Modelling Shadow Banking in China

a DSGE Approach

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Tiivistelmä – Referat – Abstract

This paper constructs and analyses a variation on a DSGE model with a shadow banking system integrated in the financial sector by Falk Mazelis. Shadow banking is fundamentally described as credit intermediation outside the regular banking system and the description is specified in this paper during the process of historical review of the Chinese financial sector. Excess credit in the shadow banking sector and theoretical studies of banks' and shadow banks different reaction to monetary policy shocks are the main motives behind this study.

The Mazelis model builds upon a Gertler-Karadi DSGE model of financial intermediation with unconventional monetary policy. After mapping previous literature on banking, shadow banking and DSGE modelling the detailed model of Mazelis is adjusted by altering the monetary policy rule and four model parameters towards Chinese economical characteristics. The adjustments are and argued with data, previous literature, and theoretical arguments motivated by the historical review. The main objective of this approach is, trough the variation, to capture the effect of Chinese economical characteristics towards an economy with modelled shadow banking sector.

The implications of the original model are considered as a foundation for the altered model. In the original model after tightening monetary policy, regular banks reduce the amount of loans on their balance sheet while shadow banks increase lending. This reduces the real effects of the shock, but at the same time shadow banks amplify the reaction of key variables to real shocks and can make the financial sector and the whole economy more unstable.

The analysis of the altered model provides suggestions that the implemented Chinese characteristics make the economy slightly more vulnerable to a monetary policy tightening reducing capital and consumption. In addition, simulated shocks to productivity and monetary policy amplify the reactions of the financial sector in bank and shadow bank loan supply suggesting that the altered model can make the economy all the more unstable. The DSGE framework used in this paper does not try to model Chinese economy, but rather provides hints of economic elements in it and highlights specific aspects of it.

Avainsanat – Nyckelord – Keywords
Shadow Banking, China, DSGE model, Financial Sector, Banking, Chinese Economy, Monetary Policy Rule

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Tiivistelmä – Referat – Abstract

Tämä työ rakentaa ja analysoi variaation Falk Mazeliksen DSGE malliin, jossa on varjopankkisysteemi integroituna finanssisektoriin. Varjopankkitoiminta on fundamentaalisesti kuvailtu luoton välittämiseksi normaalin pankkitoiminnan ulkopuolelta. Tätä määritelmää tarkennetaan Kiinan finanssisektorin historiallisen katsauksen kautta. Tämän tutkimuksen päämotiivit ovat varjopankkisektorin liiallinen luoton määrä ja teoreettiset tutkimukset pankkien ja varjopankkien erilaisista reaktioista rahapolitiikan shokkeihin.

Mazeliksen malli pohjautuu Gertler ja Karadin DSGE malliin, jossa finanssisektorin välitystä analysoidaan epätavanomaisella rahapolitiikalla. Pankkitoimintaa, varjopankkitoimintaa ja DSGE mallintamista käsittelevän kirjallisuuskatsauksen jälkeen Mazeliksen malli tarkennetaan ja esitetään yksityiskohtaisesti. Rahapolitiikan sääntöä ja neljää mallin parametria muokataan kohti kiinalaisen talouden erityispiirteitä. Muokkaaminen tarkennetaan ja perustellaan datalla, aikaisemmalla kirjallisuudella ja teoreettisilla argumenteilla historiallisen katsauksen pohjalta. Tämän lähestymistavan päämäärä on, variaation kautta, tutkia kiinalaisen taloudellisten erityispiirteiden vaikutusta mallinnettuun varjopankkisektoriin.

Alkuperäisen mallin implikaatiot tarkastellaan pohjana muokatun mallin analysoimiselle. Alkuperäisessä mallissa rahapolitiikan tiukentuminen johtaa lainojen vähentymiseen pankkien taseessa, kun taas varjopankit lisäävät lainanantoa. Tämä vähentää shokin reaalisia vaikutuksia, mutta samaan aikaan varjopankit vahvistavat avainmuuttujien reaktioita ja voivat tehdä finanssisektorista ja koko taloudesta epätastabiilimman.

Muokatun mallin analyysi viittaa siihen, että kiinalaisen talouden erityispiirteiden sisällyttäminen tekee taloudesta hieman haavoittuvaisemman rahapolitiikan tiukentumiselle vähentäen pääomaa ja kulutusta. Lisäksi, simuloidut shokit tuottavuuteen ja rahapolitiikkaan voimistavat finanssisektorin reaktiota, tarkemmin varjopankkien ja pankkien lainojen tarjonnan reaktioita. Tämä vihjaa, että muokattu malli voi tehdä taloudesta entisestään epästabiilimman. Tämän työn DSGE työkalut eivät pyri mallintamaan Kiinan koko taloutta, vaan ennemminkin välittämään sen taloudellisten elementtien viitteitä ja korostamaan sen tiettyjä aspekteja.

Avainsanat – Nyckelord – Keywords
Varjopankkitoiminta, Kiina, DSGE malli, finanssisektori, pankkitoiminta, Kiinan talous, rahapolitiikan sääntö

1 Introduction

This paper uses a monetary dynamic stochastic general equilibrium (DSGE) model by Falk Mazelis (2015) with shadow banking system integrated in the financial sector slightly adjusting the model, to discuss the financial sector of China with a historical approach providing justification towards the adjustment. The examined model is altered towards Chinese characteristics to theoretically study and analyse macroeconomic shock effects of the adjustments through the six-agent economy while reflecting the concept of shadow bank modelling in China.

The main motives behind the approach are recent worries of excess credit in the shadow banking sector as well as theoretical studies of banks' and shadow banks' different reactions to monetary shocks. The latter is a finding that emerged after the sub-prime crisis in 2008. Additionally, the unique characteristics China's economy amplify the interest within the motives.

State-ownership with gradual actions towards a marked-driven economy and historically tremendous economic growth are only a few examples of what make China's banking sector different and very interesting. China's financial sector has frictions that allows non-efficient allocation of capital, such as Interest rate ceilings and implicit guarantees. Both will be a a topic of detailed discussion in this paper. (Anzoategui et al., 2015).

There is no all-encompassing definition for a shadow bank, which is one of the reasons scientific economic discussion has started to use terms such as shadow banking sector and shadow banking system. Shadow banking system bundles financial institutions and organizations that offer similar services

and assume similar risks than banks, but are not institutionally recognized as banks. The concept has broadly emerged as popular issue of debate during and after the sub-prime crisis of 2008. A correlation between the crisis and shadow banking sector has been established and has motivated new approaches to study shadow banking, such as Verona et al., 2011. However, one must be careful when defining the shadow banking sector.

Shadow banking sector's form and array is dependent on legislation. When forming an overall opinion on the shadow banking system, one must strongly emphasize the elements of versatility and complexity. The entire system is a collection of different financial institutions with similar business approaches and reactions to economic phenomena. Financial Stability Board (2012) defines shadow banking as "the system of credit intermediation that involves entities and activities outside the regular banking system" (Li, 2014). Even the definition of shadow banking differs by country, but the previous quote could act as the global basis upon which more precise definitions are being constructed.

No official statistics of shadow banking systems' size exist, which means all data related to it is based on estimations. The term occasionally includes even negative associations, but to analytically define the neutral term being used in this paper, chapter three captures what is existentially meant by shadow banking in China.

Next, adjustments to the base model are carefully presented and explained. The implications of the adjusted model suggest a slight vulnerability of the altered economy's production after tightening of monetary policy. Simulated

shocks to interest rate as well as production amplify the reaction of the financial sector through different lending channels studied by Mazelis (2015). When the modelled central bank raises the interest rate, banks reduce lending while shadow banks increase lending (Mazelis, 2015).

Structurally, this paper is divided into four main sections, excluding the introduction and concluding remarks. The second chapter discusses the literature behind DSGE modelling, banking and shadow banking in the financial sector, and the main sources of influence for this paper. Then, the brief history of the development of the banking sector in China is studied and, via the banking reforms, the current financial frictions are considered. Furthermore, the concept of Chinese shadow banking is discussed in more detail. The fourth chapter consists of studying the DSGE model of Falk Mazelis (2015) and presenting the first order conditions, equilibrium, and the solved steady state with implications of the inclusion of shadow banking briefly examined. As a conclusion to the main sections, the adjustments are introduced, argued, and analysed.

2 Literature

Being a rather new phenomenon, or a new topic of discussion to be more precise, shadow banking has not yet extensively found its way to economic models in financial sectors even though the volume of research on the matter has risen in recent years. Few of the models introduced here are dynamic stochastic general equilibrium (DSGE) models, dynamic due to economy evolving over time and stochastic due to random shocks, such as macroeco-

nomic policy shocks.

One of the largest errors related to forecasting economic crises deals with the size of the shocks that impact the economy. Financial markets are imperfect due to asymmetric information between borrowers and lenders, and costly enforcement of financial contracts, among many other things. During times of extreme economic turbulence, non-linearities and non-stationarities are more likely, which suggests an emphasis on non-linear models when analysing and forecasting the impacts and effects of financial crises. (Geoff and Julian, 2011).

Many state-of-the-art DSGE models and other mainstream macroeconomic models used in central banks for forecasting face criticism for having unrealistic assumptions, such as perfect information or rational expectations.Partial or full exclusion of financial frictions and non-linear dynamics has also aroused criticism. Moreover, non-linear models do not fit into economic analysis without critique. It is probable to find good non-linear models to fit the data for a given crisis, but during "normal times" the models might not be beneficial at all since they usually explain and emphasize features in data that occur infrequently. (Geoff and Julian, 2011).

This chapter deals with mainly macroeconomic financial linear and non-linear models, DSGE models and other types of models. Examined models are with and without exogenous or endogenous shocks and with and without shadow banking to map out previous literature on the subject.

2.1 Modelling the Financial Sector

The volume of macroeconomic research on the financial sector has increased after the sub-prime crisis, yet a variety of banking system structures have existed in macroeconomic literature before the latest well known global crisis. For instance, Jermann and Quadrini (2009) considered a financial sector that can act as a source of the business cycle, proposing shocks that affect the financial sector directly in addition to the propagation of shocks originating in other economic sectors.

