binding deposit rate ceiling and bank loan quota, which inadvertently enhances two existing distortions in the economy. First, the household allocates more funds away from WMP and back into bank deposit, hence more capital flows into the low-productivity SOE and less capital into the high-productivity PE. Second, more funds flow into bank deposit, which is subject to ultra-high RRR and creates more capital idleness. However, full interest rate liberalization reduce PE default loss, due to shrinking shadow banking activity. Overall, the household is better off due to higher interest rates—deposit rate and WMP rate, the PE is worse off due to less financing from shadow banking and higher financing cost, and the bank remains unchanged with zero or fixed profit. However, the SOE can be either better off or worse off, depending on whether the gain from more bank loan financing offsets the losses from less bank credit transfer to the more productive PE and from higher bank loan financing cost. *Pareto* improvement cannot be achieved from full interest rate liberalization alone in China.

[1] Alternatively, we can assume that the bank bargains with the household to share the latter's profit gain, which serves as an important motivation in real world for the bank to engage in shadow banking activities. Our current simplified setting focuses on the SOE's incentive to participate in shadow banking and achieves closed-form solutions, while the bank's guaranteed profit margin is more or less supported by the extreme tight financial regulations in China today.

Lin (1992) and Lau, Qian, and Roland (2000) study dual-track reforms in the agricultural and industrial sectors in China. Our work shares their insights that, in the presence of multiple structural distortions, the pragmatic dual-track reform mechanism could outperform the single-track reform mechanism to achieve *Pareto* improvement. Our model has unique policy implications. Today's financial sector in China, unlike the agriculture and industry sectors in 1980s and 1990s, is a controlled system rather than a fully planned system (Brandt and Zhu, 2000; Brunnermeier, Sockin, and Xiong, 2017). *Pareto* improvement in the financial sector reform cannot be achieved with forced execution of the plan track, as in the real sector reforms in the 1980s and 1990s. Market mechanism—such as credit transfer in shadow banking—plays a crucial role in achieving *Pareto* improvement in the financial sector reforms. [2]

There is a burgeoning literature on China's shadow banking activities. Allen, Qian, Tu, and Yu (2019) study entrusted loans, while Acharya, Qian, and Yang (2019) investigate wealth management products (WMP). They show that shadow bank instruments based on market interest rates provide alternative financing to the non-state-owned firms and become more risk sensitive in terms of loan pricing, which supports our modeling framework. Chen, He, and Liu (2019) find that credit tightening after the RMB 4-trillion stimulus package promoted the growth of shadow banking in China. Hachem and Song (2017b) try to rationalize that a move to stricter bank liquidity standards would trigger credit boom through the less regulated off-balance-sheet channel. These findings support our argument that, since the government plays a central role in financial market (Xiong, 2018), shadow banking development in China must have received the government's tacit endorsement. Cong, Gao, Ponticelli, and Yang (2019) document that the credit expansion driven by the RMB 4-trillion stimulus disproportionately favored the less efficient state-owned firms, reversing the process of capital reallocation toward the more efficient private firms that characterized the high growth period in China before 2008. Their finding is in line with

[2]Financial intermediary is also ignored in Lin (1992) and Lau, Qian, and Roland (2000), because forced execution of the plan track in the real economy sector reforms dose not rely on it. However, financial intermediaries, especially banks, are an integral part of the market-based interest rate reform mechanism.

the key implication in our model that shadow banking in China provides financing to the private sector and improves productivity.

Chen, Ren, and Zha (2018) demonstrate that the contractionary monetary policy during the 2009-2015 period caused shadow banking loans to rise rapidly, offsetting the expected decline of traditional bank loans, and that shadow banking tends to reduce the effectiveness of monetary policy. Our model predicts such a substitution effect between shadow bank credit and formal bank credit, with the latter being more directly affected by monetary policy. More precisely, the shadow banking regime as a phase during interest rate liberalization helps to circumvent the rigid controls on bank loan price and quota, which are imposed alongside the conventional monetary policy. Chang, Liu, Spiegel, and Zhang (2019) show that, within a two-sector dynamic stochastic general equilibrium (DSGE) model, increasing reserve requirements reallocates resources to more productive private firms and improves aggregate productivity, which is related to the substitution effect mentioned above. Liu, Wang, and Xu (2019) use model calibration to illustrate that in the second-best environment where multiple distortions exist, interest-rate liberalization can reduce aggregate productivity and welfare, unless other policy reforms are also implemented to alleviate the SOEs' distorted incentives and/or to improve the private firms' credit access. Our model produces the exact same implications for the phase of full interest rate liberalization, yet we show in contrast that shadow banking as the second best approach can improve aggregate productivity by effectively financing the more efficient private firms.

The interconnected reforms in interest rate policy and in the SOE and banking sectors are of critical importance to the efficiency and stability of the Chinese economy in the coming decades. Our market equilibrium model has the potential to incorporate these reforms and other insights of the existing literature into a unified framework, to study a broad range of economic and financial reform issues going forward in China.

The remainder of the paper is organized as follows. Section 2 reviews China's interest rate policy, banking sector, and shadow banking sector. Section 3 introduces our model. Section 4 analyzes the results. Section 5 presents numerical analysis. Section 6 concludes.

2 Institutional Background

This section reviews China's interest rate policy, banking sector, and, shadow banking development. It provides an important context for understanding the shadow banking activities in China from the perspective of interest rate liberalization.

2.1 China's Interest Rate Policy

In China, interest rates have been under rigid control since the era of planned economy. *Price-based* and *quantity-based* controls are primarily exercised through banking regulations, as banks dominate the country's financial system. The *price-based* control involves deposit rate ceiling and loan rate floor that were imposed to transfer wealth from creditors to borrowers (Lardy, 2008) and to ensure a sizable profit margin for banks.[3] Repressed interest rates would lead to excessive credit demand, over-investment, and high inflation. To maintain economic stability, *quantity-based* controls are imposed to limit bank loan volume, which is equivalent to controlling overall money supply. In particular, banks were not allowed to lend over 75% of their deposits until October 2015. The PBoC requires banks to hold deposit reserves at levels that are much higher than those in the developed economies.[4] Banks also receive window guidance from the PBoC to adjust lending to the sectors whose growth the government intends to influence.[5]

2.1.1 Formation of China's Interest Rate Policy

China's interest rate policy was formed in the planned economy era. Interest rates were repressed to facilitate the economic development strategy to prioritize the development

[3]Official loan rate floor and deposit rate ceiling were removed in 2013 and 2015, respectively. However, bank deposit and lending rates are still effectively controlled by the People's Bank of China (PBoC) through instructions and window guidance nowadays.

[4]As of January 2018, the required reserve ratios (RRRs) for large depository institutions and small- and medium-sized institutions are 17.0% and 15.0%, respectively. In comparison, the RRRs in the U.S., Eurozone, and Japan are around 0-10%, 0-1%, and 0-1.3%, respectively.

[5]For example, lending to local government financing vehicles after the 2008 global financial crisis, to government-supported industries such as new energy cars several years ago, and to small- and medium-sized enterprises and the private sector in recent two years.

of the heavy industries (Lin, 1990; Lin and Zhou, 1993).[6] The heavy industries are capital-intensive, while capital was the scarcest production resource during the early stage of economic development. China artificially reduced the cost of capital through interest rate repression and exchange rate repression. Wage and raw materials prices were also repressed to ensure a high profit margin for the heavy industries. However, interest rate repression would inevitably enlarge the gap between capital demand and supply (Kornai, 1980). To solve the problem, China established a highly centralized planned economy to ration resources to the heavy industries. In addition, enterprises were nationalized to relocate profits toward the heavy industries. China quickly established a complete heavy industry system and achieved rapid economic growth between 1949 and 1956. However, the strategy to prioritize the development of the heavy industries was not sustainable. On the one hand, the surpluses transferred from the other sectors and households were gradually exhausted. In particular, the agriculture and consumer industries experienced almost no growth during the same period of time. On the other hand, the excessive heavy industry outputs could not be afforded by the other sectors and households. Most households remained impoverished due to low wage and slow wealth accumulation. China experienced economic stagnation from 1956 to 1978.

China started economic reforms in 1978 and has gradually transitioned from a planned economy to a market economy. The state-controlled procurement system of agricultural and industrial products was gradually demolished (Lin, 1992; Lau, Qian, and Roland, 2000). Some SOEs were partially privatized and went public (Sun and Tong, 2003; Liao, Liu, and Wang, 2014). Wage and prices of major goods and services became market-determined. Private enterprises (PEs) emerged in 1980s and have experienced rapid growth (Song, Storesletten, and Zilibotti, 2011). However, interest rates largely remain under tight

[6]China chose to prioritize the growth of the heavy industries for the following reasons: China needed to quickly establish a nationwide defense system; impoverished agricultural economy did not provide necessary market conditions for the debut of economic development; the heavy industries have the advantage of consuming their own outputs to support their own growth at initial stage. The same strategy was adopted by the former Soviet Union, India, and some Eastern European and Latin American countries in early economic development.

control, and the long waited liberalization reform has been progressing very slowly (Brandt and Zhu, 2000).

2.1.2 Problems of Interest Rate Repression

Interest rate repression underlies major structural imbalance and distortions in the Chinese economy. Low interest rates induced incentives for excessive investment. Cheap credit flew into the capital-intensive industries, such as steel and coal mining, leading to over capacity and environmental pollution. Artificial low interest rates tend to encourage both enterprise investment and household consumption. The Chinese economy exhibits abnormally volatile aggregate demand and policy-driven economic cycles.

An economic boom typically started with simultaneous increases in investment and consumption, as the government injected abundant liquidity in the banking system and eased investment restrictions in some sectors. To facilitate the government policy, banks quickly expanded credit supply to meet the rapidly rising capital demand. After experiencing rapid growth usually for a couple of years, the economy became over-heated due to excessive credit supply; inflation rose as demand for goods and services exceeded their supply. Brandt and Zhu (2000) show that economic growth and inflation move in tandem in China.

To arrest the run-away inflation, monetary and fiscal policies were reversed to prevent the economy from being overheated. The PBoC ordered banks to reduce credit supply, and the government tried to control price increases of necessity goods. Both investment and consumption receded dramatically, exposing the economy to the risk of hard landing. The government would face difficulty in balancing its budget, if the economic slowdown persisted (Lin and Zhou, 1993). Fiscal pressure forced the government to soften restrictions on investment in some sectors again, setting off a new round of policy-driven economic cycle.

Despite these well-known problems, the interest rate reform has been conducted

extremely slowly and cautiously (Brandt and Zhu, 1995, 2000; Lardy, 1998). In the absence of efficient bond markets, monetary policy was more effectively transmitted via interest rate controls in the banking sector, rather than via financial markets (Zhou, 2009). Policy makers concerned that a large-scale, premature interest rate liberalization could lead to disastrous economic turmoil and social instability, as the reform would fundamentally weaken the SOEs and banks, which had low efficiency but were important for economic stability in China. SOEs worried about loosing their privileged low financing cost, and banks worried about loosing their guaranteed wide interest spreads. Both opposed to the reform. Hence, interest rate liberalization requires a pragmatic approach to overcome resistance from the vested interests, in order to achieve the broadest societal support.

2.2 Banking Sector in China

Banks dominated the Chinese credit system, with an unrivaled client base including SOEs. For households, there were few legitimate alternative investment choices other than bank deposit, given the underdeveloped bond and equity markets and the nearly closed capital accounts. Banks benefited from a *de facto* guarantee on the deposits from the People's Bank of China (PBoC).[7]

The banking system in China is a controlled system, although not a strictly planned system. The government effectively controls the national banks through majority shareholding. Executives of the banks, especially those state-owned ones, are appointed by the government. Although the official bank loan rate floor and deposit rate ceiling were removed in 2013 and 2015, respectively, the government still effectively controls bank deposit rates through formal instructions and informal window guidance. Meanwhile, although the government removed the 75% cap on loan-to-deposit ratio in August 2015, quantitative limits on loan volume are still in place and binding for most banks. Some of them are imposed as part of the macro-prudential supervision, while the others might be

[7]In May 2015, China announced to establish the bank deposit insurance system that provides official guarantee of bank deposit up to 500 thousand yuan per account.

exercised as regulatory measures targeted at credit extended to some specific industries and sectors, e.g., real estate and local governments.

Banks are addicted to lending to SOEs that are endowed with either explicit or implicit government guarantee. Making non-performing loans to SOEs is unlikely to be penalized as harshly as making non-performing loans to PEs. Banks are particularly reluctant to lend to PEs, especially small- and medium-sized enterprises (SMEs), which usually have higher credit risk but are more productive than SOEs.

2.3 Shadow Banking Development in China

Shadow banking in China has experienced explosive growth in the past decade (Table 1).[8] Banks play a central role in the shadow banking activities. In particular, banks raise capital from households through wealth management products (WMPs) to bypass deposit rate ceiling and high reserve requirement, make trust loans to bypass loan quota, and serve as financial intermediaries to make entrusted loans on behalf of large enterprises. Non-bank financial institutions (NBFIs) are also involved in shadow banking to help bypass regulatory restrictions.[9]

This China-style shadow banking practice must be understood in the context of banks' dominance in the credit system. In essence, banks have an unrivaled privilege over other financial institutions in accessing individual and institutional savings. Historically, only

[8]Table 1 shows that the new issuance of entrusted loans (trust loans) increased from 270 (83) billion yuan in 2006 to 2,547 (1,840) billion yuan in 2013, with the share in the aggregate financing to the real economy rising from 6.3% (1.9%) in 2006 to 14.7% (10.6%) in 2013. In contrast, the new issuance of corporate debt and equity were 1,811 and 222 billion yuan in 2013, respectively. The ratio of domestic loans to aggregate financing to the real economy fell continuously from 91.9% in 2002 to 51.3% in 2013—the peak of shadow banking development, implying that business flew away from formal banking towards shadow banking over time.

