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# Shadow Banks, Banking Policies and China's Macroeconomic Fluctuations

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**Abstract**

This paper develops a model of the Chinese economy using a DSGE framework that accommodates a banking sector and money. The model is used to shed light on the period of the Global Financial Crisis. It differs from other applications in the use of Indirect Inference to estimate and test the model. Officially mandated bank lending and government spending were used to supplement monetary policy to aggressively offset shocks to demand. This paper examines the efficacy of monetary policy in terms of the reduction in the frequency of severe economic slowdowns. We find that monetary policy can be used more vigorously to stabilise the economy, making direct banking controls and fiscal activism unnecessary. A nominal GDP targeting monetary policy is the most efficient, compared with a conventional Taylor Rule, a Friedman rule or a price level targeting rule.

**Keywords**: DSGE Model; China Shadow Banking; Severe Economic Slowdowns; Indirect Inference; Monetary Policy.

**JEL classification**: E3; E44; E52

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# 1 Introduction

Shadow banking activities consist of all financial services provided by uninsured and unregulated financial institutions. The shadow banks came under the spotlight of policy and research debates after the global financial crisis (GFC), as they are widely believed to be one of the major contributors of the crisis.

Shadow banks have long been in existence in the developed economies in a variety of forms such as the asset-backed commercial paper, the asset-backed securities, repurchase agreements and collateralized debt obligations. For example, Pozsar et al. (2013) documented that in the US shadow bank liabilities surpassed commercial bank liabilities in the middle 1990's, and reached more than $20 trillion, almost double the size of the bank liabilities, in the GFC, and ebbed below bank liabilities after 2010.

Due to the distinct feature of the Chinese financial system (for a recent review, see e.g., Elliott and Yan, 2013; Chen, Ren and Zha, 2018), shadow banking in China has a quite different story. In 2000, shadow banks accounted for less than 10 percent of China's economy. In response to the GFC, China launched an unprecedented multitrillion RMB stimulus package in 2008. It soon switched to a contractionary monetary policy in 2009-2015, which gave further impetus to the expansion of the shadow banking sector. Shadow banks reached a peak in 2016 at over 80 percent of gross domestic product (GDP). In recent years it has fallen due to regulatory pressure. Shadow banking in China is also distinguished from its Western counterpart in two specific areas. First, it is much less complex. Basically, shadow banks in China are engaged in providing credit that otherwise would have been provided by the regulated commercial banks. Second, it is much more integrated into the regular banking system than in the West (Elliott, Kroeber and Qiao, 2015; Chen, Ren and Zha, 2018).

Concerned by the growth of shadow banking, China initiated in 2016 a series of regulatory measures to contain the financial risk and maintain the financial stability of the economy. The campaign of "deleveraging" as it is known (Chan, 2018; Boulter, 2018), has as its central target the reduction of the level of debt of the economy. But the deleveraging campaign has at best partially achieved its objectives. Within two years, the shadow banking sector in China has indeed shrunk about 5%. However, this comes with several side-effects. The deleveraging exacerbated the financial difficulties of the SMEs, leading to unprecedented corporate bond defaults. The net assets of private enterprises (mainly SMEs) declined sizably in 2018, a phenomenon that has not been seen for decades. Moreover, though the relative size of the shadow banking sector has shrunk, the actual leverage ratio of the overall economy has grown (see Li, 2018 and Xu, 2019 for detailed discussions on the effects of the deleveraging campaign). Can a general equilibrium-based model with shadow banking be used to make predictions on the effects of Chinese regulation policy on shadow banking, and can we propose more effective monetary policy for financial and economic stability when regulatory policy fails to deliver satisfactory outcomes? This is the objective of this paper.

This paper builds a DSGE models with a shadow banking sector to evaluate the effects of various banking policy tools in China. We divide the banking policies into the microprudential ones and the macroprudential ones. The microprudential policy refers to the regulations on banks' in and off-balance sheet operations that affect premium and collateral, such as what the deleveraging campaign is mainly about. The macroprudential policy refers to tools applied to the whole financial system. This covers the Taylor Rule, price level targeting rule, nominal GDP targeting rule, and a Friedman type money supply rule. We examine simultaneously the effects of microprudential and macroprudential polices in a DSGE framework.