Temporary small financial shocks can have a potentially large impact on the whole economy due to the time consuming net worth rebuild of indebted agents of the economy, as well as an impact on financial constraints, as discussed by Brunnermeier and Sannikov (2013) in their creation of macroeconomic model with a financial sector. The core of their model used two types of agents, productive experts and less productive households, to examine the equilibrium dynamics of an economy that occasionally faces volatile crisis episodes due to nonlinear amplification effects. They studied the volatility paradox in which endogenous risk persists in crisis, even if the exogenous risks are at a very low level.

Brunnermeier and Sannikov (2013) describe a risk of experts having the ability to better hedge idiosyncratic risks among one another. Then they add leverage making the economic system less stable. The result holds also when intermediaries facilitate lending from households to experts. The model underlines the importance of financial regulation subject to time and crisis presence. Regulation restricting dividends should depend primarily on the aggregate net worth of all intermediaries.

2.1.1 Monopolistic Banking Systems

The core interest of this paper, however, is concentrated on shadow banks, but here monopolistic banking systems are also considered. The former is discussed in the following subsection while the latter serves as an interesting piece constructing the historical approach of the financial sector of China. There are models comparing competitive banking and monopolistic banking with rather different approaches and mixed findings, and the extent of literature of the comparison started widening at the turn of the century. General equilibrium models propose that less competitive banks are harmful to the economy while, for instance, Cetorelli (1995, 1997) suggests a monopoly bank that facilitates technology adoption and reduces screening costs via exploration of banking structure on adoption of technology, financing of credit-constrained firms and screening processes for new loans. However, redistribution of productive resources counterweights the benefits, and he states the impact of monopoly in banking to be ambiguous (Cetorelli, 1995, 1997).

The antithesis of which kind of banking system is better for a given economy is not black and white, and one has to keep in mind that there are numerous completely different aspects of studying the two different financial systems. Furthermore, the definition of "good for economy" can be subject to a larger debate. Boyd, De Nicoló, and Smith (2003) were among the first ones to discuss the comparison specifically in the case of an banking crisis. They considered the relative probabilities of banking crises and output losses in competitive versus monopolistic banking systems. One of the main factors in their model is the rate of inflation which directly affects the nominal in-

terest rate, and how the rate of inflation affects the probability of a banking crisis contrasting the two systems.

According to their theoretical findings, the probability of a panic (a banking crisis involving the suspensions of cash payments to depositors, depletion of cash reserves, the emergence of a premium on currency, the use of emergency expedients to provide substitutes for media of exchange) is related to some threshold in the nominal interest rate. If the rate is below that threshold, monopolistic banks have a higher probability of a panic than competitive banks, and if the rate is above that threshold, competitive banks have a higher probability of a panic than monopolistic banks. Additionally, if the nominal interest rate increases so does the probabilities of a banking panic under both competitive and monopolistic banking systems. (Boyd et al., 2003).

Empirical research hinted a positive correlation between the rate of growth of real activity in an economy and the development of its financial sector. Guzman (2000) considers the equilibrium growth paths of two economies: one with competitive banking and one with monopolistic banking ceteris paribus, analyzing connections between credit rationing, capital accumulation, monitoring, and development trap phenomena to capture interrelationships between intermediation and growth.

According to Guzman (2000), monopolistic banking system decreases equilibrium growth of capital stock for two possible reasons, assuming monopoly banks have monopoly power in loan markets and deposit markets and choose to exercise this power separately. Firstly, monopolistic banking system results in credit rationing more likely than competitive banking system and

when credit rationing exists, monopolistic banks ration credit more extensively. Secondly, without credit rationing the monopolistic banking system monitors credit-financed investments excessively. (Guzman, 2000).

La Croce and Rossi (2015) discussed the endogenous firm entry in an economy with monopolistic competitive banks in a DSGE model and implied that free entry results in higher volatilities of both real and financial variables. This contrasts a DSGE model that uses a fixed number of firms and a monopolistic banking system.

2.1.2 Shadow Banking

Gennaioli, Shleifer, and Vishny (2013) introduced a model of shadow banking where banks create and trade loans, assembling them into diversified portfolios and financing these portfolios with riskless debt. The demand for riskless debt is driven by outside investor wealth. They build on their previous production model of Gennaioli et al. (2012) and present a model that describes securitization without any risk transfer outside the core banks. The process of diversifying idiosyncratic risk while concentrating banks' exposure to systematic risk enables them to expand their balance sheets by funding carry trades with riskless debt.

Gennaioli et al. (2013) portray financial crises as man-made disasters, which implies that they occur more frequently than in a neoclassical framework, where market participants minimize the risks of default and bankruptcy. The model implies also that during the latest financial crisis market participants were not fully aware of risks being taken.

Ferrante (2015) modelled how introducing shadow banks as an additional banking sector can make the economy more unstable even though credit availability is increased. In the model, intermediaries, traditional banks and shadow banks can originate risky projects (loans), but asymmetric information about the loans that banks fund affects the limit of the amount raised by outside investors. Traditional banks and shadow banks react differently to the agency-information problem. Ferrante (2015) states that the shadow banking sector amplifies exogenous shocks as it increases the aggregate leverage of the financial sector.

A DSGE macroeconomic model of a monetary policy shocks in the banking sector extended with a shadow banking sector by Verona, Martins and Drumond (2011) was motivated by the sub-prime crisis. Without any solid evidence of causal connection between excessively loose monetary policy and the sub-prime crisis, the model builds upon strong correlation between the two. It assumes that the financial sector has a central role piloting the boom and bust business cycles we are experiencing today (Verona et al., 2011).

Merged from the Real Business Cycle (RBC) models and the New Keynesian sticky-price models, the DSGE models of today do not put significant weight on credit creation in the financial markets. The Verona et al. (2011) DSGE model with shadow banking system (VMD model) aims to shift the attention from financial frictions caused by the behaviour of borrowers towards analysing financial intermediaries themselves. This is done by composing the micro-founded financial system of two different financial intermediaries; retail banks and investment banks, both which intermediate funds from households

(lenders) to two sets of entrepreneurs (borrowers).

In the model of Verona et al. (2011) the two sets of bankers face two different principal-agent problems between the borrowers and the lenders: retail banks face an agency-information problem in which information is asymmetric and the realized return is observed by the entrepreneurs with no cost, but the retail banks observe it only after monitoring cost. This agency problem is similar to the one introduced in the Ferrante (2015) model earlier. The extended shadow banking sector introduces an agency-money problem in which the investment bank manager faces incentives of side payments to boost his private revenue at the expense of stockholders' profits, converting a fraction of stockholders' profits for his own benefit. The model seeks to answer questions such as how do these perverse incentives in the financial sector affect the transmission of monetary policy shocks through the economy comparing findings to other DSGE models, and does policy of too low interest rates for too long cause a boom-bust cycle. As well as the effects of the combination of these two; perverse incentives in the financial sector with the persistently low interest rate environment.

Funke, Mihaylovski and Haibin (2015) used a non-linear DSGE model to distinguish the different of reactions to monetary policy by commercial banks and shadow banks. They examined the effects and impacts of interest rate liberalization and the dynamics of the parallel shadow banking sector, identifying opposite reactions of shadow banks and commercial banks towards contractionary monetary policy: shadow banks grow while commercial banks retrench.

Another DSGE model that integrates the shadow banking sector and yields similar results as the Funke et al. (2015) model is a model by Falk Mazelis (2015), which is examined further in this paper. His model is a follow-up on the monetary DSGE model of Mark Gertler and Peter Karadi (2011) with financial intermediaries. The Gertler-Karadi (2011) model (GK model) simulates financial crisis and focuses on the effect of central banks' unconventional monetary policy and the endogenous balance sheet constraints of private financial intermediaries. The balance sheet constraints on private intermediaries tighten during a crisis and the central banks -which are not balance sheet constrained- raise the net benefits from intermediation due to their ability to elastically obtain funds by issuing riskless government debt.

The GK model analysis suggests that the net benefits of the unconventional monetary policy diminish as the economy returns to normal and financial intermediaries re-capitalise. This with effects outside the model, such as "politicisation" of credit allocation in normal times, should make unconventional monetary policy suitable only for crisis situations (Gertler and Karadi, 2011). Mazelis (2015) model adds a second financial intermediation sector to the GK model, a shadow banking sector, that issues loans to firms. Considering the crisis-oriented motive for this paper, the framework presented here works as a good layout for the DSGE approach.

Distinguishing between banks and shadow banks and their funding constraints, Mazelis (2015) proposes that banks' reaction to monetary policy shocks corresponds with the balance sheet channel while shadow banks' reaction to shocks is better explained by the lending channel since they are constrained by the funding available to them. Mazelis proposed the same

impact as Funke et al. (2015), that banks and shadow banks react differently to monetary policy shocks: when tightening monetary policy occurs, regular banks reduce the amount of loans on their balance sheets while shadow banks increase lending (Mazelis, 2015).

Studying the monetary transmission channel and how credit intermediation of shadow banks affect the aggregate loan supply to monetary policy, the Mazelis model (2015) examines the contribution of the shadow banking sector to macroeconomic fluctuations. In the model, commercial banks create credit endogenously and shadow banks raise funds from households to be able to loan to firms. These funds are available to shadow banks by households' incentive to save instead of consuming due to an increase in the monetary policy rate, decreasing the willingness of banks to lend. This leads to the constraints described.

2.2 Mechanism of Monetary Policy

The main objective of this paper is to capture the effect of Chinese economical characteristics has towards an economy with modelled shadow banking sector. Therefore, this paper focuses on the DSGE model of Mazelis (2015), which is based on US data, and constructs a variation that aims to capture the characteristics of banking and shadow banking with Chinese economical tendencies. This is done by slightly adjusting the parameters and the monetary policy of the model. The minor adjustments to parameters focus on a production parameter, a depreciation parameter, a banking parameter and a shadow banking parameter. These adjustments represent hints of economical properties of an economy with Chinese characteristics.

Chen, Funke, Lozev and Tsang (2020) build a DSGE model with commercial banking sector analysing the effects of a "window guidance" tool by the regulatory policy of PBoC introduced in 1998. Chen et al. (2020) discusses the aim of PBoC to focus its monetary policy on the quantity of money rather than the price, while slowly shifting the focus towards monetary policy similar to western central banks.