[9]Major NBFIs, including trust companies, securities companies, insurance companies, mutual funds and their subsidiaries, involve in shadow banking activities through asset management products, most of which are initiated by and cooperated with banks. These major NBFIs essentially help channel credit from banks to productive but riskier firms which usually have limited access to bank loans, under the tight regulation and supervision by the authorities. Other small-sized NBFIs, such as finance companies, pawn shops, microcredit companies, online peer-to-peer lending platforms, financial leasing companies, and financial guarantee companies, also extend a small proportion of credit to the corporate sector. However, the scale of their business is much smaller than the "bank-initiated" shadow banking.

state-owned banks were allowed to take deposits, so banks inherit a huge client base. Before the establishment of formal deposit insurance in 2015, bank deposits had *de facto* government guarantee, whose scope, however, was vague, leading to the misperception that government will bail out the entire bank in case of default. Banks take advantage of this misperception to issue WMPs at relatively low costs (Dang, Wang, and Yao, 2014).

The development of shadow banking in China has three stages. The first stage was shadow banking boom (2006-2010). After the 2008 global financial crisis, the government launched a RMB 4 trillion stimulus package to stabilize domestic investment and economic growth. However, the central government provided only RMB 1.2 trillion funding, so the remaining funding needed to come from the local governments and financial institutions. Facing binding budget constraints, the local governments set up local government financing vehicles (LGFVs) to promote infrastructure construction and other investments (Ang, Bai, and Zhou, 2019). Traditional bank credits could not fully meet the capital demand, so banks turned to off-balance-sheet business (Hachem and Song, 2017b; Chen, Ren, and Zha, 2018; Chen, He, and Liu, 2019). Small- and medium-sized banks, which had a smaller deposit customer base and were less regulated, took the lead in conducting shadow banking activities. Intensified competition between small and large banks induced the latter to engage in shadow banking business (Hachem and Song, 2017a; Allen, Qian, Tu, and Yu, 2019). As a result, the off-balance-sheet shadow banking credits provided necessary funding to stabilize the economy.

The government tacitly endorsed the shadow banking development, as it provided an alternative market track to supplement the existing controlled track of credit supply, which is subject to a variety of regulatory distortions in prices and quantities that are difficult to remove in the short term. In particular, shadow banking helped financial institutions to learn how to operate with market interest rates and to become sensitive to default risk—preparing for the interest rate liberalization reform. Shadow banking also helped to alleviate the financing difficulty for PEs and SMEs (Allen, Qian, Tu, and Yu, 2019).

The second stage of shadow banking development is characterized by regulatory

arbitrage and risk accumulation (2011-2015). As the interplay between banks and NBFIs—trust companies, securities firms, mutual funds and their subsidiaries, private equity funds, and insurance companies—became excessive, the profit margin of shadow banking began to narrow. More capital is circulating within the financial industry among various, complicated financial products for regulatory arbitrage, rather than flowing to the real economy (credit to non-financial sectors, e.g., corporates and households), amid domestic growth slowdown. Shadow banking credits were misused for regulatory arbitrage—banks tried to "beautify" their balance sheets by selling off non-performing assets to other financial institutions through structured products. Shadow banking products became more complex, increasing credit system opaqueness and aggregate risk (Song and Xiong, 2018).

During this period, many of the shadow banking activities of regulatory arbitrage were carried out under the banner of financial innovation, making regulation more difficult. Supervision lagged behind the evolution of shadow banking, especially before 2018, as the PBoC, China Banking Regulatory Commission (CBRC, the bank regulator), China Securities Regulatory Commission (CSRC, the securities firm regulator), and China Insurance Regulatory Commission (CIRC, the insurance company regulator) have segmented supervision duties, and there was a lack of coordination among them.

The third stage of shadow banking development involved significant tightening of financial regulation, aiming to contain the shadow banking risks (2016-2018). Regulators comprehensively strengthened the supervision of WMPs, in terms of source of capital, product design, investment and risk control. Financial institutions and individuals faced more stringent laws and regulations and heavier penalties for wrongdoings involved in shadow banking activity. In 2017, the Financial Stability and Development Commission of the State Council was established to strengthen communication and coordination among the regulators.[10] The monetary policy was also tightened in coordination with financial

[10]China's bank and insurance company regulators, CBRC and CIRC, were merged into a single commission, namely, the China Banking and Insurance Regulatory Commission (CBIRC) in April 2018. The CBIRC oversees both banking and insurance sectors under the direct control of the State Council, China's cabinet. A major objective of the merger is to enhance the coordination of regulation and policymaking.

regulation, to reduce the scale of trust loans, entrusted loans, and undiscounted banker's acceptance—the main shadow banking assets.

Tightening financial supervision and contractionary monetary policy caused a rapid decline in credit supply to real economy and increased financial institutions' risk aversion. While credit supply to SOEs remained stable, lending to PEs was significantly reduced. As capital supply shrunk and financing costs increased, the private sector experienced a phenomenal wave of increase in default and bankruptcy. The significant downturn in the private sector dragged down the growth of the real economy, especially in 2018 and likely to extend to 2019. The disproportionally stronger adverse effects of shadow banking crackdown on the more efficient private sector and SMEs highlight the importance of shadow banking as an alternative financing channel to support economic growth.

Policy stance changed in 2018. The government publicly stressed the need to increase credit support to PEs and SMEs. In December 2018, the governor of PBoC, Mr. Gang Yi, stated at prominent public forum that shadow banking is a necessary complement to China's financial system, while its operation needs to be properly regulated. In January 2019, the central bank adjusted the bank performance evaluation standards to promote bank lending to SMEs.These policy corrections essentially aimed to fill up the vacancy left over by shrinking shadow bank lending to the private sector and SMEs.

As a pilot reform program of interest rate liberalization in China, shadow banking inevitably experienced misconducts, excesses, and corrections (Xiong, 2018; Song and Xiong, 2018; Cong, Gao, Ponticelli, and Yang, 2019; Chen, He, and Liu, 2019). However, during its historical development, shadow banking has played a remarkable positive role of benchmarking market interest rates and financing the private sector and SMEs that have long been deprived of credit access under the controlled formal banking system (Allen, Qian, Tu, and Yu, 2019). Perhaps, most importantly, it prepares the regulators and other economic agents ready for full interest rate liberalization coming soon.

3 Model Setup

We develop a market equilibrium model to study the economic implications of dual-track interest rate liberalization with formal banking and shadow banking. This section introduces our baseline model, which is then modified to resemble China's credit systems both before the rise of shadow banking and after the full interest rate liberalization.

3.1 The Baseline Model

The baseline model describes a dual-track credit system, which has four representative agents: a household, a bank, an SOE, and a PE. Throughout the paper, we use the superscripts "H", "B", "S", and "P" to represent the household, the bank, the SOE, and the PE, respectively. The household has an endowment (E) and is the ultimate capital provider. As illustrated in Figure 1, the credit system channels formal banking credit (bank loans) to the SOE and shadow banking credit (trust and entrusted loans) to the PE and SOE. The formal banking track is subject to deposit rate ceiling, loan quota, and reserve requirement, while the shadow banking track is not.

We make the following assumptions:

Assumption 1: The PE is more productive than the SOE. This assumption is supported by ample empirical evidence. Dollar and Wei (2007) find that the average return on capital of PEs is about twice of that of SOEs in China. Song, Storesletten, and Zilibotti (2011) estimate that the average productivity (measured by the ratio of profit to fixed assets net of depreciation) gap between SOEs and PEs is about nine percentage points in China. Thus, we assume $A^P > A^S$, where A^P and A^S denote the productivity of the PE and SOE, respectively.[11]

[11]SOEs in China have been carrying out policy burdens on behalf of the government—including addressing market failures in sectors with positive externalities and absorbing redundant labors to safeguard social stability (Lin and Tan, 1999). Otherwise, it would be irrational for the government to subsidize SOEs through cheap bank credits. If such policy burdens are not removed, privatization may increase the subsidies for SOEs, as seen in former Soviet Union and Eastern European countries (see, e.g, Lin and Li, 2008).

Assumption 2: Credit Rationing under Formal Banking. We assume that bank credit is entirely rationed to the SOE. The PE has no access to bank loan. This assumption is consistent with the notion that the Chinese banks strongly favor lending to SOEs (Wei and Wang, 1997; Cong, Gao, Ponticelli, and Yang, 2019; Chen, He, and Liu, 2019). Brandt and Zhu (2000) show that before financial decentralization, bank credit was entirely allocated to SOEs. After decentralization, banks began to have limited discretion to allocate a small portion of credit to the PEs. One can think of the PE in our model as the SME that literally have no access to bank loans. This assumption greatly simplifies the model's analytical derivation, however, relaxing it will not qualitatively change the main results.

Assumption 3: Credit Resale under Shadow Banking. We assume that the SOE and PE can resell credit to each other at a market price under the shadow banking track. The assumption is consistent with the entrusted loan practice in China, that is, large enterprises, mostly SOEs, make entrusted loans to other firms using banks as an intermediation (Allen, Qian, Tu, and Yu, 2019). Table 1 shows that entrusted loans account for a significant proportion of shadow banking activity. Given Assumptions 1 and 2, it is easy to show that in equilibrium, the SOE resells credit to the PE, not *vise versa*. As detailed in Assumption 4, entrusted loan and trust loan are exposed to the same level of default risk, and hence, have the same rate, ruling out arbitrage within shadow banking activities.

Assumption 4: Default Risk from Shadow Banking. We assume that both the SOE and PE can default. In case of default, the PE's creditors will suffer a loss, while the SOE's creditors will experience no loss due to government guarantee. Assuming full SOE default recovery or zero expected default loss is technically equivalent to assuming

no SOE default.[12] We assume the following default probability function for the PE:

$$p(T^P) = \frac{T^P}{M} \in [0, 1], \tag{3.1}$$

where T^P denotes the aggregate shadow banking credit obtained by the PE, and M is a normalization parameter that sets PE default probability between 0 and 1. We can think of $\frac{1}{M}$ as the marginal cost of shadow banking, as it captures the sensitivity of PE's default risk (p) with respect to the size of shadow bank credit (T^P). One can also view M as a fixed amount of non-productive equity endowed by the PE, then $\frac{T^P}{M}$ describes the PE's leverage ratio. Black and Scholes (1973) and Merton (1974) show that leverage ratio is a fundamental determinant of default risk. Equation (3.1) suggests that the PE's default probability, p, is endogenously determined and increases with the size of shadow banking credit. For simplicity and without loss of generality, we model the PE's default probability as a linear function of the size of shadow banking credit.[13] Based on the market equilibrium conditions for trust (entrusted) loan and WMP markets (in Section 3.1.5), the default probability can be re-written as follows: $p(T^P) = (T^S + T^B)/M = (T^S + W)/M$, where T^S, T^B, and W denote entrusted loans obtained by the PE from the SOE, trust loans obtained by the PE from the bank, and WMP credits obtained by the bank from the household, respectively.

Assumption 5: Profit Sharing Rule in Formal Banking. Without imposing deposit rate ceiling, the SOE, bank, and household negotiate deposit rate and bank loan rate to share the SOE's production profit. For simplicity, we assume that the bank earns zero profit, which is equivalent to a fixed guaranteed profit. The relative bargaining power of the household against the SOE is θ, which implies that without deposit rate ceiling, the

[12] Assuming effectively no default for the SOE loans confirms the field practice in China that the government bails out troubled loans for SOEs from banks. However, there is a significant cost associated with such a government guarantee—likely reflected in the huge differential between the PE and SOE productivities within our simple framework (Dollar and Wei, 2007; Song, Storesletten, and Zilibotti, 2011).

[13] We could, perhaps more realistically, model default probability as a non-linear convex function of the size of shadow banking credit. Doing so, however, will not change our conclusions, but will make solving the model significantly more difficult.

natural level of bank deposit rate will be equal to θ multiplied by the SOE's productivity (return on capital, A^S). For example, if $\theta = 0.7$ and $A^S = 5\%$, the equilibrium deposit rate is $r^D = 3.5\%$ ($= \theta \times A^S = 0.7 \times 5\%$). The bank loan rate is subsequently determined according to the bank's objective function. The artificially repressed deposit rate effectively distorts the relative bargaining power in favor of the SOE.

Assumption 6: Default Loss Sharing Rule in Shadow Banking. We assume that upon default, the PE will lose all its borrowed capital. The PE itself will bear a portion, γ, of the loss with its endowed equity and accumulated profits. Shadow bank creditors bear the rest $1-\gamma$ of the loss, among which, the SOE bears the loss for entrusted loans, and the household bears the loss for trust loans. For simplicity, we assume that the bank, as a financial intermediary, bears no default loss. Notably, we also have the following remark:

Remark 1. *The SOE will unconditionally obtain a non-negative profit in equilibrium after the rise of shadow banking, even though it is exposed to the expected default loss of the PE.*

See Appendix A.1 for proof. The remark suggests that the SOE will not go bankrupt in equilibrium, as participating in shadow banking activities is a free option for the SOE; and it can at least achieve a non-negative profit through own-production with bank loans only. Our numerical simulation in Section 5 also offers an example, based on a set of parameters characterizing the Chinese economy more realistically.

In our model, four representative agents maximize their own objective functions. Market equilibrium is then established based on agents' optimization outcomes. Different from the standard banking literature that typically allocate all profits to households and focus on examining the optimization problem of the household sector (see, e.g., Diamond and Dybvig, 1983; Allen and Gale, 2000), we assume that each agent retain their own profits in equilibrium. This setting captures the nature of transitioning economy in China (Qian and Roland, 1998; Lin, Cai, and Li, 1998; Lin and Tan, 1999; Lau, Qian, and Roland, 2000): 1) most of Chinese enterprises seldom pay dividends; 2) SOEs and large banks are wholly or

largely owned by the government, with a considerable proportion of profits flowing back to the government sector; 3) one of our main objectives is to examine whether the dual-track reform could potentially allow winners to compensate losers.

We do not explicitly consider direct financing in the model. First, direct financing is of a much smaller size compared to those of formal banking and shadow banking. For example, as shown in Table 1, the total amount of equity and bond issuance was only 6.8% of the aggregate financing to the real economy in 2017. Moreover, most PEs, especially SMEs, are not eligible for issuing public equity and bond in practice. In this sense, one can regard direct financing as a part of the controlled credit track in our model. For simplicity and without loss of generality, we omit direct financing here, and focus on modeling formal banking and shadow banking that are central to our economic analysis.