The DSGE modelling of Chen et al. (2020) suggest a welfare tradeoff in stimulating monetary policy by the window guidance tool kit having negative welfare effects in certain cases. This paper uses the Chen et al. (2020) DSGE model monetary policy of PBoC as a foundation, but disregards the window guidance as a nonstandard monetary policy tool. The standard monetary tool in the Chen et al. (2020) model contains the Taylor rule with PBoC targeting gradually to a specific interest rate and inflation. The parameters are calibrated to match key features of the Chinese economy hence it is used in the variation to replace the monetary policy in the Mazelis (2015) model.

The next chapter will discuss the essence of China's financial sector by outlining important historical progress and debating current financial issues, and the specific adjustments introduced here are detailed in chapter five.

3 Financial Sector of PDR China

3.1 Banking Sector

The incomprehensible growth of China's banking sector is a corollary of the step-by-step opening of a formerly closed socialist economy as well as tremen-

dous economic growth. Simultaneously, the economy, as observed through the banking sector, has remained largely state-owned. After WWII and a civil war that coincided with the foundation of the People's Republic of China in 1949, the financial sector was controlled by one bank, the People's Bank of China (PBoC). Consolidated from Huabei Bank, Beihai Bank and Xibei Farmer Bank, the PBoC acted as the central bank and tool of monetary policy as well as all commercial banking operations. After the economic reforms in the 1970's and 1980's and the creation of the Bank of China (BOC) (formerly a non-deposit taking division of PBoC), few new banks were established and the new core of China's banking system along with BOC consisted of the Agricultural Bank of China (ABC), China Construction Bank (CCB, formerly The People's Construction Bank of China) and The Industrial and Commercial Bank of China (ICBC). These became also known as the Big Four. It was after a decent period of huge economic growth and a sturdy and efficient retrenchment of poverty when the banking sector expanded greatly and the number of Chinese banks rose to triple-digits, with numerous banks serving the vast rural areas of the country.

China's economic growth is heavily based on savings and investment, and what distinguishes it from other similar economies and former economies, such as the socialist countries of Central and Eastern Europe, is that the banking sector is tightly operated by domestic banks, whereas many socialist economies let foreign banks to enter their financial market. Bank loans remain the most important source of external funding for the non-financial sector in China, and the share of total financing decreased to 14 % in 2011 from 20 % in 2004. However, banks' financing of investments increased in absolute terms from RMB 1,278 billion to RMB 3,364 billion during the

same period, revealing a glimpse of a vivid expansion of the financial sector. (Fungacova-Korhonen, 2011).

This historical approach lays ground for adjusting the model as well as reasons the motives behind the adjustment approach. The section is divided into consideration of the core banking in the financial sector and the birth of shadow banking on top of it.

3.1.1 Banking Reforms and State-ownership

This vast expansion was predated by major banking reforms. These reforms became necessary as a banking system that was neither competitive nor market-based led to a period that included significant amounts of non-performing loans (roughly 20 % of all loans).

The Big Four was created to supply credit to mainly state-owned enterprises (SOEs) but since SOEs were usually not profit-driven, defaults on their loans followed preventing banks from credit creation with high-risk high-yield projects. The Big Four served, without decision-making powers, under the Ministry of Finance until 1986. Meanwhile, the number of loss-making SOEs increased enormously during 1980's and after 1990's, forcing the government to reform the banking industry. (Kumbhakar-Wang, 2007).

Ten new banks were established in the 1980's. Only one of them was privately owned and the remaining were owned privately and by the state. For simplicity, let us call these ten banks the joint-equity banks of the banking reform, since they were set to form the private banking sector of China in the long-term, and each of the Big Four had initially separate funding purposes for constructing and maintaining a future market-driven economy.

Gradually implemented policies to improve the efficiency of Chinese banks were put in place, and Kumbhakar-Wang (2007) studied the efficiency and total factor productivity (TFP) change in 14 national Chinese banks during a sample period of 1993-2002. Large banking reforms were implemented during this period, and the study reveals an annual TFP growth of 4.4 %, 5.5 % in joint-equity banks and 1.4 % in state-owned banks. This suggests that state-owned banks are less efficient.

Recent studies of Chinese banks' efficiency after the 1994 banking reform expose some variety of results. The Big Four were found to be less efficient, less profitable and had worse asset quality than other types of banks, as discovered by Lin-Zhang (2009) with a regression analysis applied over a period between 1997-2007. Jiang et al. (2009) found with a stochastic distance function that technical efficiency of Chinese banks has improved during 1995-2005. Time periods of these studies include China joining the World Trade Organization (WTO) in 2001. A consensus exists regarding joint-equity banks having better profitability than state-owned banks in China.

The empirical evidence of how the nature of ownership affects bank efficiency is rather mixed. Bhattacharyya et al. (1997) studied state-owned banks in India and discovered them to be more efficient than private banks, whereas Fries-Taci (2005) studied cost and profit efficiency of 289 banks in 15 Eastern European post-communist countries and found that most foreign-owned private banks were the most efficient, compared to relatively less efficient domestic-owned private banks and the least efficient state-owned banks. These studies suggest that bank efficiency is more dependent on institutional environment and other economic factors than the nature of ownership.

The structures of ownership in Chinese banks have undergone changes after the reform period, but still more than 90 % of bank assets in China are owned by the state. State-ownership dominates the ownership structure of the Big Four in China as ICBC, CCB, BOC, and ACB are at least 60 % state-owned by nature (Fungacova-Korhonen, 2011). In addition, China has harnessed the independent regulator model as an instrument of governance. A model of a regulator independent from business in private and state-owned enterprises and advocated widely by large international organizations, the independent regulator model has been a tool to enhance the value of state-owned assets in China, and rather than releasing the bureaucratic grip of the government on companies, it actually tightened it.

Since 1992, China's State Council has established new regulatory commissions in financial services such as banking, securities, and insurance. For example, by 2003 three regulatory bodies had been established in financial services: China Securities Regulatory Commission, China Insurance Regulatory Commission, and China Banking Regulatory Commission. These bodies regulate fields of the financial sector that were formerly regulated by PBoC. This is a good example of socialist market economy with Chinese characteristics; dominated and regulated by the public sector, maximizing efficiency with antitrust laws and consumer protection fostering competition, thus minimizing the occurrence of market failures. (Pearson, 2005).

3.1.2 Financial Deregulation

China, as the world's second largest economy, has rather successfully reformed from a state-controlled economy to a market-oriented economy. However, the financial sector's reforms have been slower and somewhat unsuccessful in terms of the future of gradually liberalized interest rates. Lending rates were fully liberated in 2013 and deposit rates in 2015, but banks have had a difficult time adjusting to the new environment since the whole financial sector has historically leaned on easy credit. This challenge has been especially present in SOEs as well as government-backed institutions and entities.

The historical economic growth has been strengthened with the reduction of cost of capital, which has been made possible by implementing low, administratively controlled interest rates and artificially high savings rates, thus boosting the economy that is dominated by SOEs. Policies on levelling the playing field between SOEs and private companies is an increasing topic of discussion in the Chinese financial sector, as more privately owned agents are entering the still heavily state-owned market. The economy, however, is currently in an unsustainable equilibrium of inefficient allocation of capital, maintained by high national savings that cover the losses, but the inevitable adjustment occurs when the supporting and buffering actions are exhausted or become exhausted. (Anzoategui et al., 2015).

Implicit guarantees and interest rate controls are distortions that have led the economy to this point, and for capital allocation to improve, thus making debt sustainable, the key is to remove these distortions. Implicit guarantees, referring to a privileged access to credit due to creditors' assumption of implicit support by the government, are still a major problem in the Chinese

financial market. The problem exists even though the interest rate controls are now more or less freed by the Third Plenum reform blueprint which aims to deal with these distortions. The government has let some loans of SOEs to default to test the ground, but for example bond default is a rarity in China, and clear evidence exists of bailing out creditors in the event of lending to implicitly guaranteed enterprise has gone south. (Anzoategui et al., 2015).

3.2 Shadow Banking Sector

Shadow Banking in China does not significantly differ from the biggest shadow banking sector that is in the United States, which will be the main object of comparison in this paper. The growth has been vast, as Standard & Poor's estimated an annual growth of 34 % over the period of 2010-2015 (Li, 2014). Data from PBOC for 2011 stated that 58.3 % of system-wide financial aggregate were bank loans and the rest (41.7 %) may be defined as shadow banking loans. Furthermore, two-thirds of these shadow banking loans are estimated to be operated by banks at the core of the transaction (Hsu and Li, 2012) (Elliot and Yu, 2015).

The theory of shadow banking is rather young since the terminology started developing in the 21st century, and it was only after the sub-prime crisis that shadow banking entered the economic literature and macroeconomic models more extensively. However, the extent of economic literature on shadow banking is clearly not wide enough when the estimated magnitude of shadow banking in several financial sectors is considered.

3.2.1 Birth of Demand

As the financial system of China faced a turning point in the mid-1990s when more than 20 % of loans were non-performing, and vast reforms in the banking sector to harness profitable and well-capitalized banks succeeded a decade later, the foundation for the demand for a shadow banking sector was born. Preventing the banks to collapse, a policy in the form of regulated interest rate system had a consequence of forcing households to endure artificially low interest rates on bank deposits. This, combined with Chinese banks' tendency to lend to large corporations while at least partially neglecting small- and medium-sized companies (SMEs), a growing demand emerged for a shadow banking system as an important channel for alternative funding instruments. (Funke et al., 2015).

Shadow banking in China is very different due to a system controlled by large state-owned banks, which are under the central bank, PBoC. However, the main reason why shadow banking continues to grow globally remains roughly the same in countries with commercial banking sector independent of state ownership: the tightening regulation, requirements, and limits within the banking sector.

Caps regulated by the PBoC, constricting a 75 % limit of banks loans to deposits, lower capital and liquidity requirements, PBoC's costly reserve requirements are among the reasons why shadow banking is reasonable for Chinese firms operating in the financial sector (Elliot and Yu, 2015). Moreover, a consumer seeking high risk and high yield, combined with a growing proportion of people and small private sector businesses left outside of some banking services, explains the boost of the demand for shadow banking.

3.2.2 Size and Array

When estimating the size of the shadow banking system in China, one has to remember that size estimates vary greatly and are utterly dependent on the financial instruments included in the definition of shadow banking sector as well as the fundamental viewpoint taken on the matter.