3.1.1 The Bank

The bank is the nexus of the formal banking track and the shadow banking track. On its balance sheet, the bank raises capital from the household in the form of deposit and makes loans to the SOE. Off its balance sheet, the bank raises capital from the household through the WMP and makes trust loans to the firm sector. For the bank, formal banking and shadow banking are separate business lines. As the bank's trust loan is eventually funded by the household through WMP investment, we assume that when the PE defaults, the bank will pass the loss of shadow banking business directly to the household. However, as stated in Assumption 4, the SOE enjoys government guarantee hence no loan default.

The bank's objective function is

$$\max_{L,T^B} \Pi^B = \max_{L,T^B} \left\{ \underbrace{(r^L L - r^D D)}_{Formal\ \ Banking} + \underbrace{(1-p)(r^T T^B - r^W W)}_{Shadow\ \ Banking} \right\},$$

$$\begin{aligned} \text{s.t.} \qquad L &\leq (1-\alpha)D, \\ T^B &\leq W. \end{aligned}$$

where L, D, T^B, and W denote the sizes of loan, deposit, trust loan, and WMP, respectively; r^L, r^D, r^T and r^W denote the interest rates on loan, deposit, trust (entrust) loan, and WMP; α denotes RRR. For simplicity, we assume that the central bank pays no interest on deposit reserve.[14]

Bank loans to the SOE are effectively default-free. The bank's profit under the formal banking track equals the revenue from loan investment minus the cost from deposit financing ($r^L L - r^D D$). Given binding budget constraints, this is equal to the spread between bank loan rate and deposit rate multiplied by the size of bank loan ($(r^L - r^D)L$) *minus* interest loss due to deposit reserve requirement ($\alpha r^D D$).

Trust loans to the PE are subject to default risk. Thus, the bank's profit under the shadow banking track equals PE survival probability $(1-p)$ multiplied by shadow banking profit upon survival ($r^T T^B - r^W W$). In case the PE defaults, the bank will pass the loss to the household and obtain zero profit. Shadow banking constitutes a buffer between private firm insolvency and systemic bank failure (Allen, Qian, Tu, and Yu, 2019).

We assume that banks operate their assets on- and off-balance-sheet separately, i.e., assets obtained from deposits net of deposit reserves (on the balance sheet) can be used for making controlled bank loans to the corporate sector only, while assets obtained from WMPs (off the balance sheet) can be used for making market trust loans to the corporate sector only. This is in line with the current regulation and field practice. We also assume that the bank earns zero profit in equilibrium.[15] Then there are following relationships

[14]The PBoC has been paying interest rates of 1.62% for required reserve and 0.72% for excess reserve since November 2008. This assumption helps simplify the model without changing the main conclusions.

[15]The assumption is to simplify the model. Considering bank's optimization problem, for example, by imposing its bargaining power against the SOE and household, will allow us to solve for r^T and r^W in equilibrium. Relaxing this assumption is technically feasible, but it will make the model much messier without gaining much additional insight. In the presence of Pareto improvement, the household and SOE can always give up a slight portion of their profits to make the bank obtain non-zero profit, and attract it to participate in shadow banking. In this sense, we assume that the household and SOE hold absolute dominant bargaining power against the bank. This simplification does not alter the main result.

among the interest rates:

$$\begin{aligned} r^D &= (1-\alpha)r^L, \\ r^T &= r^W. \end{aligned}$$

The first equation tells that, even if the banking sector is perfectly competitive, the bank loan rate is higher than the deposit rate in equilibrium, due to deposit reserve requirement. The second equation shows that, since the bank bears no PE default loss, the bank charges a trust loan rate on par with the WMP rate.

The deposit rate (r^D) is set to equal the binding deposit rate ceiling ($\bar{r}^D$) prior to the full interest rate liberalization. We use a constant ψ to denote the ratio of deposit rate ceiling to the SOE's return on capital, $\psi = \frac{\bar{r}^D}{A^S}$. A feasible deposit rate must be within the range of $\left[0, A^S\right]$. We have $\psi < \theta$, reflecting deposit rate repression (θ is the household's bargaining power against the SOE; and after full interest rate liberalization, $r^D = \theta A^S$).

Bank loan quota and RRR are effectively substitutable *quantitative* credit control tools in China, as RRR is substantially higher than those in the developed economies. We use RRR as the binding loan quantity control in the model. The amount of bank loan equals the amount of deposit net of deposit reserve, $L = (1-\alpha)D$.

3.1.2 The PE

The PE and SOE entirely rely on external financing for production. They have "AK-type" production functions that are linear in capital. According to Assumption 2, the PE has no access to bank loan financing, hence its production entirely rely on the shadow banking credit. The PE's objective function is

$$\max_{T^P} \Pi^P = \max_{T^P} \left\{(1-p)(A^P - r^T)T^P - p\gamma T^P\right\}.$$

where A^P denotes the productivity (return on capital) of the PE. T^P refers to the capital obtained by the PE from the shadow banking track, including trust loan from the bank

and entrusted loan from the SOE. r^T refers to the interest rate of the trust or entrusted loan. The PE's profit follows a binary distribution: if the PE operates normally with a probability of $(1-p)$, it will obtain a profit of $(A^P - r^T)T^P$; while if the PE defaults with a probability of p, it will bear a loss proportional to its total liabilities $(-\gamma T^P)$.

Solving the first order condition (FOC) of the objective function with respect to T^P, we obtain the PE's optional financing rule:

$$T^P = \frac{M(A^P - r^T)}{2(A^P - r^T + \gamma)}.$$

The PE's credit demand (T^P) increases with its productivity (A^P), indicating that a more productive PE tends to borrow more shadow bank credit. Its demand for credit is decreasing in the trust loan rate (r^T) and in the portion of default loss born by the PE (γ).

3.1.3 The SOE

The SOE generates profit from two sources: its own production and credit resale to the PE via entrusted loan. Its objective function is

$$\max_{T^S} \Pi^S = \max_{T^S} \left\{ \underbrace{(A^S - r^L)(L - T^S)}_{Production} + \underbrace{\left[(1-p)r^T - p(1-\gamma) - r^L\right] T^S}_{Credit\ \ Resale} \right\}$$

$$s.t. \qquad T^S \leq L.$$

where T^S denotes the size of entrusted loan supplied by the SOE, hence $(L - T^S)$ measures the residual capital that the SOE employs for production, and $(A^S - r^L)(L - T^S)$ measures the SOE's profit from production. The SOE is exposed to the PE default risk, due to credit resale to the PE under the shadow banking track. And its profit from credit resale also follows a binary distribution: if the PE operates normally with a probability of $(1-p)$, the SOE will obtain a profit of $(r^T - r^L)T^S$; while if the PE defaults with a probability of p, the SOE will bear a loss proportional to the size of its lending to the PE, and cover the funding cost of bank loans $(-(1-\gamma)T^S - r^L T^S)$.

The budget constraint of the SOE suggests that it cannot resell credit exceeding the amount of bank loan borrowed, although the constraint is not necessarily binding. In one extreme case, if the SOE resells all bank loans to the PE ($T^S = L$), the SOE effectively becomes a downstream financial institution. In another extreme case, if the SOE resells zero credit to the PE ($T^S = 0$), the objective function of the SOE is reduced to $\Pi^S = (A^S - r^L)L$.

Solving the FOC of the SOE's objective function with respect to the size of entrusted loan (T^S), we obtains the following credit resale rule:

$$T^S = \frac{(r^T - A^S)M}{2\,(r^T + 1 - \gamma)} - \frac{T^B}{2}.$$

The supply of entrusted loans (T^S) is decreasing in the SOE's productivity (A^S), implying that a less productive SOE would resell more credit to the PE. The supply of entrusted loans is increasing in entrusted loan rate (r^T) and in the portion of default loss born by the PE (γ). It is intuitive that a higher credit resale profit and a lower PE default loss would induce the SOE to resell more credit to the PE, *ceteris paribus*. The entrusted loan supply is decreasing in the size of trust loan (T^B). Trust loans and entrusted loans are substitutable to the PE. An increase in the supply of trust loan would crowd out entrusted loans supplied by the SOE. Thus, the SOE's problem is to trade off the profit generated by its own production versus the profit from reselling credit to the PE.

3.1.4 The Household

The household allocates endowment to bank deposit and WMP to maximize investment profit. The household's objective function is

$$\max_W \Pi^H = \max_W \left\{ r^D D + (1-p) r^W W - p(1-\gamma) W \right\}.$$

$$s.t. \qquad D + W \leq E.$$

where W denotes the size of the household's investment in WMP, and r^W denotes the interest rate of WMP. Given the zero-profit condition of the bank under the shadow banking track, we have $W = T^B$ and $r^W = r^T$. The household obtains default-free profit from her deposit holding ($r^D D$), while her profit from WMP investment follows a binary distribution: if the PE operates normally, the household will obtain a profit of $r^W W$ with a probability of $(1-p)$; while if the PE defaults, the household will bear a loss proportional to the scale of her WMP investment ($-(1-\gamma)W$) with a probability of p.

Assumption 4 yields that p is linear in W, hence Π^H is a quadratic function of W, which ensures an interior solution for the optimal W. The household's profit first increases and then inverts to decrease with W. When W increases above a certain level, the expected marginal default loss exceeds the expected marginal profit gain, so shadow banking will not entirely drive out formal banking.

Solving the FOC of the household's objective function with respect to W, we obtain

$$W = \frac{M(r^W - r^D)}{2(r^W + 1 - \gamma)} - \frac{T^S}{2}.$$

The WMP supply (W) is decreasing in the deposit rate (r^D). The household would optimally allocate less endowment into the WMP if deposit pays a higher interest. W also increases with the WMP rate (r^W) and in the portion of default loss born by the PE (γ), suggesting that the household would allocate more endowment to the WMP when its interest rate is higher, or when more value can be recovered in the case of PE default.

We solve for the household's optimal supply of bank deposit,

$$D = E - \frac{M(r^W - r^D)}{2(r^W + 1 - \gamma)} + \frac{T^S}{2}.$$

It is intuitive that bank deposit (D) decreases as the WMP rate (r^W) increases. Deposit rate ceiling artificially represses deposit rate, discouraging the household to invest in bank deposit. A higher WMP rate would attract more capital away from formal banking to shadow banking.

3.1.5 Equilibrium

Market equilibrium is established when all the market sectors are cleared as the aggregate credit demand meets the aggregate credit supply. Since the bank earns zero profit, the bank loan market is cleared when $r^L = \frac{\bar{r}^D}{1-\alpha}$, in the presence of deposit rate ceiling. The trust (entrusted) loan sector is cleared when the PE's capital demand meets the supplies of trust loan from the bank (funded by WMP) and entrusted loan from the SOE, that is, $T^P = T^S + T^B = T^S + W$. In other words, the PE default probability, p, and the costs of shadow bank loans, r^T, and WMP, r^W are all endogenously determined in equilibrium through credit demand and supply. We substitute the objectives of the household, SOE, and PE into these market clearing conditions to solve for the equilibrium interest rates.

The market clearing condition for the shadow banking sector (trust and entrusted loan), $T^P = T^S + T^B$, implies that

$$\frac{M\left(A^P - r^T\right)}{2\left(A^P - r^T + \gamma\right)} = \frac{M\left(r^T + r^D - 2A^S\right)}{3\left(r^T + 1 - \gamma\right)} + \frac{M\left(r^T + A^S - 2r^D\right)}{3\left(r^T + 1 - \gamma\right)}. \tag{3.2}$$

which is solved to obtain

$$r^T = \frac{N - \sqrt{N^2 - 4\left[3A^P(1-\gamma) + 2\left(\gamma - A^P\right)\left(r^D + A^S\right)\right]}}{2}, \tag{3.3}$$

where

$$N = A^P + 3 + \gamma + 2(r^D + A^S).$$

See Appendix A.2 for proof. We have the following remark:

Remark 2. *The trust (entrusted) loan rate (r^T) is increasing in the PE productivity (A^P), the SOE productivity (A^S), and the bank deposit rate (r^D), but decreasing in the portion of default loss born by the PE (γ).*

See Appendix A.3 for proof. A more productive PE (higher A^P) leads to a stronger demand for shadow bank credit, driving up its price. A higher deposit rate (r^D) and a more productive SOE (higher A^S) tend to reduce the supply of trust loan and entrusted

loan, which also drive up shadow bank credit price. If the PE bears a higher portion of default loss, the PE's demand for capital would diminish, leading to a lower trust (entrusted) loan rate.

Substituting the equilibrium rates back into the agent's objective functions, we compute the agents' profits and the aggregate profit. We have the following remark:

Remark 3. *The SOE will resell credit to the PE under the shadow banking track if and only if* $r^T > 2A^S - r^D$.

See Appendix A.4 for proof. We assume two-way entrusted loan lending, that is, the SOE and the PE can lend to each other. In equilibrium, the SOE would make entrusted loan to the PE, because the latter has higher productivity and can afford a higher financing cost. Allen, Qian, Tu, and Yu (2019) document that "...lenders of nonaffiliated (entrusted) loans have excess cash but low growth rates and therefore use the loans as an alternative investment channel." The less efficient SOE may participate in shadow banking and benefit from it. This remark suggests that for the SOE to resell credit to the PE, the trust (entrusted) loan rate needs to be strictly higher than the SOE productivity.

3.2 Modeling Other Reform Stages

To examine the economic implications of dual-track interest rate reform and full interest rate liberalization, we need to model China's credit system before the rise of shadow banking and after full interest rate liberalization, respectively. This section describes how to modify the baseline model to characterize China's credit system at those stages.

3.2.1 Before the Rise of Shadow Banking

To model China's credit system before the emergence of shadow banking, we simply need to shut off the shadow banking track. An intuitive approach is to set $M = 0$, that is, the marginal cost of shadow banking is infinitely high. In Figure 1, the "WMP", "Trust Loan", and "Entrusted Loan" channels are shut off. The household does not invest in

the WMP. The SOE does not resell credit to the PE. The PE does not produce without external financing.

3.2.2 After Full Interest Rate Liberalization

China has set the full interest rate liberalization as one ultimate goal of its on-going financial reforms. After the full liberalization, bank loan quota "$L = \bar{L}$" and deposit rate ceiling "$r^D = \bar{r}^D$" in Figure 1 are removed, while the shadow banking track remains. In this situation, the deposit rate will rise to its natural equilibrium level, θA^S, from the ceiling level, ψA^S. Accordingly, the bank loan rate will rise to $(\theta A^S/(1-\alpha))$ from $(\psi A^S/(1-\alpha))$.

4 Theoretical Analysis

This section analyzes the economic implications of the dual-track and full interest rate liberalization reforms in China. To facilitate the analysis, we use the numerical subscripts "$i = 0, 1, 2, 3$" to represent the following reform stages: 0 for before the rise of shadow banking; 1 for dual-track reform with shadow banking; 2 for full interest rate liberalization with shadow banking; 3 for single-track interest rate reform, i.e., full interest rate liberalization without shadow banking.

4.1 Aggregate Profit Gain

We first examine whether the dual-track interest rate reform helps to improve the aggregate profit. Before the rise of shadow banking, the aggregate profit is completely generated by the SOE's production and equals

$$\Pi_0 = A^S(1-\alpha)E.$$

Under the dual-track credit system with shadow banking, the aggregate profit is

$$\Pi_1 = (1 - p_1)A^P T_1^P + A^S(L_1 - T_1^S) - p_1 T_1^P, \tag{4.4}$$

which equals the production profits of the PE and SOE *minus* the expected PE default loss. Therefore, the profit gain of the dual-track interest rate liberalization is

$$\Delta\Pi_{1-0} = \Pi_1 - \Pi_0 = \underbrace{A^S \alpha W_1}_{Capital} + \underbrace{\left[(1 - p_1)\, A^P - A^S\right] T_1^P}_{Productivity} - \underbrace{p_1 T_1^P}_{Risk}. \tag{4.5}$$

where $\Delta\Pi_{i-j}$ refers to the change of aggregate profit (the sum of profits of all agents, including the SOE, the PE, and the household) from Stage j to Stage i.

Equation (4.5) describes the profit gain after the rise of shadow banking. The gain is determined by: (1) *Reduction in capital idleness (the "capital" channel)*: Shadow banking attracts capital away from the formal banking track, and hence, reduces the amount of capital subject to the ultra-high RRR, making more capital available to production; (2) *Productivity improvement (the "productivity" channel)*: Shadow banking channels credit to the more productive PE and generates greater profit; (3) *Expected default loss (the "risk" channel)*: The profit gain is decreasing in the expected loss incurred in case of PE default. We have the following proposition:

Proposition 1. *The dual-track interest rate liberalization leads to a Kaldor-Hicks improvement (aggregate profit gain), when the gain from financing the more productive PE and reduction in capital idleness outweigh the expected PE default loss.*

Proof. We assume $W_i = \omega_i T^P$, then $\omega_i = \frac{W_i}{T_i^P}$ represents the share of total trust loan funded by the household through the WMP in the total credit obtained by the PE at reform stage i. Accordingly, we have $T_i^S = (1-\omega_i)T_i^P$. We could show that a *Kaldor-Hicks* improvement ($\Delta\Pi_{1-0} > 0$) is achieved if the probability of PE default satisfies the following condition:

$$p_1 < \frac{A^P - (1 - \alpha\omega_1)A^S}{1 + A^P}, \tag{4.6}$$

where

$$\omega_1 = \frac{r_1^T + A^S - 2r_1^D}{2r_1^T - A^S - r_1^D} = \frac{1}{2} + \frac{3\left(A^S - r_1^D\right)}{2r_1^T - A^S - r_1^D} \in \left(\frac{1}{2}, 1\right).$$

Inequality (4.6) implies that when the probability of PE default is below a certain level, the profit gains from capital and productivity channels outweigh the loss due to PE default. Q.E.D. □

The rise of shadow banking influences the profit gain through capital, productivity, and risk channels, but the effect of these channels depend on different sets of factors. Some factors may have mixed effects on the profit gain through different channels. For example, a lower marginal cost of shadow banking (a higher M) will lead to a larger scale of credit reallocation from formal banking to shadow banking, resulting in more profit gains from the capital and productivity channels, while generating more losses from the risk channel. See Appendix A.5 for more details.

According to our numerical simulation in Section 5, given a set of parameter values fitting China's macroeconomy and financial markets, as shown in Figure 2, the profit gain is increasing in the productivity gap between the PE and SOE (A^P/A^S) and deposit reserve requirement ratio RRR (α, controlling loan volume), but decreasing in the marginal cost of shadow banking ($1/M$, or equivalently, increasing in the inverse of the marginal cost of shadow banking, that is, M).

4.2 Pareto Improvement

Pareto improvement means that at least one agent benefits from the reform, while no agents are worse off. This section examines feasibility of *Pareto* improvement under dual-track interest rate liberalization. First, we have the following remark:

Remark 4. *A Kaldor-Hicks improvement is a necessary but insufficient condition for a Pareto improvement.*

See Appendix A.6 for proof. Whether a *Kaldor-Hicks* improvement is also a *Pareto*

improvement crucially depends on how the profit gain is distributed among the agents. A dual-track interest rate liberalization that generates a *Pareto* improvement would be a case of "reform without losers."

It is straightforward to show that the household and PE unconditionally benefit from the dual-track interest rate liberalization. They are given the options to participate in shadow banking or stay away from it to avoid being worse off. The PE can afford to borrow at a high trust loan rate because of its high productivity. As a result, the PE offers a WMP rate via the bank that is more attractive than the deposit rate after adjusting for the PE's default risk. The bank earns zero profit and bears no shadow banking risk, so it does not gain or lose in the reform.

Consequently, whether the dual-track interest rate reform leads to a *Pareto* improvement depends critically on how the profit gain from the reform is distributed to the SOE. The dual-track interest rate reform presents a feasible approach for the SOE to avoid being worse off, by participating in shadow banking and sharing the profit gain through credit transfer to the more productive PE. Equation (4.6) shows that the aggregate profit gain increases with the PE productivity. The PE default loss has an upper limit, so there exists a lower bound of PE productivity that generates a sufficiently high profit gain to compensate the SOE for its reform loss. The equilibrium interest rates determine profit distribution among the agents along the credit supply chain. Deposit rate ceiling (ψ) and loan quota (α) have anchoring effects on the market interest rates, so the government is able to adjust these controls to make *Pareto* improvement feasible. We have the following proposition:

Proposition 2. *The dual-track interest rate liberalization can lead to a Pareto improvement. The household and the PE unconditionally benefit from the reform. The SOE can avoid being a reform loser through participating in shadow banking.*

See Appendix A.7 for proof. Based on our numerical simulation in Section 5, Figure 3 shows that a greater productivity gap is needed between the PE and SOE for a *Pareto*

improvement than for a *Kaldor-Hicks* improvement as shown in Figure 2. Shadow banking has an adverse effect on the SOE's production profit, as the associated credit reallocation by the household from formal banking to shadow banking shrinks the low-cost credit that the SOE could obtain from bank loans. However, the SOE could also be compensated by the profit sharing generated from the credit transfer to the more productive PE. At least, the SOE will not suffer a loss greater than in a single-track interest rate reform, as illustrated in our numerical analysis in Section 5.

A reform mechanism that generates creditable *Pareto* improvement would achieve vast *ex ante* support and reduce the possibility of *ex post* reversal. The dual-track reforms in China's agriculture and industry sectors in the 1980s and 1990s relied on forced execution of the planned track to guarantee *Pareto* improvement (Lau, Qian, and Roland, 2000). In contrast, the financial sector in China is subject to government control rather than strict planning (Brandt and Zhu, 2000). Thus, *Pareto* improvement in recent financial reforms may only be achieved through a market-based mechanism such as the negotiated credit transfer.

It is noteworthy that the single-track interest rate liberalization is a special case of the full interest rate liberalization, in the absence of shadow banking. However, the single-track interest rate reform could face strong opposition from the existing institutions that could become reform losers. When the deposit rate ceiling is removed, the SOE's profit margin will decrease as the bank loan rate increases with the deposit rate. The SOE will certainly be worse off in the single-track reform. We have the following remark:

Remark 5. *The single-track interest rate liberalization does not lead to a Pareto improvement, as it reduces the SOE's profit.*

See Appendix A.8 for proof. Indeed, one key obstacle of interest rate reform in China is the strong opposition from politically connected and economically powerful state-owned sector(s). The single-track reform is also exposed to considerable economic and social risks in aggregate (Murphy, Shleifer, and Vishny, 1992; Lin, Cai, and Li, 1996). For example,

the former Soviet Union practiced the so-called "shock therapy"—single-track reform or "overnight privatization" in early 1990s, which proved to be a failure with GDP shrinking by more than 50% in late 1990s.

4.3 Full Interest Rate Liberalization

The dual-track interest rate liberalization introduces a shadow banking, market credit track without demolishing the pre-existing formal banking, controlled credit track. In our framework, the full interest rate liberalization removes the binding deposit rate ceiling and keeps the shadow banking track in place. Given the anchoring effect of the deposit rate, we have the following remark:

Remark 6. *The trust (entrusted) loan rate and bank loan rate increase with the deposit rate, that is,*

$$\frac{\mathrm{d}r^L}{\mathrm{d}r^D} > 0, \quad \frac{\mathrm{d}r^T}{\mathrm{d}r^D} > 0.$$

All interest rates—deposit rate, loan rate, and trust (entrusted) loan rate—will increase after the full interest rate liberalization.

See Appendix A.9 for proof. Since the banks earns zero profit, an increase in the deposit rate will be passed through to the loan rate. The deposit rate hike encourages the household to allocate more endowment to bank deposit. Some capital flows back into the formal banking track, which is subject to deposit reserve requirement, resulting in a larger portion of capital idled. This also magnifies bank credit misallocation in favor of the less productive SOE. The trust (entrusted) loan rate will increase, due to diminishing shadow bank credit supply. A higher trust (entrusted) loan rate implies a smaller amount of shadow bank credit but a lower PE default probability, hence less expected PE default loss—one silver lining of the full interest rate liberalization. The aggregate profit will decrease if the profit loss from the capital channel and the productivity channel exceed the gain from the risk channel.

The PE suffers a profit loss for certain after the full interest rate liberalization, because the increase in financing cost and reduction in shadow bank credit supply exceed its gain from the reduction in expected default loss. The full interest rate liberalization will not lead to an additional *Pareto* improvement relative to the dual-track interest rate reform. Whether the SOE will benefit from the full interest rate liberalization depends on the trade-off between its gain from the increase in bank credit supply and the rising cost of bank loan. Rising deposit rate and WMP rate make the household unconditionally better off from the full interest rate liberalization. We have the following proposition:

Proposition 3. *The full interest rate liberalization does not lead to additional Pareto improvement. The PE's profit will decrease for certain. The SOE can be either worse off or better off. However, the household unconditionally benefits.*

See Appendix A.10 for proof.

5 Numerical Analysis

This section presents our numerical analysis. We focus on whether *Kaldor-Hicks* improvement and *Pareto* improvement are feasible under the dual-track reform mechanism, with the model parameter values resembling the real economy and financial markets in China.

5.1 Model Calibration

Table 2 reports the values of the key model parameters. We set the RRR at 20%, which is roughly the official RRR in 2013. We set the PE and SOE's productivity (return on capital) at 20% and 5%, where the 4/1 productivity ratio is within the range estimated by Bai, Hsieh, and Qian (2006) and Song, Storesletten, and Zilibotti (2011). We set $M = 200$ so that the maximal probability of PE default equals 50% ($p = T^P/M \leq E/M = 50\%$), in the extreme case that all credits are channeled to the PE through shadow banking. We normalize the household's endowment to be 100.

We set the deposit rate ceiling at 3.0%, which is close to the observed deposit rate in 2013. He, Wang, and Yu (2015) estimate that the natural rate of interest (equivalent to r^{D*} in our model setting) in China was about 3.5% at the end of 2012. We measure the degree of interest rate repression using the ratio of the natural deposit rate and the potential return rate, that is, we set $\theta = 0.7$ ($=r^{D*}/A^S = 3.5\%/5.0\%$). The deposit rate ceiling effectively distorts the bargaining strength of the household downward, that is, we set $\psi = 0.6$ ($= \bar{r}^D/A^S = 3.0\%/5.0\%$).

The shadow banking creditors partially recover the principal value of their trust/entrusted loans upon the PE default. We set the default recovery ratio (γ) at 0.3, which implies that the debt-to-asset ratio of defaulted PE is 77%, if it repays part of the liabilities by using up all its non-productive equity.[16] Tan, Huang, and Woo (2016) show that the average debt-to-asset ratio of "zombie" companies, that is, companies cannot break even without financial helps from the government, was 70%-80% in China during the period of 2005-2007.

Table 3 reports that the model-implied trust (entrusted) loan rate and bank loan rate are 14.21% and 3.75%, respectively. Allen, Qian, Tu, and Yu (2019) report that the average nonaffiliated entrusted loan (the type of entrusted loan that is most relevant to our model) rate is 13.9% during the period 2004-2013. The implied PE default probability is 8.09%. The ratio of expected default loss to the total amount of credit used for production equals 1.59% ($= p \times T^P/(T^B + L)$), which is somewhat higher than the non-performing bank loan ratio of 1.00% announced by China Banking Regulatory Commission (CBRC) in 2013.