Standard & Poor's has stated that China's shadow banking credit grew at an annual rate of 34 % between the end of 2010 and 2015 (Li, 2014). There are plenty of estimates to grasp the size of the shadow banking sector, but according to data from PBoC for 2011, banking loans from all-system financing aggregate covered 58.3 % and the rest is defined to be shadow financial activity that covered 41.7 % (Hsu and Li, 2012). Depending on the definition of shadow banking, as in what entities are included in the definition, the size estimates vary greatly.

According to Elliot and Yu (2015), six reasonable estimates in the recent past range from RMB 5 trillion to RMB 46 trillion, or roughly from 8 % to 80 % of Gross Domestic Product of China. Comparing with similar basis of estimation, Yu estimated China's shadow banking size to be RMB 25 trillion (43 % of GDP) in 2013, while the Financial Stability Board estimated that global shadow banking assets comprise 120 % of global GDP and 150 % of GDP in the US, with generally the estimated outstanding volume of shadow banking in China ranging from 40 % of GDP to 60 % of GDP (Ueda and Gomi, 2013).

It is estimated that from this shadow financial activity, two-thirds are operations in which banks are at the core of the transaction. They assume most of the risks and returns but pay a non-bank for participation, thus avoiding

constraints and regulatory costs (Elliot and Yu, 2015).

To further particularize the definition, let us identify the transaction tools used by shadow banking system in China. The use of one or more of the following institutions, techniques or instruments deepen the understanding of the shadow banking system in China. (Elliot and Yu, 2015)

Trust companies with loans and leases, and similar elements of banks and asset managers, are Chinese financial firms generally included in the shadow banking system. *Entrusted loans* are loans made on behalf of large corporations using banks or financial firms as intermediaries. The interbank version of this kind of loan where one bank will act on behalf of another also counts as shadow banking. *Financial leasing*, possibly provided by companies specializing on leasing, is not a short-term operating lease and not on the balance sheet of a bank or trust company, and it is also included in the shadow banking system. (Elliot and Yu, 2015).

There are various *micro finance companies* that have the license to lend small amounts to provide easy service for small and rural borrowers. To connect the savers and users of funds, there are plenty of *internet finance activities* including peer-to-peer (P2P) lending networks and crowd funding platforms. *Pawn shops*, lending to many households and small businesses, serves similar consumers and sometimes there can clearly be informal or illegal operations by *various unofficial lenders*. (Elliot and Yu, 2015).

Guarantee companies may not have a legal license to provide direct loans, as their main purpose is to provide guarantees that sometimes manage shadow

banking transactions. Derivative transactions such as *trust beneficiary rights (TBRs)* are sometimes used by banks to move instrument similar to loan into this category, as it is more favourably treated in the balance sheet, thus retaining the economic benefits of a loan. When purchasing a TBR, the consumer receives all or some proportion of the returns acquiring to the trust. *Wealth management products*, such as hedge funds, are being used instead of formal deposits due to higher expected returns. Large corporations use finance subsidiaries to lend money to banks in a manner similar to deposits, avoiding caps on deposit rates while the bank is not being forced to regulatory costs of deposits. This kind of shadow banking activity is called *inter-bank market activities*. (Elliot and Yu, 2015).

So, shadow banking in China includes a vast variety of financial activities and even though some activity inside the bundle could be labelled negative, such as illegal lending, the whole ensemble is considered a neutral term. It interconnects aforementioned institutions, techniques and instruments into a whole sector that is analysed in this paper. During the time of writing this paper, the size of the shadow banking sector in China is not as large as the biggest shadow banking sectors in the world, but due to its growth in complexity and size, it has been recognized globally as a financial factor to be considered.

4 The DSGE Model

Falk Mazelis of Humboldt University of Berlin constructed a DSGE model with shadow banking, based on a monetary DSGE model with financial inter-

mediaries of Gertler and Karadi (2011). This paper solves and examines the subsequent Mazelis (2015) model to set up a foundation to renovate minor adjustments to the model with specific interest to Chinese characteristics in the general economy and the financial sector. There are six types of agents in the Mazelis model. First, let us introduce the fundamental problems and the basic settings of the agents and solve the basic first order conditions (FOCs), and then expand and specify the model by examining the steady state.

4.1 Basic Setting of the Model

First, **households** that are spread evenly across $[0, 1]$ and include $1 - f$ workers consuming, saving and supplying labour and f $(0 < f < 1)$ bankers accumulating profits over several periods. Both maximize discounted lifetime utility

$$\max_{C_t, B_{t+1}, L_t} E_t \sum_{i=0}^{\infty} \beta^i [ln(C_{t+i} - hCt + i - 1) - \frac{\chi^{HH}}{1+\varphi} L_{t+i}^{1+\varphi}.$$

This is the aggregate form with budget constraints sequence of period

$$C_t + B_{t+1} + T_t = W_t L_t + \Pi_t + R_t^w B_t$$

where C_t = consumption, L_t = unit of labour, W_t = real wage, B_t = savings (government bonds, deposits at banks, fund shares with shadow banks), T_t = lump sum taxes R_t^w = weighted interest rate on savings, Π_t = profits of capital producers (banks and shadow banks), β = discount factor, h = habit parameter, χ^{HH} = relative utility weight of labour and φ = inverse Frisch elasticity and labour supply.

Denoting $U(C_t, L_t)$ as the utility maximation-problem of the aggregated

households, let us derive the first order conditions:

$$\frac{dU(C_t, L_t)}{dC_t} = \sum_{i=0}(C_t - hC_{t-1})^{-1}\beta^0 + E_t\sum_{i=1}(C_{t+1} - hC_t)^{-1}(-h)\beta^1 - \lambda_t^{HH} = 0$$

$$\Leftrightarrow \varrho_t = (C_t - hC_{t-1})^{-1} - \beta h E_t(C_{t+1} - hC_t)^{-1}$$

$$\frac{dU(C_t, L_t)}{dL_t} = \frac{\chi^{HH}}{1+\varphi}(1+\varphi)L_t^{1+\varphi-1} - W_t\varrho_t = 0 \Leftrightarrow W_t\varrho_t = \chi^{HH}L_t^{\varphi}$$

From Euler condition

$$\frac{dU}{dC_t} = \beta E_t[\frac{dU}{dC_{t+1}}(1+r_{t+1})] \Leftrightarrow 1 = \beta E_t\Lambda_{t+1}R_{t+1}^w, \quad \Lambda_{t+1} = \frac{\frac{dU}{dC_{t+1}}}{\frac{dU}{dC_t}}, \ (\frac{dU}{dC_t} = \varrho_t)$$

Banks are the second type of an agent in the model and their balance sheet is given by

$$\begin{aligned} N_{t+1} &= R_{kt+1}Q_tS_t - R_{t+1}D_{t+1} \\ &= (R_{kt+1} - R_{t+1})Q_tS_t + R_{t+1}N_t \end{aligned}$$

since $D_{t+1} = Q_tS_t - N_t$. S_t = loan portfolio, Q_t = price of the portfolio thus price of capital, N_t = net worth of the bank, D_{t+1} = deposits from households, R_{t+1} = interest paid for deposits, and R_{kt+1} = rate of return for loans. Banks maximize their expected terminal net wealth V_t before they exit the industry with a probability θ per period. An agency problem to motivate an endogenous constraint on banks' ability to obtain funds is the fraction λ_t of the loan portfolio a banker can divert and the depositors at the bank are not able to recover. With the motivation of not declaring bankruptcy in a given period, households keep their deposits at individual banks as long as the franchise value of the bank $V_t \geq \lambda_t Q_t S_t$, the divertible amount. V_t is

given by $V_t = \nu_t Q_t S_t + \eta_t N_t$ with

$$\nu_t = E_t[(1-\theta)\beta\Lambda_{t+1}(R_{kt+1} - R_{t+1} + \beta\Lambda_{t+1}\theta x_{t+1} v_{t+1}],$$
$$\eta_t = E_t[(1-\theta) + \beta\Lambda_{t+1} z_{t+1}\theta\eta_{t+1}],$$

where z_{t+1} = is growth rate in net worth and x_{t+1} = growth rate in assets. The size of a banker's loan portfolio depends on the size of their net wealth

$$\begin{aligned} V_t &= \lambda_t Q_t S_t \\ \nu_t Q_t S_t + \eta_t N_t &= \lambda_t Q_t S_t \\ Q_t S_t(\lambda_t - \nu_t) &= \eta_t N_t \\ Q_t S_t &= \frac{\eta_t}{\lambda_t - \nu_t} N_t. \end{aligned}$$

A financial measurement of capital in the form of debt and equity, the leverage ratio can be defined as

$$\phi_t \equiv \frac{\eta_t}{\lambda_t - \nu_t}.$$

The leverage ratio reacts to an economy-wide productivity endogenously, and it is dependent on the borrowing rate and monetary policy. We can use that to define growth rates z_{t+1} and x_{t+1}:

$$\begin{aligned} z_{t+1} &= \frac{N_{t+1}}{N_t} \\ &= \frac{(R_{kt+1} - R_{t+1})Q_t S_t + R_{t+1} N_t}{N_t} \\ &= \frac{(R_{kt+1} - R_{t+1})Q_t S_t}{N_t} + \frac{R_{t+1} N_t}{N_t} \\ &= (R_{kt+1} - R_{t+1})\phi_t + R_{t+1}. \end{aligned}$$

$$\begin{aligned} x_{t+1} &= \frac{Q_{t+1} S_{t+1}}{Q_t S_t} \\ &= \frac{\phi_{t+1} N_{t+1}}{\phi_t N_t} \\ &= \frac{\phi_{t+1}}{\phi_t} z_{t+1} \end{aligned}$$

The third kind of agent is the **shadow bank**, which does not create credit but sells fund shares FS_t to households. As simple intermediaries shadow banks can issue loans S_t^{SB} by

$$Q_t S_t^{SB} = FS_t.$$

Shadow banks advertise their fund shares spending v_t to gain a probability of q_t of a successful deposit by a household. This search and matching of fund shares for deposits is depicted mainly by the assumed constant probability of separation χ^{SB}. Search and matching theory in economics has numerous applications within labour economics as firm-worker matches, but applications in monetary economics and financial systems have emerged in the recent past as seller-buyer derivatives. Shadow banks maximize their discounted future profits choosing fund advertisements and loan issuance:

$$\max_{v_t, S_t^{SB}} E_t \sum_{i=0}^{\infty} \beta^i \Lambda_{t,t+i} \Pi_{t+i}^{SB}$$

where

$$\Pi_t^{SB} = (R_{kt} - R_t^{SB}) Q_{t-1} S_{t-1}^{SB} - v_t.$$

Let us define $SB(v_t, S_t^{SB})$ to be the maximization function. Fund shares that have not been converted as well as new mathces from advertisement generates the total funding of a shadow bank in period t. Shadow banks' funding contraint of shadow banks is given by

$$FS_t = (1-\chi^{SB}) FS_{t-1} + q_t v_t \Leftrightarrow (1-\chi^{SB}) Q_{t-1} S_{t-1}^{SB} - Q_t S_t^{SB} + q_t v_t = 0$$

$$\frac{dSB}{dv_t} = -1 + \lambda_t^{SB} = 0 \Leftrightarrow \lambda_t^{SB} = \frac{1}{q_t}$$

$$\frac{dSB}{d_t^{SB}} = E_t \beta \Lambda_{t+1} (R_{kt+1} - R_{t+1}) Q_t - \lambda_t^{SB} Q_t + E_t \beta \Lambda_{t+1} \lambda_{t+1}^{SB} (1-\chi^{SB}) Q_t = 0$$

$$\lambda_t^{SB} = E_t \beta \Lambda_{t+1} \{ (R_{kt+1} - R_{t+1}) + \lambda_{t+1}^{SB} (1-\chi^{SB}) \}$$

$$\frac{1}{q_t} = E_t \beta \Lambda_{t+1} \{ (R_{kt+1} - R_{t+1}^{SB}) + (1-\chi^{SB}) \frac{1}{q_{t+1}} \}.$$

Mazelis also introduces a shadow bank ability to issue repo (B_{t+1}^{SB}) similar to bank deposits with the exception of that not every agent in the economy accepts these credit claims as payment whereas every agent accepts banks deposits. However, this extension of the Mazelis model (2015) is disregarded in this paper.

The fourth type of agent is the **goods producer** which finances its capital by borrowing from intermediaries. Goods producer is a firm with perfect competition selling manufactured intermediate goods to the retailer. The lending is capital constrained affecting the supply of funds to firms and the interest rate for borrowing R_{kt+1}. The firm maximizes profits with the equation

$$K(K_{t+1}, L_t) = \beta \max_{K_{t+1}, L_t} E_t \sum_{i=0}^{\infty} \beta^i \Lambda_{t+1} [P_{mt} Y_t + (Q_t - \delta)\xi_t K_t - W_t L_t - R_{kt} K_t Q_{t-1}]$$

$Y_t = A_t(\xi_t K_t)^{\alpha} L_t^{1-\alpha}$, where α = capital share and $1 - \alpha$ = labour share.

P_{mt} = the relative output price of the intermediate good, K_t = capital, Q_t = the real price of capital, δ = depreciation rate, ξ = matching elasticity, and Y_t output. Marking $\Psi = E_t \beta \Lambda_{t+1}$, we can solve the first order conditions

$$\frac{dK(K_{t+1}, L_t)}{dK_{t+1}} = \Psi P_{mt+1} \alpha A_{t+1} (\xi_{t+1} K_{t+1})^{\alpha - 1} L_{t+1} + \Psi(Q_t - \delta)\xi_{t+1} - \Psi R_{kt+1} Q_t = 0$$

$$R_{kt+1} Q_t = P_{mt+1} \alpha \frac{Y_{t+1}}{K_{t+1}} + (Q_{t+1} - \delta)\xi_t$$

and solve the optimal capital for the next period by

$$K_{t+1} R_{kt+1} Q_t = P_{mt+1} \alpha Y_{t+1} + K_{t+1}(Q_{t+1} - \delta)\xi_t$$

$$K_{t+1} = \frac{P_{mt+1} \alpha Y_{t+1}}{R_{kt+1} Q_t - (Q_{t+1} - \delta)\xi_t}$$

And similarly for labour,

$$\frac{dK(K_{t+1}, L_t)}{dL_t} = \Psi P_{mt}(1-\alpha)A_t(\xi_t K_t)L_t^{1-\alpha-1} - \Psi W_t = 0$$
$$\Leftrightarrow P_{mt}(1-\alpha)\frac{Y_t}{L_t} = W_t$$
$$L_t = \frac{P_{mt}(1-\alpha)Y_t}{W_t}$$

The firms do not earn profits due to ex post returns going as interest payments to capital resulting in paying the profits out to the financial sector, their creditors, thus the equation $K_{t+1} = S_t + S_t^{SB}$.

Capital producers are the fifth type of agent in the model. They sell units of new, refurbished capital left over from goods producers using input of final output. They set the price Q_t with the maximization problem of

$$\max_{I_{nt}} E_t \sum_{\tau=t}^{\infty} \beta^{\tau-t}\Lambda_{t,\tau}\{(Q_t-1)I_{n\tau} - f(\frac{I_{n\tau}+I_{SS}}{I_{n\tau-1}+I_{SS}})(I_{n\tau}+I_{SS}), I_{nt} = I_t\mu_t - \delta\xi_t K_t$$

where μ = investment (I_{nt}) specific shocks, I_{SS} = steady state value of investments, denoting $f(\frac{I_{n\tau}+I_{SS}}{I_{n\tau-1}+I_{SS}})$ by $f(.)$, obeying $f(1) = f'(1) = 0$, and $f''(1) > 0$. First order condition for the price Q_t is given by

$$Q_t - 1 - f'(.)\frac{1}{I_{nt-1}+I_{SS}}(I_{nt}+I_{SS}) - f(.) - \Psi f'(.)(I_{nt+1}+I_{SS})(-\frac{1}{I_{nt}+I_{SS}})^2(I_{nt+1}+I_{SS}) = 0$$
$$Q_t = 1 + f(.) + \frac{I_{nt}+I_{SS}}{I_{nt-1}+I_{SS}}f'(.) - E_t\beta\Lambda_{t+1}(\frac{I_{nt}+I_{SS}}{I_{nt-1}+I_{SS}})^2 f'(.).$$

Retailers who buy intermediate goods from goods producers at P_{mt} are the sixth and final kind of agent in Mazelis model. They, f, produce the final output and it is produced by

$$Y_t = [\int_0^1 Y_{ft}^{\frac{\epsilon-1}{\epsilon}}\ \mathrm{d}x]^{\frac{\epsilon-1}{\epsilon}},$$

which is a CES composite of continuum and where ϵ = elasticity of substitution. Users of final output minimize costs, and the retailers choose their

reset price P_t^* by the maximization problem

$$\max_{P_t^*} E_t \sum_{i=0}^{\infty} \gamma^i \beta^i \Lambda_{t+1} [\frac{P_t^*}{P_{t+i}} \prod_{k=1}^{i} (1+\pi_{t+k-1})^{\gamma_p} - P_{mt+i}] Y_{ft+i}$$

with FOC

$$E_t \sum_{i=0}^{\infty} \gamma^i \beta^i \Lambda_{t+1} [\frac{P_t^*}{P_{t+i}} \prod_{k=1}^{i} (1+\pi_{t+k-1})^{\gamma_p} - \frac{\epsilon}{\epsilon-1} P_{mt+i}] Y_{ft+i} = 0$$

The price level evolution is given by

$$P_t = [(1-\gamma)(P_t^*)^{1-\epsilon} + \gamma(\Pi_{t-1}^{\gamma_p} P_{t-1})^{1-\epsilon}]^{1/(1-\epsilon)},$$

where γ is a probability that each retailer can reset prices each period. Otherwise they index their prices to lagged inflation. Thus, the intermediate goods price P_{mt} and inflation π_t follow a calvo contract pricing model. The endogenous variables related to calvo pricing are specified and solved in the steady state section.

The government is depicted by

$$Y_t = C_t + v_t + I_t + f(\frac{I_{nt} + I_{SS}}{I_{nt-1} + I_{SS}})(I_{nt} + I_{SS}) + G_t,$$

which is the aggregate resource constraint. Taylor rule characterizes the monetary policy with $i_t = (1-\rho)[i_{SS} + \kappa_\pi \pi_t + \kappa_y (logY_t - logY_t^*)] + \rho i_{t-1} + e_i$, where nominal interest rate i_t depends on steady state interest rate i_{SS}, the natural rate of output $logY_t^*$, an interest rate smoothing parameter p, inflation coefficient k_π and output coefficient k_y. The exogenous shock to monetary policy e_i has an effect through the economy via the Fisher relation

$$1 + i_t = R_t E_t (1 + \pi_{t+1})$$

4.2 Model Variables and Shocks

The steady state of the model can be solved with the first order conditions by perturbation methods of Dynare (2011) around the deterministic steady state. Uniting and complementing the agents' problems in the economy, there are altogether 41 endogenous variables of interest with seven shock variables to be included in the steady state calculation methods of Dynare and they are: output Y_t, wholesale Y_{mt}, consumption C_t, capital K_t, labour L_t, wages W_t, investment I_t, net investment I_{nt}, depreciation rate δ_t, marginal utility of consumption ϱ_t, stochastic discount rate Λ_t, utility U_t, savings B_t, bank deposits D_t, banks loans S_t, aggregate net worth of banks N_t, net worth of new banks N_{nt}, net worth of existing banks N_{et}, value of banks' net wealth η_t, value of banks' capital ν_t, growth rate of banks' capital z_t, growth rate of banks' net wealth x_t, optimal leverage ϕ_t, shadow bank loans S_t^{SB}, price of capital Q_t, deposit interest rate R_t, borrowing rate R_{kt}, shadow banks' fund rate R_t^{SB}, the weighted interest rate of banks and shadow banks R_t^w, shadow banks' fund share vacancy postings FS_t, price of shadow bank advertising v_t, probability of shadow bank matching funds q_t, matching function of shadow banks Θ_t, policy rate i_t, inflation π_t, price dispersion D_{pt}, retail output price Pm_t, optimal price choice with π_t^*, F_t, and Z_t, and the government spending via lump-sum tax G_t.