The PE obtains 16.17% of the household's endowment capital, with 10.46% from trust loan and 5.71% from entrusted loan. The implied shadow bank credit interest rate (14.21%) is between the PE's productivity (20%) and the SOE's productivity (5%), yet higher

[16] A debt-to-asset ratio of 77% implies that non-productive equity of the defaulted PE accounts for 23% of its total assets, equivalent to 30% of its total liabilities (=23%/77%). For simplicity and without loss of generality, we assume that the default recovery ratio in the presence of shadow banking is a constant, either before or after full interest rate liberalization. After full liberalization, there will be some credit flowing back to the formal banking from the shadow banking track. Given less credit obtained from trust/entrusted loans, the PE will still be able to meet the fixed default recovery ratio.

than the deposit rate (3.00%), reflecting the effects from both deposit rate repression or anchoring and credit risk premium of shadow banking.

Additional details on the design and implementation of the numerical analysis can be found in Appendix A.11.

5.2 Result Analysis

This section presents and analyzes the numerical results about the aggregate profit gain, *Pareto* improvement, and the full interest rate liberalization.

5.2.1 Profit Gain

Table 4 shows that the aggregate profit increases from 4.00 to 4.96 after the dual-track reform, translating into a percentage gain of 24%. The productivity, capital, and risk channels contribute 2.16, 0.10, and -1.10, respectively. A dominant portion of the gain is from financing the more productive yet capital-deprived PE.

The capital-weighted average productivity ($\frac{T^P}{T^B+L} \times A^P + (1 - \frac{T^P}{T^B+L}) \times A^S$) increases from 5.0% before the dual-track reform to 8.0% after. This result echoes the finding in Song, Storesletten, and Zilibotti (2011) that *de facto* privatization has fueled China's economic growth in the past decades. For the capital channel, the total amount of credit available for production is 82.10 after the emergence of shadow banking, higher than 80.00 before. The negative impact of the expected PE default loss (-1.10) suggests that shadow banking risks could have a non-trivial effect on the aggregate reform gains.

5.2.2 Pareto Improvement

Table 4 also shows that the household's profit increases by 15.3% (from 3.00 to 3.46) after the rise of shadow banking, as the household reallocates 10.5% of endowment from bank deposit to the WMP. The PE's profit gain is 0.47, after the rise of shadow banking. These results confirm that both the PE and the household benefit from the dual-track interest

rate reform. The SOE's profit increases by 0.03 after the dual-track reform. Its gain from credit resale (0.21) exceeds the reduction in its production profit (0.18). The dual-track interest rate reform can help the SOE to avoid being worse off. Figure 3 shows that *Pareto* improvement is more likely achieved when there is a greater productivity gap between the PE and the SOE (higher A^P/A^S), a higher RRR (α), and a lower marginal cost of shadow banking (higher M).

Credit transfer to the more productive PE could bring the SOE a higher profit gain. The upper-left graph of Figure 3 depicts that the positive and nonlinear relationship between the SOE's profit gain and the PE/SOE productivity gap. There exists a lower bound of the productivity gap that triggers credit transfer (see Remark 3). Comparing this graph with the upper-left graph in Figure 2, we find that a greater PE/SOE productivity gap is needed for *Pareto* improvement than for *Kaldor-Hicks* improvement. A higher RRR leads to a greater increase in the aggregate profit gain, due to shadow banking, by reducing more capital idleness. The SOE will experience a greater profit gain, when exposed to lower shadow banking default risk. Allen, Qian, Tu, and Yu (2019) show that there exists a substantial difference between nonaffiliated entrust loan rates (13.9% on average) and official bank loan rates (6% on average). Thus, the state-owned firms were able to benefit from the reform gain. Give the size of entrusted loans of RMB 2,527 billion in 2014, the potential profit gain could be substantial.

5.2.3 Full Interest Rate Liberalization

Table 4 shows that the full interest rate liberalization may not achieve additional profit gains; if bank credit misallocation in favor of the SOE persists, and the low SOE productivity remains unimproved. The full interest rate liberalization leads to increases in the interest rates. Both the SOEs and PE need to finance at higher costs, and their profits decrease by 40.8% and 4.3%, respectively. The household benefits from the full liberalization as its profit increases from 3.46 to 3.90, translating into a 12.7% gain. Full interest rate liberalization does not eliminate shadow banking, as its advantages over formal banking

remain in terms of reducing capital idleness and financing the more productive PE.

Liu, Wang, and Xu (2019) find in a calibration exercise of their DSGE model that the liberalization policy can reduce aggregate productivity and welfare, unless other policy reforms are also implemented to alleviate SOEs' distorted incentives or to improve private firms' credit access. Song and Xiong (2018) warn that the distortions in the PE/SOE dual-track system may cause a vicious circle that leads to more policy distortions and lowers economic growth.

Column 4 of Table 4 shows that after a single track interest rate reform, the household's profit increases from 3.00 to 3.50, while the SOE's profit falls from 1.00 to 0.50. The PE still has no access to bank credit and earns a zero profit. The aggregate profit remains at 4.00. The numerical results confirm that single track reform would reduce the subsidy to the SOE and reallocate the reform gain to the household, without changing the aggregate profit gain, consistent with Remark 5.

6 Conclusion

In China, banks have developed shadow banking under tacit government endorsement. Shadow banking essentially constitutes a dual-track interest rate liberalization, which introduces a market credit track alongside the preexisting controlled credit track, and can generate profit gains by financing high productivity PEs and reducing capital idleness. *Pareto* improvement is also plausible as SOEs—potential reform losers—participate in shadow banking and share the reform gains.

Full interest rate liberalization may not generate additional *Pareto* improvement; if bank credit misallocation in favor of SOEs persists, and SOE's low productivity remains unimproved. This finding highlights the importance of coordinating full interest rate liberalization with reforms in the banking and SOE sectors. A new monetary policy and regulatory framework needs to be established after full interest rate liberalization, and shadow banking helps to prepare the regulators and agents for such a complex transition.

References

Acharya, V. V., J. Q. Qian, and Z. Yang. 2019. In the Shadow of Banks: Wealth Management Products and Issuing Banks' Risk in China. Unpublished Manuscript, New York University.

Allen, F., and D. Gale. 2000. Financial Contagion. *Journal of Political Economy* 108:1–33.

Allen, F., Y. Qian, G. Tu, and F. Yu. 2019. Entrusted Loans: A Close Look at China's Shadow Banking System. *Journal of Financial Economics* 133:18–41.

Ang, A., J. Bai, and H. Zhou. 2019. The Great Wall of Debt: Real Estate, Political Risk, and Chinese Local Government Financing Cost. Unpublished Manuscript, Tsinghua University PBC School of Finance.

Bai, C.-E., C.-T. Hsieh, and Y. Qian. 2006. The Return to Capital in China. *Brookings Papers on Economic Activity* 2:61–101.

Black, F., and M. Scholes. 1973. The Pricing of Options and Corporate Liabilities. *Journal of Political Economy* 81:637–654.

Brandt, L., and X. Zhu. 1995. The Development of Non-bank Financial Institutions in China. Unpublished Manuscript, University of Toronto.

Brandt, L., and X. Zhu. 2000. Redistribution in a Decentralized Economy: Growth and Inflation in China under Reform. *Journal of Political Economy* 108:422–439.

Brunnermeier, M., M. Sockin, and W. Xiong. 2017. China's Gradualistic Economic Approach and Financial Markets. *American Economic Review* 107:608–613.

Chang, C., Z. Liu, M. Spiegel, and J. Zhang. 2019. Reserve Requirements and Optimal Chinese Stabilization Policy. *Journal of Monetary Economics* 103:33–51.

Chen, K., J. Ren, and T. Zha. 2018. The Nexus of Monetary Policy and Shadow Banking in China. *American Economic Review* 108:3891–3936.

Chen, Z., Z. He, and C. Liu. 2019. The Financing of Local Government in China: Stimulus Loan Wanes and Shadow Banking Waxes. *Journal of Financial Economics* forthcoming.

Cong, L. W., H. Gao, J. Ponticelli, and X. Yang. 2019. Credit Allocation Under Economic Stimulus: Evidence from China. *The Review of Financial Studies* 32:3412–3460.

Dang, T. V., H. Wang, and A. Yao. 2014. Chinese Shadow Banking: Bank-Centric Misperceptions. *HKIMR Working Paper* .

Diamond, D. W., and P. H. Dybvig. 1983. Bank Runs, Deposit Insurance, and Liquidity. *Journal of Political Economy* 91:401–419.

Dollar, D., and S.-J. Wei. 2007. Das (wasted) Kapital: Firm Ownership and Investment Efficiency in China. *NBER Working Paper* .

Hachem, K. C., and Z. Song. 2017a. Liquidity Regulation and Unintended Financial Transformation in China. Unpublished Manuscript, University of Chicago.

Hachem, K. C., and Z. Song. 2017b. Liquidity Rules and Credit Booms. Unpublished Manuscript, University of Chicago.

He, D., H. Wang, and X. Yu. 2015. Interest Rate Determination in China: Past, Present, and Future. *International Journal of Central Banking* 11:255–277.

Kornai, J. 1980. *Economics of Shortage*. North-Holland Publishing Co.

Lardy, N. R. 1998. *China's Unfinished Economic Revolution*. Brookings Institution Press, Washington.

Lardy, N. R. 2008. Financial Repression in China. *Peterson Institute for International Economics Policy Brief* 08.

Lau, L. J., Y. Qian, and G. Roland. 2000. Reform without Losers: An Interpretation of China's Dual-Track Approach to Transition. *Journal of Political Economy* 108:120–143.

Liao, L., B. Liu, and H. Wang. 2014. China's Secondary Privatization: Perspectives from the Split-Share Structure Reform. *Journal of Financial Economics* 113:500–518.

Lin, J. Y. 1990. Collectivization and China's Agricultural Crisis in 1959-1961. *Journal of Political Economy* 98:1228–1252.

Lin, J. Y. 1992. Rural Reforms and Agricultural Growth in China. *American Economic Review* 82:34–51.

Lin, J. Y., F. Cai, and Z. Li. 1996. The Lessons of China's Transition to a Market Economy. *Cato Journal* 16:201.

Lin, J. Y., F. Cai, and Z. Li. 1998. Competition, Policy Burdens, and State-Owned Enterprise Reform. *American Economic Review: Papers and Proceedings* 88:422–427.

Lin, J. Y., and Z. Li. 2008. Policy Burden, Privatization and Soft Budget Constraint. *Journal of Comparative Economics* 36:90–102.

Lin, J. Y., and G. Tan. 1999. Policy Burdens, Accountability, and the Soft Budget Constraint. *American Economic Review: Papers and Proceedings* 89:426–431.

Lin, J. Y., and H. Zhou. 1993. Reform Financial System and Lift the Control of Interest Rates to Facilitate Long-Run Economic Growth. *Reform* 2:97–105.

Liu, Z., P. Wang, and Z. Xu. 2019. Interest-Rate Liberalization and Capital Misallocations. Unpublished Manuscript, Federal Reserve Bank of San Francisco.

Merton, R. C. 1974. On the Pricing of Corporate Debt: The Risk Structure of Interest Rates. *Journal of Finance* 29:449–470.

Murphy, K. M., A. Shleifer, and R. W. Vishny. 1992. The Transition to a Market Economy: Pitfalls of Partial Reform. *The Quarterly Journal of Economics* 107:889–906.

Qian, Y., and G. Roland. 1998. Federalism and the Soft Budget Constraint. *American Economic Review* pp. 1143–1162.

Song, Z., K. Storesletten, and F. Zilibotti. 2011. Growing like China. *American Economic Review* 101:196–233.

Song, Z., and W. Xiong. 2018. Risks in China's Financial System. *Annual Review of Financial Economics* 10:264–286.

Sun, Q., and W. H. Tong. 2003. China Share Issue Privatization: The Extent of Its Success. *Journal of Financial Economics* 70:183–222.

Tan, Y., Y. Huang, and W. T. Woo. 2016. Zombie Firms and the Crowding-out of Private Investment in China. *Asian Economic Papers* 15:32–55.

Wei, S.-J., and T. Wang. 1997. The Siamese Twins: Do State-Owned Banks Favor State-Owned Enterprises in China? *China Economic Review* 8:19–29.

Xiong, W. 2018. The Mandarin Model of Growth. Unpublished Manuscript, Princeton University.

Zhou, X. 2009. Development of China's Inter-Bank Market. Speech at the opening ceremony of the Shanghai Clearing House, available at http://bis.org/review/r100122b.pdf.

Appendix

A.1 Proof for Remark 1

Proof. Re-arranging the expression of the SOE's expected profits in equilibrium,

$$\Pi^S = (A^S - r^L)(L - T^S) + \left[(1-p)r^T - p(1-\gamma) - r^L\right] T^S$$

we have

$$\begin{aligned} \Pi^S &= (A^S - r^L)L + \left[(1-p)r^T - p(1-\gamma) - A^S\right] T^S, \\ &= (A^S - r^L)L + \left[r^T - A^S - p(r^T + 1 - \gamma)\right] T^S. \end{aligned}$$

The trust (entrusted) loan market clearing condition yields,

$$T^P = T^S + T^B = \frac{M\left(2r^T - r^D - A^S\right)}{3\left(r^T + 1 - \gamma\right)},$$

Hence, in equilibrium we have

$$p = \frac{T^P}{M} = \frac{\left(2r^T - r^D - A^S\right)}{3\left(r^T + 1 - \gamma\right)},$$

Given that, the SOE's expected profit in equilibrium could be re-arranged as

$$\begin{aligned} \Pi^S &= (A^S - r^L)L + \left[r^T - A^S - \frac{\left(2r^T - r^D - A^S\right)}{3}\right] T^S, \\ &= (A^S - r^L)L + \frac{1}{3}\left(r^T + r^D - 2A^S\right) T^S. \end{aligned}$$

A non-negative amount of the SOE's credit resale requires $r^T + r^D - 2A^S \geq 0$, as

$$T^S = \frac{M\left(r^T + r^D - 2A^S\right)}{3\left(r^T + 1 - \gamma\right)}.$$

Therefore, in equilibrium both $(A^S - r^L)L \geq 0$ and $\frac{1}{3}\left(r^T + r^D - 2A^S\right) T^S \geq 0$ hold. The SOE unconditionally obtains a non-negative profit if it participates in shadow banking as a supplier of entrusted loan credit. Q.E.D. □

A.2 Solving the Baseline Model

The equilibrium interest rates for the formal banking track are determined according to the model assumptions, so our analysis focuses on the interest rates under the shadow banking track. We solve for the equilibrium trust (entrusted) loan rate, which equals the equilibrium WMP rate, and the equilibrium sizes of shadow banking assets (trust loan, entrusted loan, and WMP) held by different entities.