The characterizing equations are log-linearised around the steady state to examine percentage-change more effectively, but they are expressed here in linear form for presentational purposes. The initial values of the endogenous variables serve as base of operations for Dynare (2011) and for this paper are probed with numerical solver-scripts with model parameters.

The endogenous shock variables are total-factor productivity (TFP) shock A_t, capital quality shock ξ_t, government spending shock G_{sht}, shock to banks' net wealth N_{st}, shock to banks' divertible share (leverage) λ_t, investment efficiency shock μ_t, shock to shadow banks' fund shares FS_{sht}, and they enter the model via their exogenous standard deviations e_A, e_ξ, e_G, e_{Ne}, e_λ, e_μ, e_{FS}, respectively, alongside with an additional monetary policy shock e_i. All of these shocks are 0 in the steady state (log-linearised as a factor of 1) except the shock variable λ_t which is defined as a positive number in the steady state, $\overline{\lambda}$.

4.3 Equilibrium

The characterizing equations (their number should be exactly the same as the number of endogenous variables in the model dynare-script) specify the model and act as a foundation for the steady state. The equations are constructed from Mazelis (2015) and Gertler-Karadi (2011) DSGE models and are defined as:

(i) Production output subject to the (technological) total-factor productivity (TFP) shock, A_t and the capital quality shock ξ_t:

$$Y_t = A_t(\xi_t K_t)^\alpha L_t^{1-\alpha},$$

(ii) Euler equation of household consumption:

$$\beta R_t^w \Lambda_{t+1} = 1,$$

(iii) Stochastic discount rate:

$$\Lambda_t = \frac{\varrho_t}{\varrho_{t+1}},$$

(iv) Marginal utility of consumption:

$$\varrho_t = (C_t - hC_{t-1})^{-1} - \beta h(C_{t+1} - hC_t)^{-1},$$

(v) Labour market clearance (FOC of labour):

$$\chi^{HH} L_t^{\varphi} = \varrho_t P_{mt}(1-\alpha)\frac{Y_{mt}}{L_t},$$

(vi) Return to capital (FOC of goods producer):

$$R_{kt} = \frac{P_{mt}\alpha\frac{Y_{mt}}{K_{t-1}} + (Q_t - \delta_t)}{Q_{t-1}},$$

(vii) Fisher relation:

$$i_t = R_t\pi_{t+1} \leftrightarrow R_t = \frac{i_t}{\pi_{t+1}},$$

(viii) Net investment subject to the investment shock μ_t and the capital quality shock ξ_t:

$$I_{nt} = I_t\mu - \delta_t\xi_t K_{t-1},$$

(ix) Capital & investment subject to the capital quality shock ξ_t:

$$K_t = \xi_t K_{t-1} + I_{nt},$$

(x) The price of capital, optimal investment decision:

$$Q_t = 1+\frac{\eta}{2}(\frac{I_{nt}+I_{SS}}{I_{nt-1}+I_{SS}})^2-\eta((\frac{I_{nt}+I_{SS}}{I_{nt-1}+I_{SS}})-1)-\beta\Lambda_{t+1}((\frac{I_{nt+1}+I_{SS}}{I_{nt}+I_{SS}})-1)(\frac{I_{nt+1}+I_{SS}}{I_{nt}+I_{SS}})^2,$$

(xi) Policy, Taylor rule subject to the interest policy shock e_i:

$$i_t = i_{t-1}^{\rho}\left(\left(\frac{1}{\beta}\right)\pi_t^{\kappa_\pi}\left(\frac{\frac{1}{p}}{\frac{\epsilon}{\epsilon-1}}\right)^{\kappa_y}\right)^{1-\rho} e_i.,$$

(xii) Government consumption subject to the government consumption shock G_{sht}:

$$G_t = G_{ss}G_{sht},$$

(xiii) The aggregate resource constraint:

$$Y_t = C_t + v_t + I_t + \frac{\eta}{2}(\frac{I_{nt} + I_{SS}}{I_{nt-1} + I_{SS}})^2(I_{nt} + I_{SS}) + G_t,$$

(xiv) Optimal price choice (Calvo):

$$F_t = Y_t P_{mt} + \beta\gamma\Lambda_{t+1}\pi_{t+1}^{\epsilon}\pi_t^{(-\epsilon\gamma_p)}F_{t+1},$$

(xv) Optimal price choice (Calvo):

$$Z_t = Y_t + \beta\gamma\Lambda_{t+1}\pi_{t+1}^{\epsilon-1}\pi_t^{\gamma_p(1-\epsilon)}Z_{t+1},$$

(xvi) Optimal price choice (Calvo):

$$\pi_t^* = \frac{\epsilon}{\epsilon - 1}\frac{F_t}{Z_t}\pi_t,$$

(xvii) Calvo price index (inflation), the New Keynesian Philips Curve:

$$\pi_t^{1-\epsilon} = \gamma\pi_{t-1}^{\gamma_p(1-\epsilon)} + (1-\gamma)\pi_t^{*1-\epsilon},$$

(xviii) Price dispersion:

$$D_{pt} = \gamma D_{pt-1}\pi_{t-1}^{-\gamma_p\epsilon}\pi_t^{\epsilon} + (1-\gamma)\frac{1 - \gamma(\pi_{t-1}^{\gamma_p(1-\gamma)}\pi_t^{\gamma-1})}{(1-\gamma)^{\frac{-\epsilon}{1-\gamma}}},$$

(xix) Depreciation rate:

$$\delta_t = \delta + \frac{b}{1+\zeta}U_t^{1+\zeta},$$

(xx) Optimal capacity utilization rate:

$$P_{mt}\alpha\frac{Y_{mt}}{U_t} = bU_t^{\zeta}K_{t-1},$$

(xxi) Arbitrage:

$$\beta\Lambda_{t+1}R_{kt+1} = \beta\Lambda_{t+1}R_{t+1},$$

(xxii) Wholesale, the Retailers' output:

$$Y_{mt} = Y_t D_{pt},$$

(xxiii) Wages:

$$W_t = P_{mt}(1-\alpha)\frac{Y_{mt}}{L_t},$$

(xxiv) Optimal leverage ratio subject to the shock variable λ_t:

$$\phi_t = \frac{\eta_t}{\lambda_t - \nu_t},$$

(xxv) Aggregate net worth of banks:

$$N_t = N_{et} + N_{nt},$$

(xxvi) Net worth of new banks:

$$N_{nt} = \omega Q_t K_{t-1},$$

(xxvii) Net worth of existing banks subject to the bank value shock N_{st}:

$$N_{et} = N_{st}\theta z_t N_{t-1},$$

(xxviii) Growth rate of banks' capital:

$$z_t = (R_{kt} - R_t)\phi_{t-1} + R_t,$$

(xxix) Growth rate of banks' net wealth

$$x_t = \frac{\phi_t}{\phi_{t-1}} z_t,$$

(xxx) Value of banks' net wealth:

$$\eta_t = (1-\theta) + \beta\Lambda_{t+1} Z_{t+1}\theta\eta_{t+1},$$

(xxxi) Value of banks' capital:

$$\nu_t = (1-\theta)\beta\Lambda_{t+1}(R_{kt+1} - R_t) + \beta\Lambda_{t+1}\theta x_{t+1}\nu_{t+1},$$

(xxxii) Loan portfolio of banks:

$$S_t = \frac{\phi_t N_t}{Q_t},$$

(xxxiii) Banks' balance sheet:

$$D_t = Q_{t-1} S_{t-1} - N_{t-1},$$

(xxxiv) Weighed interest rate from holdings of deposits and fund shares:

$$R_t^w = R_t \frac{D_t}{B_t} + R_t^{SB} \frac{FS_t}{B_t},$$

(xxxv) Definition of fund shares subject to fund share quantity shock FS_{sht}

$$FS_t = (1 - \chi^{SB}) FS_{t-1} + q_t v_t + FS_{sht},$$

(xxxvi) Euler condition for fund adverts:

$$\frac{1}{q_t} = \beta \Lambda_{t+1} [(R_{kt+1} - R_{t+1}^{SB}) + (1 - \chi^{SB})] \frac{1}{q_{t+1}},$$

(xxxvii) Financial intermediaries profit to creditors:

$$K_{t+1} = S_t + S_t^{SB},$$

(xxxviii) Interest rate of shadow banks:

$$R_t^{SB} = (1 - \omega^{HH}) R_{t+1} + \omega^{HH} (R_{kt} + \theta_t),$$

(xxxix) Probability of shadow bank finding a suitable funding:

$$q_t = s \theta_t^{-\xi},$$

(xl) Matching function of shadow banks:

$$\theta_t = \frac{v_t}{D_{t+1} - FS_t},$$

(xli) Savings definition:

$$B_t = FS_t + D_t,$$

And in addition to the steady state characteristic equations, the shock variable equations:

(xlii) TFP shock:

$$A_t = \rho_A A_{t-1} + e_A,$$

(xliii) Capital quality shock:

$$\xi_t = \rho_\xi \xi_{t-1} + e_\xi,$$

(xliv) Government spending shock:

$$G_{sht} = \rho_G G_{sht-1} + e_G,$$

(xlv) Bank value shock:

$$N_{st} = \rho_N eN_{st-1} + e_{Ne},$$

(xlvi) Shadow bank fund share quantity shock:

$$FS_{sht} = \rho_{FS} FS_{sht-1} + e_{FS},$$

(xlvii) Banks' leverage ratio shock:

$$\lambda_t = (1 - \rho_\lambda)\overline{\lambda} + \rho_\lambda \lambda_{t-1} + e_\lambda,$$

(xlviii) Investment quality shock:

$$\mu_t = \rho_\mu \mu_{t-1} + e_\mu.$$

4.4 Parameter Values

Parameter estimation, such as Bayesian estimation, and calibration methods, such as matching second moments, are disregarded in this paper and all the calibrated parameters in the base model and few shock process parameters are taken as given, sourced from Gertler-Karadi (2011). The steady state values of investment and government spending, I_{ss}, and G_{ss}, respectively, are also considered as parameters to marginally predefine the steady state. The parameters related to shadow banking and rest of the shocks process parameters are taken from the posterior modes of Mazelis (2015) model bayesian estimation for parameters.

The values, descriptions and sources of the base model parameters are depicted in table 1 and the similarly for parameters in the shock processes in table 2.

Table 1: Parameters of the Model

Parameter	Description	Value	Source
	Households, Banks, and Labour		
β	Discount rate	0.99	GK11
h	Habit parameter	0.815	GK11
φ	Inverse Frisch elasticity of labour supply	0.276	GK11
θ	Bank survival probability	0.972	GK11
α	Capital share of output	0.33	GK11
δ	Static depreciation rate	0.02071939	GK11
b	Depreciation rate parameter	0.0376	GK11
ζ	Elasticity of marginal depreciation respect to utilization rate	7.2	GK11
η	Elasticity of investment adjustment cost	1.728	GK11
ω	Proportional starting up funds for banks	0.02	GK11
χ^{hh}	Labour utility weight	3.409	GK11
	Monetary Policy		
ρ	Interest rate smoothing parameter	0.8	GK11
κ_π	Inflation coefficent	1.5	GK11
κ_y	Output gap coefficent	-0.215	GK11
	Retail Firms & Inflation		
ϵ	Elasticity of substitution between goods	4.167	GK11
γ	Calvo parameter	0.779	GK11
γ_p	Price indexation parameter	0.241	GK11
	Steady State Values		
I_{ss}	Investment at steady state	0.14153927	GK11
G_{ss}	Government spending at steady state	0.16975710	GK11
	Shadow Bank Parameters		
χ^{SB}	Separation rate in fund share matching	0.1	M15
ω^{HH}	Divertibility, household bargaining power	0.02	M15
s	Fund matching efficiency	4.6	M15
ξ	Fund matching elasticity	0.87	M15

Table 2: Shock Variable Parameters

Parameter	Description	Value	Source
	Shock Processes		
ρ_A	Persistency of TFP shock	0.95	GK11
ρ_ξ	Persistency of capital quality shock	0.66	GK11
ρ_G	Persistency of government spending shock	0.95	GK11
ρ_λ	Persistency of bank divertible share shock	0.61	M15
$\overline{\lambda}$	Fraction of bank assets that can be diverted	0.381	GK11
ρ_{Ne}	Persistency of bank net wealth shock	0.16	M15
ρ_{FS}	Persistency of shadow bank fund share redemption shock	0.76	M15
ρ_μ	Persistency of investment efficiency shock	0.63	M15

4.5 Implications of the Base Model

Mazelis (2015) used the GK (2011) model for most of the structural parameters of the model since it is built upon that model, and estimated the new parameters mainly of the shadow banking sector using calibration and Bayesian estimation. This section covers some implications Mazelis (2015) made on his model study.

He analysed how monetary policy shocks propagate through the economy with two different scenarios: with shadow banks and without them. An unexpected monetary policy tightening (monetary policy shock) causes government bonds to increase. In the scenario without shadow banks, banks raise interest rates on deposits to keep the savings of the depositors, affecting the net worth of firms with a reduction of net present value of future operations. Capital demand decreases and the price of the capital and investment reduces due to least productive firms exiting the market. Savings increase

and consumption decrease, thus reducing prices and putting more pressure for capital demand for production to decrease. In the scenario with shadow banks, the initial reaction for the shock is the same but shadow banks negotiate the fund rate over their expected profits and households' alternative savings. Borrowing rate and the deposit rate rise, making the fund rate rise, and due to the borrowing rate increasing more than the funds rate, shadow banks increase advertisement expenditures and offer more credit. This diminishes the fall of investment since shadow banks replace some of the lost credit which strongly reduces capital decumulation.

The reason for these different lending reactions to monetary policy described earlier are the different constraints. A bank is willing to extend credit as long as a borrower is likely to be able to pay a high enough interest rate at a given risk, where the amount of lending depends on the leverage ratio and the net worth of the bank which are affected by the firm's ability to borrow. This is the essential of the balance sheet channel of monetary policy transmission. Shadow banks have the constraint on their ability to acquire funds. When savings increase, the amount of funds available to shadow banks increase. This is the essential to the lending channel. The reality is, of course, much more complicated than a simple separation in theory. Many shadow banks are subsidiaries of commercial banks or banks themselves are in the core of shadow banking activity. Furthermore, many financial products that commercial banks offer are comparable to the lending channel, such as long-term saving deposits or other products that are not immediately with-drawable by the saver. (Mazelis, 2015).

After a monetary policy tightening shock banks reduce lending and shadow

banks increase lending reducing the real effects of the shock, but at the same time shadow banks amplify the reaction of key variables to real shocks and can make the financial sector and the whole economy more unstable.

5 Altering the Model

The idea behind the changes is to slightly alter the model parameters and monetary policy rule towards an economy with more Chinese characteristics as introduced in chapter two. The direction and magnitude of the model adjustments are motivated and the implications examined with the idea of providing areas for further research. Drastic conclusions should not be made based on such minor adjustments, merely observations of educating effects of adjusting and tuning the model.

The main focus of this analysis is to run a productivity shock, an interest rate shock and an investment shock through the economy and simulate impulse response functions (IRFs) for output, consumption, capital, bank loans, investment, shadow bank loans, the interest rate, inflation and labour and compare the results with the model without adjustments towards Chinese characteristics.

This section is divided into two parts: The first will introduce and argue the altered model segments bundling them into previous discussion of the Chinese financial sector, and the second part will examine the effects and implications of the adjustment.

5.1 The Adjustments

The monetary policy in the original model is modified because one of the focal points in the model analysis is the monetary policy shock and due to PBoC's slightly different historical approach towards monetary policy and targeting inflation, the original monetary policy is reshaped based on Chen et al. (2020). In addition, four parameters in the original model are adjusted, α (capital share), δ (depreciation), θ (bank survival probability) and χ^{SB} (shadow bank separation rate) with the idea of small-scale revision of general economic elements (capital share and depreciation) and the financial sector (banks and shadow banks).

The log-linearised version of the monetary policy with parameter estimated natural rate of output and interest rate smoothing in the base model is

$$i_t = i_{t-1}^{\rho} \left(\left(\frac{1}{\beta} \right) \pi_t^{\kappa_\pi} \left(\frac{\frac{1}{p}}{\frac{\epsilon}{\epsilon-1}} \right)^{\kappa_y} \right)^{1-\rho} e_i.$$

This is altered to the targeted inflation monetary policy with slight parameter adjustments:

$$i_t = i_{ss}^{1-\phi_i} i_{t-1}^{\phi_i} \left(\left(\frac{\pi_t}{\pi_{ss}} \right)^{\phi_\pi} \left(\frac{y_t}{y_{t-1}} \right)^{\phi_y} \right)^{1-\phi_i} e_i.$$

The new parameters introduced in the targeted monetary policy and the adjusted parameters of the model can be found detailed in table 3. The original and altered monetary policy rules share a similar structure. With $i_{ss} \sim \frac{1}{\beta}$, and $\rho \sim \phi^i$, the distinction comes from the right hand terms of $\left(\frac{\frac{1}{p}}{\frac{\epsilon}{\epsilon-1}} \right)^{\kappa_y}$ altered to $\left(\frac{y_t}{y_{t-1}} \right)^{\phi_y}$ and $\pi_t^{\kappa_\pi}$ to $\left(\frac{\pi_t}{\pi_{ss}} \right)^{\phi_\pi}$. Parameter values for κ_y and ϕ_y are vastly different and they serve a different purpose. The original monetary policy rule output gap is derived entirely from parameters where the altered

rule smooths towards the gap dynamically from the growth rate of y_t to the power of ϕ_y. The steady state value of the inflation is log-linearised to unity hence the targeting difference is captured in the difference of the values of κ_π and ϕ_π. $\phi_\pi > \kappa_\pi$ thus an economy with more Chinese characteristics is targeting higher inflation. Models with steady state of inflation deviating from unity will have more dynamic value in the inflation growth pattern.

The main idea behind the adjusted parameters is to argue the direction of the adjustments, not necessarily the absolute value, since DSGE model in economical sense are delicate to major modifications in the steady state due to Dynare steady state requirements. Thus, the altered model is not supposed to be a completely new model, just a slight deviation from the original steady state and processes.

The adjustment of the capital share of output, α reflects a slight increase to its original value due to data and previous literature. For example, Funke et al (2015) and Chen et al. (2020) used a DSGE models to design and analyse Chinese economical issues and both papers use capital share of $\alpha = 0.5$, which is originally calibrated in Funke and Paetz (2012), a DSGE framework analysis evaluating Chinese financial reform initiatives and proposals. According to World Bank data (2020) the 20-year average of Chinese capital share of output is 0.424.

Table 3: New and Adjusted Parameters

Parameter	Description	Value	New Value	Source
	New Monetary Policy Parameters			
ϕ_i	Interest rate inertia towards target rate	0.8177	-	CHEN20
ϕ_y	Output gap parameter	0.8269	-	CHEN20
ϕ_π	Inflation parameter towards targeted inflation	1.7584	-	CHEN20
i_{ss}	Steady state value of the nominal interest rate	0.0100501	-	MODEL
π_{ss}	Steady state value of the inflation	0	-	MODEL
	Adjusted Parameters			
α	Capital share of output	0.33	0.375	Orig. GK11
δ	Static depreciation rate	0.02071939	0.035	Orig. GK11
θ	Bank survival probability	0.972	0.9775	Orig. GK11
χ^{SB}	Separation rate in fund share matching	0.1	0.078	Orig. M15

In DSGE models the depreciation is occasionally considered an estimated parameter, a calculated parameter or a process (variable). In the original model the process of δ_t witness here an adjustment to the parameter δ mainly due to open platform data of Knoema (2020) suggesting that the average 10-year depreciation is 0.05, which is the base of increasing δ.

The adjustments in the financial sector, θ, and χ^{SB} are more theoretical. Due to the implicit guarantees discussed in chapter three, we can argue that the Chinese financial sector has a higher bank survival probability and a lower separation rate (higher $1 - \chi^{SB}$). Since the government lets fewer firms to fall, the implicit guarantee can be seen effective within both agents in the financial sector, which is the reason behind the increase in θ and decrease in χ^{SB}.