The market clearing condition of the trust loan and entrusted loan markets, $T^P = T^S + T^B$, implies

$$\frac{M\left(A^P - r^T\right)}{2\left(A^P - r^T + \gamma\right)} = \frac{M\left(2r^T - r^D - A^S\right)}{3\left(r^T + 1 - \gamma\right)}.$$

Solving the equation, we obtain

$$r^T = \frac{N \pm \sqrt{N^2 - 4\left[3A^P(1-\gamma) + 2\left(\gamma - A^P\right)\left(r^D + A^S\right)\right]}}{2},$$

where

$$N = A^P + 3 + \gamma + 2(r^D + A^S).$$

In equilibrium, the trust loan held by the PE and the entrusted loan supplied by the SOE should be non-negative, implying that $r^T \in [A^S, A^P]$. Hence, there is only one valid solution for r^T:

$$r^T = \frac{N - \sqrt{N^2 - 4\left[3A^P(1-\gamma) + 2\left(\gamma - A^P\right)\left(r^D + A^S\right)\right]}}{2}.$$

The equilibrium trust (entrusted) loan rate is not subject to the marginal cost of shadow banking ($1/M$) and the RRR (α), that is,

$$\frac{\partial r^T}{\partial M} = 0; \qquad \frac{\partial r^T}{\partial \alpha} = 0.$$

Before the rise of shadow banking, there is only bank credit track. The household allocates all endowment to the bank deposit. Bank loan is entirely rationed to the SOE, while the PE has no access to the credit market. In equilibrium, the deposit rate is ψA^S and θA^S before and after the full interest rate liberalization, respectively. The former is determined by deposit rate ceiling, while the latter is determined by the relative bargaining strength between the household and the SOE. Under the single-track interest rate reform in the absense of shadow banking, the deposit rate will increase to its natural level θA^S after the deposit rate ceiling being removed.

A.3 Proof for Remark 2

Proof. In the presence of shadow banking, we re-arrange the market clearing condition of the trust (entrusted) loan by multiplying $[6\left(A^P - r^T + \gamma\right)\left(r^T + 1 - \gamma\right)]/M$ on the left- and right-hand sides of Equation (3.2):

$$3\left(A^P - r^T\right)\left(r^T + 1 - \gamma\right) = 2\left(2r^T - A^S - r^D\right)\left(A^P - r^T + \gamma\right).$$

The derivatives of the equation above with respect to r^D, A^S, A^P, and γ, respectively, are

$$\begin{aligned}
\frac{\mathrm{d}r^T}{\mathrm{d}A^P} &= \frac{3\left(1-\gamma\right) - r^T + 2A^S + 2r^D}{\left[3\left(1-\gamma\right) - r^T + 2A^S + 2r^D\right] + \left(A^P - r^T\right) + 4\gamma} > 0; \\
\frac{\mathrm{d}r^T}{\mathrm{d}A^S} &= \frac{3 + \gamma + A^P + 2A^S + 2r^D - 2r^T}{2\left(A^P - r^T + \gamma\right)} > 0; \\
\frac{\mathrm{d}r^T}{\mathrm{d}r^D} &= \frac{3 + \gamma + A^P + 2A^S + 2r^D - 2r^T}{2\left(A^P - r^T + \gamma\right)} > 0; \\
\frac{\mathrm{d}r^T}{\mathrm{d}\gamma} &= -\frac{3A^P + r^T - 2\left(A^S + r^D\right)}{2\left(2A^P - A^S - r^D\right) + 3r^T + 3 + \gamma} < 0.
\end{aligned}$$

To judge the sign of $\frac{\mathrm{d}r^T}{\mathrm{d}A^P}$, we re-arrange the trust (entrusted) loan market clearing condition as

$$\frac{2\gamma}{A^P - r^T} = \frac{3\left(1-\gamma\right) - r^T + 2A^S + 2r^D}{2r^T - r^D - A^S}. \tag{A-1}$$

As $0 < \gamma < 1$, $A^P - r^T > 0$, and $r^T > A^S > r^D$, we have $3\left(1-\gamma\right) - r^T + 2A^S + 2r^D > 0$. The result suggests that the trust (entrusted) loan rate r^T is subject to a ceiling of $3\left(1-\gamma\right) + 2A^S + 2r^D$. As both the numerator and denominator of $\frac{\mathrm{d}r^T}{\mathrm{d}A^P}$ are positive, we have $\frac{\mathrm{d}r^T}{\mathrm{d}A^P} > 0$. It is easy to prove the latter three inequalities given the above conditions. We omit the proof here. Q.E.D. □

A.4 Proof for Remark 3

Proof. Combining the FOCs of the SOE's and the household's profit functions with respect to entrusted loan and WMP (trust loan) holding, respectively, we have

$$\begin{aligned}
T^S &= \frac{M\left(r^T + r^D - 2A^S\right)}{3\left(r^T + 1 - \gamma\right)}, \\
T^B &= \frac{M\left(r^T + A^S - 2r^D\right)}{3\left(r^T + 1 - \gamma\right)}.
\end{aligned}$$

Thus, $r^T > 2A^S - r^D$ is the sufficient and necessary condition to guarantee a positive T^S, wherein the SOE resells a positive amount of credit to the PE for profit maximization. Otherwise, the SOE will either be away from shadow banking business or become a shadow bank credit borrower.

The equilibrium deposit rate is pre-determined by the model assumption. Substituting $r^D = \psi A^S$ and $r^D = \theta A^S$ into the inequality, we obtain $r^T > (2-\psi)A^S$ and $r^T > (2-\theta)A^S$ as the sufficient and necessary condition for a positive credit resale by the SOE before and after the full interest rate liberalization, respectively. In both situations, $r^T > A^S$ because $A^S \geq r^D$ (or equivalently, both ψ and $\theta \in [0,1]$) always holds. Q.E.D. □

A.5 Decomposing the Effect of Shadow Banking by Channel

Proof. Equation (4.5) decomposes the profit change from the rise of shadow banking into three channels: the capital channel, the productivity channel and the risk channel. The effects of these channels are determined by different factors.

(1) Capital channel:

Shadow banking helps banks bypass the high deposit reserve requirement when extending credit to the firm sector, with more capital employed in firm production. The profit gain from the capital channel is

$$A^S \alpha W_1 = \frac{\left(r_1^T + A^S - 2r^D\right)}{3\left(r_1^T + 1 - \gamma\right)} A^S \alpha M. \tag{A-2}$$

Equation (A-2) shows that the profit gain from reduction in idle capital increases with α and M.

(2) Productivity channel:

More credit has been channeled to the more productive PE sector through shadow banking. The profit gain from the productivity channel is

$$\left[(1-p_1)A^P - A^S\right] T_1^P = \left[(1-p_1)A^P - A^S\right] p_1 M, \tag{A-3}$$

where T_1^P $(=p_1 M)$ denotes the credit reallocated from the SOE to the PE through shadow banking; $\left[(1-p_1)A^P - A^S\right]$ represents change in productivity for the re-allocated credit. In equilibrium, p is increasing in A^P.[17] If the PE is more productive (with a higher A^P), more credits are reallocated to the PE. Equation (A-3) shows that if the PE's default-

[17] In equilibrium, we have

$$p_i = \frac{A^P - r_i^T}{2\left(A^P - r_i^T + \gamma\right)} \in \left(0, \frac{1}{2}\right],$$

which suggests p_i is increasing in $\left(A^P - r_i^T\right)$, and p_i should be no higher than $\frac{1}{2}$ given $\gamma \in [0,1]$. According

adjusted productivity ($(1-p_1)A^P$) is higher than the SOE's productivity (A^S), there is a positive profit gain from the productivity channel.

(3) Risk channel:

The economy is exposed to the PE default risk as a certain amount of credit is channeled to the PE sector. The expected profit loss due to the PE default is

$$p_1 T_1^P = (p_1)^2 M = \left[\frac{A^P - r_1^T}{2\left(A^P - r_1^T + \gamma\right)}\right]^2 M. \tag{A-4}$$

Equation (A-4) shows that the expected default loss is a convex function of the probability of PE default (p). The probability of PE default increases as PE borrows more credit, but will not exceed 0.5. Therefore, if the PE is sufficiently productive, the profit gains from capital and productivity channels will outweigh the loss from the risk channel, leading to a *Kaldor-Hicks* improvement. Q.E.D. □

A.6 Proof for Remark 4

Proof. The necessary and sufficient condition for a *Kaldor-Hicks* improvement due to shadow banking is $\Pi_1 > \Pi_0$, while the necessary and sufficient conditions for a *Pareto* improvement are

$$\begin{cases} \Pi_1^S \geq \Pi_0^S, \\ \Pi_1^P \geq \Pi_0^P, \\ \Pi_1^H \geq \Pi_0^H, \\ \Pi_1^S + \Pi_1^P + \Pi_1^H > \Pi_0^S + \Pi_0^P + \Pi_0^H. \end{cases}$$

A *Pareto* improvement requires that at least one agent is better off, and no agents are worse off in the reform. Since $\Pi_i = \Pi_i^S + \Pi_i^P + \Pi_i^H$, $i \in \{0,1,2,3\}$ based on our model set-up, $\Pi_1^S + \Pi_1^P + \Pi_1^H > \Pi_0^S + \Pi_0^P + \Pi_0^H$ is equivalent to $\Pi_1 > \Pi_0$. This result implies that if the reform leads to a *Pareto* improvement, the reform must generate a *Kaldor-Hicks* improvement by the meantime, but not the other way around. Q.E.D. □

to the proof of Remark 2 in Appendix A.3,

$$\frac{\mathrm{d}r_i^T}{\mathrm{d}A^P} = \frac{3(1-\gamma) - r_i^T + 2A^S + 2r_i^D}{\left[3(1-\gamma) - r_i^T + 2A^S + 2r_i^D\right] + \left(A^P - r_i^T\right) + 4\gamma} \in (0,1).$$

Hence,

$$\frac{\mathrm{d}\left(A^P - r^T\right)}{\mathrm{d}A^P} = 1 - \frac{\mathrm{d}r^T}{\mathrm{d}A^P} > 0.$$

$\left(A^P - r_i^T\right)$ is increasing in A^P, and p_i is increasing in A^P, for $i \in \{1,2\}$ in the presence of shadow banking.

A.7 Proof for Proposition 2

Proof. (1) The PE unconditionally benefits from the rise of shadow banking:

The PE has access to external credit after the rise of shadow banking, but can at least choose to stay away from the credit markets and retain a zero profit as before the rise of shadow banking. For the PE to have a positive profit gain, it requires

$$T_1^P < \frac{M(A^P - r_1^T)}{A^P - r_1^T + \gamma}. \tag{A-5}$$

Recalling the optimal demand of trust loan from the PE, in equilibrium we have

$$T_1^P = \frac{M(A^P - r_1^T)}{2(A^P - r_1^T + \gamma)},$$

which implies Inequality (A-5) always holds in equilibrium and the PE will unconditionally benefit from shadow banking.

(2) The household is unconditionally better off after the rise of shadow banking.

The household has the option to invest either in the WMP or in the bank deposit. The expected profit of the household is

$$\Pi_1^H = r_1^D(E - W_1) + \left(1 - \frac{T_1^S + W_1}{M}\right) r_1^W W_1 - \frac{T_1^S + W_1}{M}(1-\gamma)W_1.$$

Prior to the reform, the household can only invest in the bank deposit, which yields a profit $\Pi_0^H = r_0^D E$, where $r_0^D = r_1^D = \psi A^S$. Profit gain from the dual-track interest rate liberalization is

$$\Delta\Pi_{1-0}^H = \left(1 - \frac{T_1^S + W_1}{M}\right) r_1^W W_1 - \frac{T_1^S + W_1}{M}(1-\gamma)W_1 - r_1^D W_1.$$

To achieve an aggregate profit gain ($\Delta\Pi_{1-0}^H > 0$), we need

$$\left(1 - \frac{T_1^P}{M}\right) - \frac{T_1^P}{M}(1-\gamma) - r_1^D > 0,$$

which implies

$$T_1^P < \frac{M(r_1^T - r_1^D)}{r_1^T + 1 - \gamma}. \tag{A-6}$$

Given the market clearing condition of the trust (entrusted) loan market, Inequality (A-6)

could be re-arranged as

$$\frac{M\left(2r_1^T - r_1^D - A^S\right)}{3\left(r_1^T + 1 - \gamma\right)} < \frac{M(r_1^T - r_1^D)}{r_1^T + 1 - \gamma},$$

which is equivalent to

$$r_1^T + A^S - 2r_1^D > 0. \tag{A-7}$$

As $r_i^T > A^S > r_i^D$, for any $i \in \{1, 2\}$, Inequality (A-7) always holds in equilibrium, suggesting the household is unconditionally better off after the rise of shadow banking. The intuition is simple. Shadow banking provides the household a freee option to invest in WMPs, and the household can at least keep the profit unchanged by maintain the investment of endowments in the deposit market only.

(3) The SOE can avoid being a reform loser through credit resale to the PE under the shadow banking track.