5.2 Implications of the Altered Model

Table 4: IRF Varibles

Abbreviation	Description
	Shock Processes
y	Y_t, production
c	C_t, consumption
int	i_t, the interest rate
k	k_t, capital
inv	I_t, investment
pi	π_t, inflation
sb	S_t, bank loans
ssb	S_t^{SB}, shadow bank loans
lab	L_t, labour

The graphs in this section illustrate the impulse response functions (IRFs) to a model specific shock and three shocks to nine variables are analysed. Since the model is log-linearised, the shocks to the model and the deviations from the steady state can be interpreted as percentage changes. The blue, dotted line represents the altered model and the straight black line represents the original.

Figure 1 illustrates the economy's reaction to chosen variables (which are associated to their respective graphs in table 4) in the case of a 1% positive shock to productivity (for example a positive technology shock). The altered model shows initially a slower rise in production, but over time exceeds the original model landing to 3,2 % change from the steady state production in the time horizon of 40 periods (original model 2,8 %). A similar pattern can be seen in investment where the altered model exceeds the original in a later

stage.

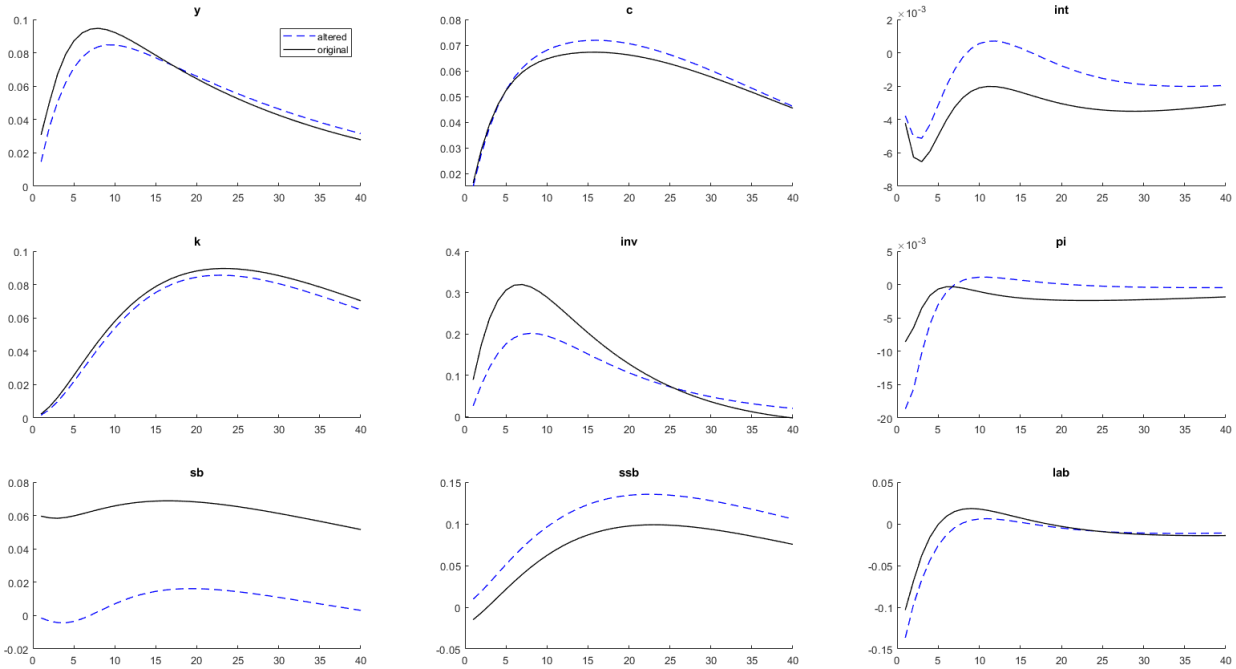

Figure 1: IRF's to a technological, positive 1% shock to productivity

However, greater differences in the case of productivity shock can be seen in nominal interest rate and inflation. Inflation decreases more in the altered model and restores balance somewhat quicker and closer to the steady state inflation. The nominal interest rate falls in the altered model less and hits near the steady state interest rate in period 10 while remaining higher in the time horizon.

The altered model slightly amplifies the rise in shadow bank loans in the more productive economic environment, but suggest leaner rise in bank loans (even small decline from the steady state right after the shock). The banks reaction

in the altered model comes through the monetary policy and Fisher relation where the real effect on the nominal interest rate is smaller thus the interest rate is higher. The productivity shock boosts the economy with lower monetary policy. Now the deposit rates are higher (Fisher) and the targeting monetary policy does not raise the borrowing rate as in the original model (initially not at all). This leads to less bank loans since the difference between borrowing rate and deposit rate is smaller; banks have less ability to leverage even if they have a slightly higher survival probability.

The shadow bank loans rise due to combination of increased bank survival probability and the altered monetary policy. Based on the former point, shadow banks have more chances to supply loans when they are not affected negatively by the Fisher relation. In fact, the latter channel reflects the increase of the deposit rate in the Fisher relation, meaning that shadow banks have more deposits to match their funding of loans.

Figure 2 depicts IRFs of a positive monetary policy shock (policy tightening). The shape of the IRF of production, Y_t, in the first periods illustrates the discussed implication of shadow banks reducing the real effect of a monetary policy shock. Moreover, the alteration suggests slightly amplified effect on production even tough the interest rate, i_t faces smaller real effect of the simulated 1 % shock in the altered monetary policy. Capital and consumption explain this effect as they take bigger falls in the altered model where the production is more capital-intense thus labour falls more in production due to policy tightening.

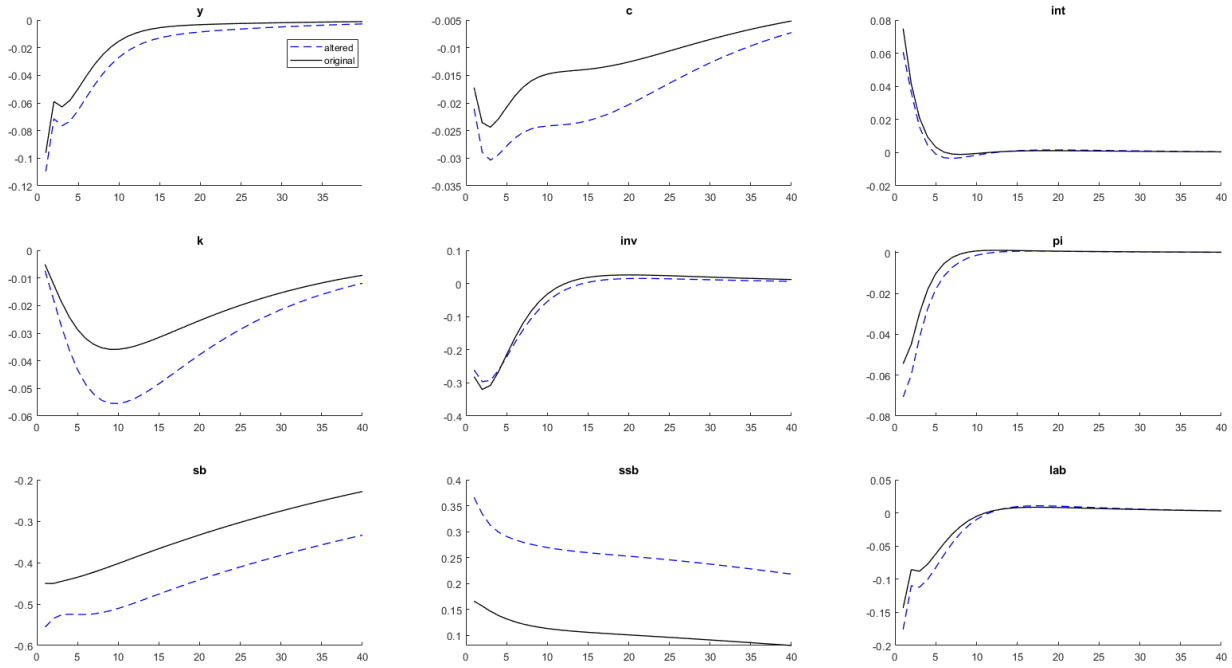

Figure 2: IRF's to a positive 1% shock to monetary policy

The original model's effect of shadow banks increasing and banks decreasing loans can be seen in the scenario of monetary policy tightening. The shock amplifies both effects in the altered model in a similar fashion than productivity shock (less bank loans and more shadow bank loans). The banks balance sheet constraint implies that if the banks' net worth and leverage ratio falls it affects the firms ability to borrow, effectively reducing bank loans. Less consumption in the altered model leads to more savings, which means more available funding for shadow banks: Shadow bank lending increases.

Less consumption, less bank loans, and less capital. Even if shadow banks increase lending, production falls more in the altered model. Together with inflation falling more they explain the smaller real effect of the shock to the

nominal interest rate since it depends more in the actual production and target inflation.

The altered model suggest that the implemented Chinese characteristics make the economy slightly more vulnerable to a monetary policy tightening with less consumption and capital. Also, the shocks to productivity and monetary policy amplify the reactions to the financial sector in bank and shadow bank loan supply, which suggests that the altered model can make the economy all the more unstable than the original model.

6 Concluding Remarks

This paper revolves around the idea of shadow bank modelling in Chinese economic environment and discusses previous literature on the subject. Chinese distinctive economical history and the volume of macroeconomic research on Chinese shadow banking suggest that there are not enough theoretical and empirical analyses on the issue.

The main motives satisfy the historical and theoretical approaches. The idea of this paper is to further inspire research on the subject of implications of Chinese characteristics and shadow banks to an economy, particularly due to the growing influence of Chinese economy in the global markets.

The DSGE adjustment is the main tool for creating added value in the topic of shadow bank modelling in China and it provides hints of economic elements in the Chinese economy. The analysis provides suggestions of the economy's vulnerability towards monetary policy tightening and amplifica-

tion of the financial sector's reaction to productivity and monetary policy shocks.

Naturally, the model analysis here has limitations and does not serve as a valid model to be applied to the entire Chinese economy, but rather it highlights specific aspects of it. The distinct features of the Chinese banking sector are disregarded in the adjustment approach, whereas models such as Chen et al. (2020) incorporate imperfectly competitive banking system in their DSGE study of the Chinese economy.

The DSGE framework here can also serve as a foundation to further analysis (simulation of different shocks, different kind of adjustments, different chosen variables to observe etc), thus the script to run the models and the model codes themselves are provided by the author if needed.

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