Credit resale could compensate the SOE's reform loss. The expected profit of the SOE in the presence of shadow banking is

$$\Pi_1^S = \underbrace{(A^S - r_1^L)(L_1 - T_1^S)}_{Production} + \underbrace{\left[(1-p_1)r_1^T - p_1(1-\gamma) - r_1^L\right] T_1^S}_{Credit\ \ Resale},$$

$$s.t. \qquad T_1^S \leq L_1,$$

where $T_1^S = (1-\omega_1)\, T_1^P$, and $L_1 = (1-\alpha)D_1 = (1-\alpha)(E - W_1) = (1-\alpha)(E - \omega_1 T_1^P)$. Given $\omega_1 = \frac{W_1}{T_1^P} \in [0, 1]$ (describing the share of shadow bank credit to the PE funded by the WMP), the budget constraint of the SOE implies

$$T_1^P \leq \frac{(1-\alpha)\, E}{1 - \alpha\omega_1} \leq E.$$

Besides, the SOE's profit before the rise of shadow banking is

$$\Pi_0^S = \underbrace{\left(A^S - r_0^L\right) L_0}_{Production} = \left(A^S - r_0^L\right) \alpha E.$$

The controlled deposit rate (r^D) and loan rate (r^L) remain unchanged after the rise of shadow banking, that is, $r_0^D = r_1^D$, and $r_0^L = r_1^L$, as interest rate repression is in place. Hence, the profit gain of the SOE after the dual-track interest rate reform is

$$\Delta\Pi_{1-0}^S = \underbrace{\left[(1-p_1)\, r_1^T - (1-\gamma) - A^S\right](1-\omega_1)\, T_1^P}_{Credit\ \ Resale} - \underbrace{\left(A^S - r_1^L\right)(1-\alpha)\,\omega_1 T_1^P}_{Capital}. \tag{A-8}$$

Shadow banking has a mixed effect on the SOE's profit, as it allows the SOE to achieve some profit gain from credit resale to the PE. On the other hand, it reduces credit available to the SOE as formal banking credit diminishes.

For the SOE to achive a non-negative profit gain, it requires

$$\left[(1-p_1)\, r_1^T - (1-\gamma) - A^S\right](1-\omega_1) \geq \left(A^S - r_1^L\right)(1-\alpha)\,\omega_1,$$

which is equivalent to

$$p_1 < \frac{(1+\omega_1)\left(r_1^T - A^S\right) - \omega_1\left(A^S - r_1^L\right)(1-\alpha)}{(1+\omega_1)\left(r_1^T + 1 - \gamma\right)}. \tag{A-9}$$

If Inequality (A-9) holds, a *Pareto* improvement will be achieved. According to Remark 5, Inequality (A-9) should be a sufficient but not necessary condition for Inequality (4.6). It suggests when a reform satisfies the condition for a *Pareto* improvement, it will be a *Kaldor-Hicks* improvement by the meantime by definition.

Notably, a *Kaldor-Hicks* improvement does not necessarily require the SOE to become better off after the dual track reform. If the profit gains of the household and PE sectors could more than offset the loss of the SOE after the reform, a *Kaldor-Hicks* improvement can be achieved. Q.E.D. □

A.8 Proof for Remark 5

In the absence of shadow banking, the household can invest in the bank deposit only. Therefore, the total amount of capital that the SOE obtains for production is fixed at $(1-\alpha)\,E$ before and after the single-track interest rate liberalization. The aggregate profit is also fixed at $A^S\,(1-\alpha)\,E$, before or after the liberalization. Hence, we have $\Delta\Pi_{3-0} = 0$. Given the PE has no access to credit in the absence of shadow banking ($\Pi_0^P = \Pi_3^P = 0$), we have $\Delta\Pi_{3-0} = \Delta\Pi_{3-0}^S + \Delta\Pi_{3-0}^H = 0$, implying the single-track liberalization only alters the profit allocation between the SOE and the household without changing the aggregate profit.

After the single-track interest rate liberalization, the deposit rate will increase to θA^S from ψA^S. As a result, the bank loan rate will rise to $\left(\theta A^S/(1-\alpha)\right)$ from $\left(\psi A^S/(1-\alpha)\right)$. The changes in the profits of the household and the SOE are

$$\begin{aligned} \Delta\Pi_{3-0}^H &= (\theta-\psi)\,E > 0; \\ \Delta\Pi_{3-0}^S &= -(\theta-\psi)\,E < 0, \end{aligned}$$

respectively, where $\Delta\Pi_{i-j}^X$ refers to the profit change of agent X ($X \in \{S, P, H\}$ for the SOE, the PE, and the household, respectively) from stage j to i. The aggregate profit

$\Pi_i = \Pi_i^S + \Pi_i^P + \Pi_i^H$. An increase in the deposit rate reduces the subsidy from the household to the SOE, but does not change the aggregate profit.

A.9 Proof for Remark 6

Proof. The zero-profit condition for the bank under the formal banking track implies

$$\frac{\mathrm{d}r^L}{\mathrm{d}r^D} = \frac{1}{1-\alpha} > 0.$$

According to Remark 2, we have

$$\frac{\mathrm{d}r^T}{\mathrm{d}r^D} > 0.$$

Hence, r^T is increasing in r^D. Given $r_2^D > r_1^D$ after the full interest rate liberalization, we have $r_2^L > r_1^L$, and $r_2^T > r_1^T$. Remark 6 also characterizes the monotonicity among the interest rates. Q.E.D. □

A.10 Proof for Proposition 3

Proof. We prove Proposition 3 in two steps. First, we show that the full interest rate liberalization may not necessarily achieve a *Kaldor-Hicks* improvement, and hence a *Pareto* improvement may not be achieved. Then, we prove that after the full liberalization, the PE will be certainly worse off; the SOE may experience additional gain or loss; while the household will benefit unconditionally.

i) Full interest rate liberalization may not necessarily lead to a *Kaldor-Hicks* improvement.

Remark 6 proves that both trust (entrusted) loan rate and loan rate will rise after the deposit rate ceiling being removed, then the size of trust loan will decrease due to a weaker trust loan demand from the PE. Mathematically,

$$T^P = \frac{M\left(A^P - r^T\right)}{2\left(A^P - r^T + \gamma\right)} = \frac{M}{2\left(1 + \frac{\gamma}{A^P - r^T}\right)},$$

suggesting the trust loan demand (T^P) is decreasing in trust (entrusted) loan rate (r^T). Thus, $r_2^T > r_1^T$ yields $T_2^P < T_1^P$. Accordingly, we have a lower default probability of the PE ($p_2 < p_1$), and hence a lower expected default loss ($p_2 T_2^P < p_1 T_1^P$).

Given Equation (4.4), the aggregate profit gains have the same functional forms before and after the full interest rate liberalization (for $i \in \{1, 2\}$):

$$\Pi_i = (1 - p_i) A^P T_i^P + A_i^S (L_i - T_i^S) - p_i T_i^P.$$

Re-arrange the equation into

$$\Pi_i = \left[\left(A^P - A^S\right) - \left(1 + A^P\right)\left(\frac{T_i^P}{M}\right)\right] T_i^P + A^S\left(1 - \alpha\right) E.$$

The partial derivative of the aggregate profit gain with respect to T^P is

$$\frac{\partial \Pi}{\partial T^P} = \left(A^P - A^S\right) - \frac{2\left(1 + A^P\right) T^P}{M}.$$

Therefore, the full interest rate liberalization does not lead to *Kaldor-Hicks* improvement if

$$p \leq \frac{A^P - A^S}{2\left(1 + A^P\right)},$$

as under this circumstance we will have $\frac{\partial \Pi}{\partial T^P} \geq 0$. Full interest rate liberalization leads to a smaller size of shadow banking sector (a lower T^P), and thus a lower aggregate profit given $\frac{\partial \Pi}{\partial T^P} \geq 0$.

ii) The PE will be unconditionally worse off after the full interest rate liberalization.

Full liberalization affects the PE's profit mainly through three channels: (1) pushing up the PE's financing cost (the cost channel); (2) reducing credit available for PE production (the capital channel); (3) reducing PE default probability as the size of shadow banking shrinks (the risk channel).

Taking the first-order derivative of the PE's profit with respect to r^D, we have

$$\frac{\mathrm{d}\Pi^P}{\mathrm{d}r^D} = \underbrace{-(1-p)T^P \frac{\mathrm{d}r^T}{\mathrm{d}r^D}}_{Cost} + \underbrace{\left[(1-p)(A^P - r^T) - p\gamma\right] \frac{\mathrm{d}T^P}{\mathrm{d}r^D}}_{Capital} - \underbrace{\left[(A^P - r^T)T^P + \gamma T^P\right] \frac{\mathrm{d}p}{\mathrm{d}r^D}}_{Risk}.$$

Given

$$\frac{\mathrm{d}r^T}{\mathrm{d}r^D} > 0; \quad \frac{\mathrm{d}T^P}{\mathrm{d}r^D} < 0; \quad \frac{\mathrm{d}p}{\mathrm{d}r^D} < 0,$$

the capital and cost channels has negative effects on the PE's profit, while the risk channel has a positive effect.

Substituting

$$\frac{\mathrm{d}p}{\mathrm{d}r^D} = \left(\frac{1}{M}\right) \frac{\mathrm{d}T^P}{\mathrm{d}r^D}$$

(implied by $p = \frac{T^P}{M}$) into $\frac{\mathrm{d}\Pi^P}{\mathrm{d}r^D}$, we have

$$\frac{\mathrm{d}\Pi^P}{\mathrm{d}r^D} = -\left[(A^P - r^T) - 2(A^P - r^T + \gamma)p\right] \frac{\mathrm{d}T^P}{\mathrm{d}r^D} - (1-p)T^P \frac{\mathrm{d}r^T}{\mathrm{d}r^D}.$$

Given the optimal trust loan demand from the PE,

$$p = \frac{A^P - r^T}{2(A^P - r^T + \gamma)},$$

the following inequality unconditionally holds in equilibrium:

$$\frac{\mathrm{d}\Pi^P}{\mathrm{d}r^D} = -(1-p)T^P \frac{\mathrm{d}r^T}{\mathrm{d}r^D} < 0.$$

Therefore, if $r_2^D > r_1^D$, then $\Pi_2^P < \Pi_1^P$, implying that the PE will be unconditionally worse off after the full liberalization, as the profit gain from risk channel just fully offset the profit loss from the capital channel, while the cost channel contributes to a net negative effect on the PE's profit gain.

iii) The SOE may be either better or worse off after the full interest rate liberalization.

The full interest rate liberalization has mixed effects on the SOE's profit. On the positive side, the reform shifts more credit from shadow banking back to formal banking so that the SOE obtains more bank loan (gain from the capital channel). It also reduces expected PE default loss (gain from the risk channel). On the other hand, the SOE experiences a rising financing cost (loss from the cost channel). If the loss outweighs the gains, the SOE will be worse off.

iv) The household will unconditionally benefit from the full interest rate liberalization.

Re-arranging the profit gain of the household with shadow banking, we obtain

$$\Pi_i^H = r_i^D(E - W_i) + (1-p_i)r_i^T W_i - p_i(1-\gamma)W_i.$$

Taking the first-order derivative of the household's profit gain with respect to r^D, we have

$$\frac{\mathrm{d}\Pi^H}{\mathrm{d}r^D} = (E-W) - \left[r^D + (1-p)r^T + (1-\gamma)p\right]\frac{\mathrm{d}W}{\mathrm{d}r^D} - \left[r^T W + (1-\gamma)\right]\frac{\mathrm{d}p}{\mathrm{d}r^D} + (1-p)W\frac{\mathrm{d}r^T}{\mathrm{d}r^D}.$$

It is easy to prove that in equilibrium,

$$\frac{\mathrm{d}W}{\mathrm{d}r^D} < 0; \quad \frac{\mathrm{d}p}{\mathrm{d}r^D} < 0; \quad \frac{\mathrm{d}r^T}{\mathrm{d}r^D} > 0.$$

Therefore, we obtain

$$\frac{\mathrm{d}\Pi^H}{\mathrm{d}r^D} > 0.$$

Given $r_2^D > r_1^D$, we have $\Pi_2^H > \Pi_1^H$, implying that the household will be unconditionally better off after the full interest rate liberalization.

Overall, the full interest rate liberalization cannot generate additional *Pareto* improve-

ment. Q.E.D. □

A.11 Interest Rates and Credit Sizes in Simulation

According to Remark 6, interest rates will all increase after the dual-track interest rate liberalization due to the anchoring effect of deposit rate ceiling on the rates. Table 3 reports that the deposit rate increases from 3.0% ($= r_1^D = \psi A^S = 0.6 \times 5\%$) to 3.5% ($= r_2^D = \theta A^S = 0.7 \times 5\%$) after the full interest rate liberalization. Meanwhile, the bank loan rate increases from 3.75% ($= r_1^D/(1-\alpha) = 3.0\%/(1-0.2)$) to 4.38% ($= r_2^D/(1-\alpha) = 3.5\%/(1-0.2)$), lower than the actual benchmark loan rate of 6.0% in 2013. The assumption that the banking sector earns a zero profit helps explain the discrepancy. Equation (3.3) implies that before and after the full liberalization, the equilibrium trust (entrusted) loan rate (r^T) is 14.21% and 14.32%, respectively, which are fairly close to the actual trust loan rate of about 12.00% in 2013.

A substantial portion of credit flows into the shadow bank track after the dual-track interest rate reform. The model-implied amount of bank loan is 71.63 after the rise of shadow banking, which is comparable to the actual bank loan size of 71.90 trillion yuan in 2013 but lower than its size before the reform ($80.00 = (1-\alpha)D_0 = (1-0.2) \times 100.00$). The model-implied amount of deposit is 89.54 after the rise of shadow banking, lower than its actual size of 104.38 (trillion yuan) and our assumed household endowment (100.00). Based on the trust (entrusted) loan market clearing conditions, the simulated size of trust loan funded by the WMP and entrusted loan are 10.46 and 5.71, respectively, resembling their actual sizes of 10.50 and 8.60 trillion yuan, respectively.[18] The simulation results suggest that the amount of credits obtained by the PE increases from zero to 16.17 after rise of shadow banking, and then falls to 15.92 after the full liberalization, slightly lower than the observed size of 19.10 trillion yuan.

The implied deposit reserve decreases from 20.00 ($= \alpha D_0 = 0.2 \times 100.00$) to 17.90 ($= \alpha D_1 = 0.2 \times 89.54$) after the emergence of the shadow banking sector, resulting in less idled capital away from firm production. The close resemblance between the model-implied interest rates and asset quantities to their empirical counterparts suggests that our model calibration is reasonable.

[18] The actual size of entrusted loans (trust loans) is the size of outstanding entrusted loans (outstanding trust loans) as of 2013. The data are provided by the PBoC.

Table 1: **Incremental Aggregate Financing in China**

This table reports incremental aggregate financing to the real economy (in RMB billion terms) in China in 2002-2018, based on the PBoC's definition before the amendation in August 2018 to obtain sufficiently long, and comparable time series. $AFRE$ represents incremental aggregate financing to the real economy; $RMBL$ denotes RMB-denominated loan; FL denotes foreign currency-denominated loan (RMB equivalent); EL denotes entrusted loan; TL denotes trust loan; UBA denotes undiscounted banker's acceptance; CB denotes net issuance of corporate bond; EQ denotes net equity issuance of non-financial firms in domestic markets. Percentages to $AFRE$ are reported in parentheses. Data sources: the People's Bank of China.

Year	$AFRE$	$RMBL$	FL	ETL	TL	UBA	CB	EQ
2002	2011	1848	73	18	43	-70	37	63
		(91.9%)	(3.6%)	(0.9%)	(2.1%)	(-3.5%)	(1.8%)	(3.1%)
2003	3411	2765	229	60	51	201	50	56
		(81.1%)	(6.7%)	(1.8%)	(1.5%)	(5.9%)	(1.5%)	(1.6%)
2004	2863	2267	138	312	61	-29	47	67
		(79.2%)	(4.8%)	(10.9%)	(2.1%)	(-1.0%)	(1.6%)	(2.4%)
2005	3001	2354	142	196	72	2	201	34
		(78.5%)	(4.7%)	(6.5%)	(2.4%)	(0.1%)	(6.7%)	(1.1%)
2006	4270	3152	146	270	83	150	231	154
		(73.8%)	(3.4%)	(6.3%)	(1.9%)	(3.5%)	(5.4%)	(3.6%)
2007	5966	3632	386	337	170	670	228	433
		(60.9%)	(6.5%)	(5.7%)	(2.9%)	(11.2%)	(3.8%)	(7.3%)
2008	6980	4904	195	426	314	106	552	332
		(70.3%)	(2.8%)	(6.1%)	(4.5%)	(1.5%)	(7.9%)	(4.8%)
2009	13910	9594	927	678	436	461	1237	335
		(69.0%)	(6.7%)	(4.9%)	(3.1%)	(3.3%)	(8.9%)	(2.4%)
2010	14019	7945	486	875	387	2335	1106	579
		(56.7%)	(3.5%)	(6.2%)	(2.8%)	(16.7%)	(7.9%)	(4.1%)
2011	12829	7472	571	1296	203	1027	1366	438
		(58.2%)	(4.5%)	(10.1%)	(1.6%)	(8.0%)	(10.6%)	(3.4%)
2012	15763	8204	916	1284	1285	1050	2255	251
		(52.1%)	(5.8%)	(8.1%)	(8.2%)	(6.7%)	(14.3%)	(1.6%)
2013	17317	8892	585	2547	1840	776	1811	222
		(51.4%)	(3.4%)	(14.7%)	(10.6%)	(4.5%)	(10.5%)	(1.3%)
2014	16457	9782	355	2507	517	-129	2425	435
		(59.4%)	(2.2%)	(15.2%)	(3.1%)	(-0.8%)	(14.7%)	(2.6%)
2015	15408	11269	-643	1591	43	-1057	2940	760
		(73.1%)	(-4.2%)	(10.3%)	(0.3%)	(-6.9%)	(19.1%)	(4.9%)
2016	17802	12437	-564	2185	859	-1953	2999	1242
		(69.9%)	(-3.2%)	(12.3%)	(4.8%)	(-11.0%)	(16.9%)	(7.0%)
2017	19444	13843	2	777	2256	536	450	873
		(71.2%)	(0.0%)	(4.0%)	(11.6%)	(2.8%)	(2.3%)	(4.5%)
2018	15859	15671	-420	-1607	-690	-634	2476	361
		(98.8%)	(-2.6%)	(-10.1%)	(-4.4%)	(-4.0%)	(15.6%)	(2.3%)

Table 2: **Model Parameters**

This table reports the parameter values in the numerical simulation. The parameters are set based on the real data or according to the literature.

Variable	Definition	Value
A^S	Productivity (return on capital) of the SOE	0.05
A^P	Productivity (return on capital) of the PE	0.2
E	Wealth endowment of the household	100
M	The inverse of marginal cost of shadow banking	200
α	Reserve requirement ratio (RRR)	0.2
γ	Share of default loss borne by the PE	0.3
θ	Ratio of deposit rate to the SOE productivity after the full liberalization	0.7
ψ	Ratio of deposit rate ceiling to the SOE productivity	0.6

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

This table reports the equilibrium interest rates and asset sizes at different interest rate reform stages: Before (the Dual-Track) Reform; Dual-Track Reform; and Full (Interest Rate) Liberalization. The parameters r^L, r^D, and r^T denote the interest rates of loan, deposit, and trust (entrusted) loan, respectively; L, D, T^B (W) denote the sizes of loan, deposit, and trust loan supplied by the bank (WMP funded by the household), respectively; T^S and T^P represent the entrusted loan supplied by the SOE and trust loan obtained by the PE, respectively; p is the probability of PE default; We then estimate the default ratio of the whole financial system as the ratio of expected default loss to the total amount of credit used for production ($P = (p \times T^P)/(T^B + L)$). The last column reports the actual interest rates and asset sizes as of 2013. Short dash indicates that the corresponding asset does not exist in the model, or is unobserved in the real data. Data sources: People's Bank of China (PBoC), China Banking Regulatory Commission (CBRC) and China Trustee Association.

Variable	Before Reform	Dual-Track Reform	Full Liberalization	2013
Interest Rates				
r^L	3.75%	3.75%	4.38%	6.00%
r^D	3.00%	3.00%	3.50%	3.00%
r^T	-	14.21%	14.32%	12.00%
Financial Products (RMB trillion)				
L	80.00	71.63	72.21	71.90
D	100.00	89.54	90.26	104.38
T^B (W)	-	10.46	9.74	10.50
T^S	-	5.71	6.18	8.60
T^P	-	16.17	15.92	19.10
Probability of Default				
p	0.00%	8.09%	7.96%	-
P	0.00%	1.59%	1.55%	$\geq$1.00%*

* The corresponding empirical default ratios in the shadow banking sector and overall credit system in China are not available. We conjecture that the default ratio in the overall credit system is over 1.00% based on the following information: First, the non-performing loan ratio of banks was 1.00% in 2013 according to the CBRC; second, the default ratio in the shadow banking sector should be higher than the default ratio in the formal banking sector because shadow bank credits were invested in relatively more risky projects.

Table 4: **Profits in Different Reform Stages**

This table presents the profits of the agents at different reform stages. Columns (2)-(5) are for Before (the Dual-Track) Reform Dual-Track Reform; Full (Interest Rate) Liberalization, and Single-Track (Interest Rate) Reform, respectively.

	Before Reform	Dual-Track Reform	Full Liberalization	Single-Track Reform
Firm	1.00	1.50	1.06	0.50
-SOE	1.00	1.03	0.61	0.50
-PE	0.00	0.47	0.45	0.00
Household	3.00	3.46	3.90	3.50
Aggregate	4.00	4.96	4.96	4.00

Figure 1: **The Baseline Model**

This figure depicts the baseline model. The arrows represent the directions of credit flows. The figure resembles the credit system before the dual-track interest rate liberalization if shadow banking activities marked by green arrows are shut off. It resembles the full interest rate liberalization if the bank credit controls highlighted by the red arrows are removed. Removing simultaneously the shadow banking activities and the bank credit controls will lead to a single-track interest rate liberalization.

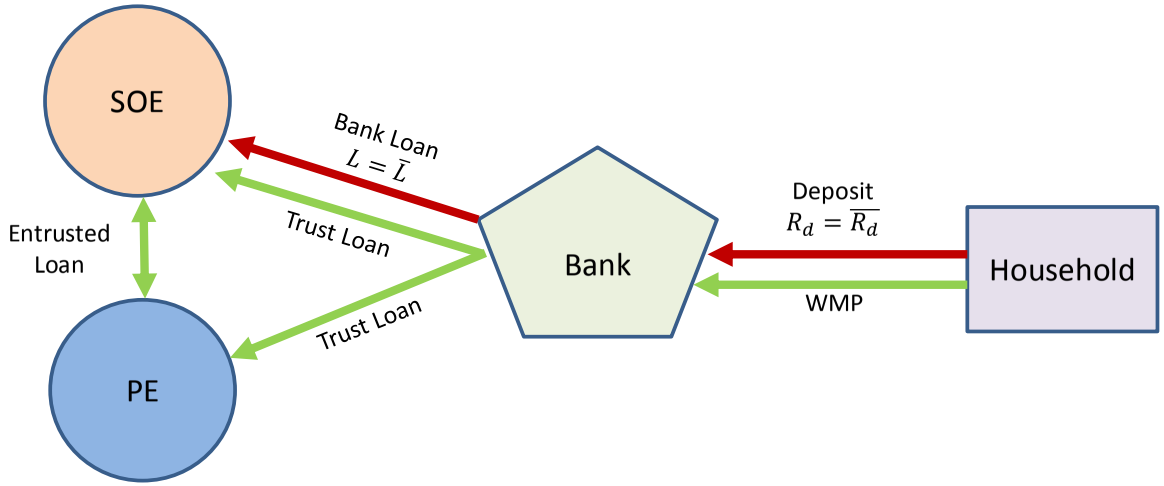

Figure 2: **Aggregate Profit Gain from Shadow Banking**

This figure depicts the relations between the aggregate profit gain after the rise of shadow banking ($\Delta W_{1-0} = W_1 - W_0$) and the productivity gap between the PE and the SOE (A^P/A^S), reserve requirement ratio (α), the inverse of marginal cost of shadow banking (M), and the degree of interest rate repression (ψ), respectively.

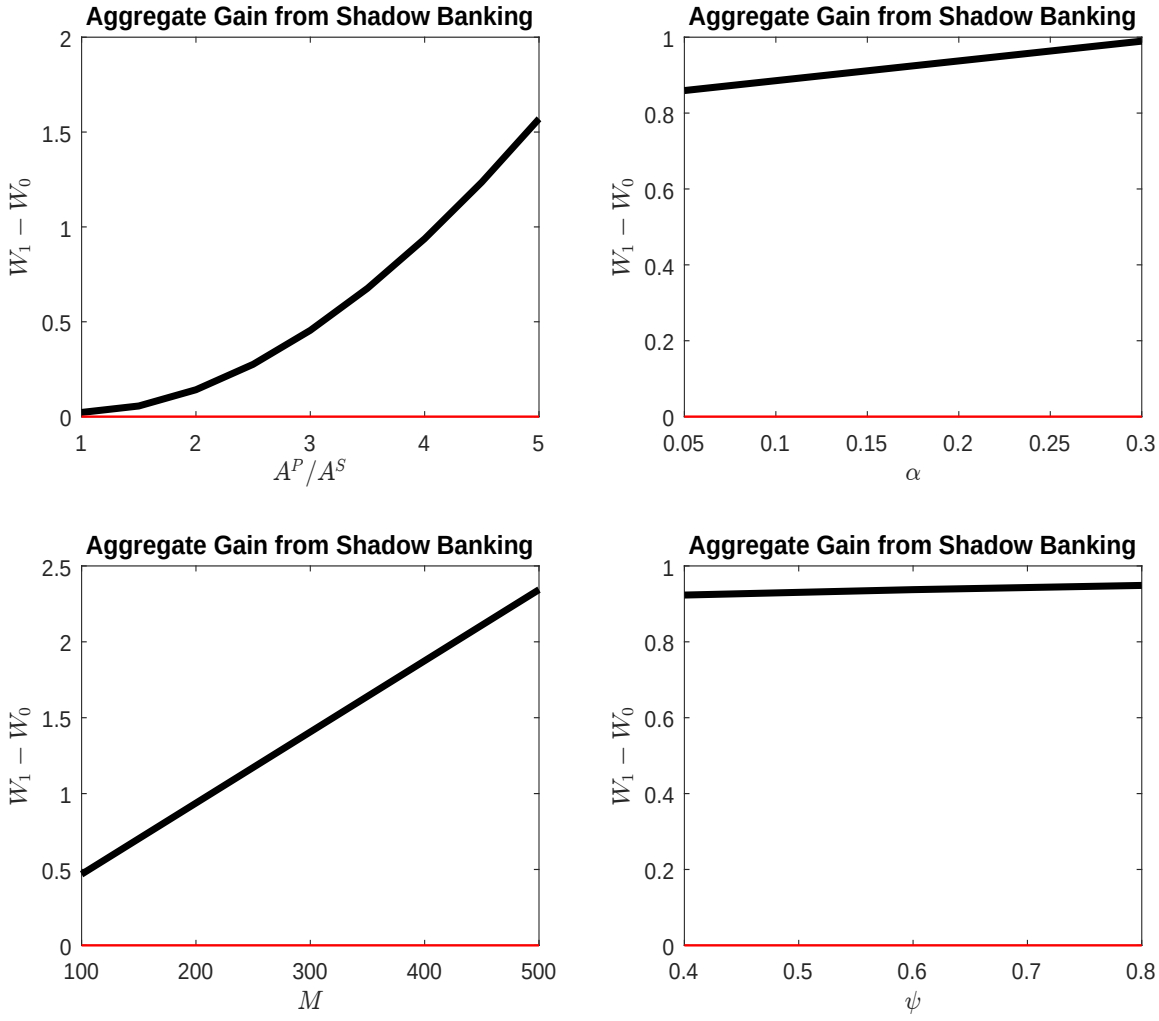

Figure 3: **The SOE's Profit Gain from Shadow Banking**

This figure shows the relations between the SOE's profit gain after the rise of shadow banking ($\Delta W^S_{1-0} = W^S_1 - W^S_0$) and the productivity gap between the PE and the SOE (A^P/A^S), reserve requirement ratio (α), the inverse of marginal cost of shadow banking (M), and the degree of interest rate repression (ψ), respectively.