The growth of the Chinese shadow banking sector after the GFC has prompted a number of Chinese scholars to examine its role in deflecting monetary policy. Qiu and Zhou (2014) is perhaps the first systematic investigation into the role of shadow banking in the monetary transmission mechanism using a DSGE framework. They argued that Chinese shadow banking is counter cyclical and will reduce the effectiveness of monetary policy. Liu, Hao and Tian (2014) and Lin, Cao and Xiao (2016) also study Chinese shadow banking using the DSGE framework and claim that shadow banking is pro cyclical. Funke, Mihaylovski and Zhu (2015) analyzed the impacts of interest rate liberalization on monetary policy transmission. Gao, Chen, Zeng and Gong (2018) find a counter cyclical pattern of Chinese shadow banking with a structural vector autoregressive (VAR) model and contend that shadow banking dampens the effects of monetary policy by substituting between commercial and shadow bank financing. These equilibrium results are largely in accordance with the reduced form analysis of Chen et al. (2018) with a panel VAR on the distortionary effect of shadow banking on monetary policy.

Unlike the existing monetary DSGE models of Chinese shadow banking, this paper follows the model of Smets and Wouters (2007, henceforth SW) to evaluate the sources of Chinese macroeconomic fluctuations with a shadow banking sector.[2] Specifically, we employ a variant of the SW model due to Le et al. (2011). The model is augmented with the quantity of credit and money in a way we explain in detail below. The basic idea is that the monetary base (M0)

[2] Li and Liu (2017) also used the Smets and Wouters (2007) Bayesian DSGE framework for studying the relative performance of China's monetary policy rules without shadow banking.

acts as collateral for loans because it is entirely liquid and riskless. Hence it is a powerful agent of credit growth in a way that has hitherto been relatively neglected in DSGE models. This framework allows us to comment on policy relating monetary quantities and bank credit (including the activity of the shadow banking system) as opposed to just interest rates.

The focus of this paper is empirical. In contrast to the mainstream Bayesian approach, we apply Indirect Inference testing and estimation procedure to this theoretical set-up using unfiltered data from 1991-2015, and check whether China's macroeconomic fluctuations can be explained by this model. Part of the macroeconomic fluctuations was that China was not immune to the GFC. As Le et al. (2014, henceforth LMMMX) show, China also experienced a severe loss of output in the GFC in the sense of the 'Lucas Wedge' and suffered a strong growth slowdown and has not recouped this loss nor reached its previous trend growth rate. However, the model of LMMMX did not explicitly formulate the features of balance sheets, the quantity of money and bank credit. We want the estimated model including all these features to be able to also mimic these business cycle behaviours. Then the estimated model is used to evaluate the effectiveness of monetary policy as exercised by the Peoples Bank of China (PBOC) in a target framework. We also look at how frequently the estimated model says China would experience a severe economic slowdown (henceforth SES). We do this by simulating the model and calculating how often there would be a cumulative loss of real GDP of varying sizes. We then see how changing monetary policy could affect the frequency of SES. Therefore, we can model both the prediction of the frequency of SES and also a ranking of the stabilising properties of monetary policy.

To anticipate our results, we find a version of this model to fit the Chinese economy covering the period of the GFC. We use the model to evaluate alternative monetary stabilisation rules and find that price level targeting and nominal GDP targeting rules are superior to the Taylor Rule with an inflation targeting priority or a Friedman monetary rule. In terms of minimising the frequency of SES, the most efficient monetary policy rule the PBOC should adopt is a nominal GDP targeting rule.

In our empirical analysis we use the Indirect Inference procedure to test the model on some initial starting parameter values, and then allow the parameters to move freely until they maximise the criterion of replicating the data behaviour.[3] This allows us to test the model itself rather than a specific set of parameter values that could be at fault. The main advantage for using Indirect Inference over the Bayesian maximum likelihood is that it tests the overall ability of the model to replicate key aspects of data behaviour, which are not guaranteed results with Bayesian estimation. Another advantage of the Indirect

[3] For a review of the method of Indirect Inference and why it is relevant for testing with DSGE models, see Gourieroux, Monfort and Renault (1993), Le et al. (2011), Le et al. (2014), Le et al. (2016a), Le et al. (2016b), and Minford (2016)

Inference method is that it works on the original data directly, while the usual estimation method of maximum likelihood or Bayesian works on the de-trended data thus engendering potential information loss as macro time series data are often nonstationary (Del Negro et al., 2015; Kollmann et al., 2016; Fernandez-Villaverde et al., 2017). Meanwhile, with Indirect Inference we can simulate the frequency of SES by bootstrap, thus providing additional insights on the probability distribution of the adverse macroeconomic consequences.

Of course, it can be argued that the model, developed out of the SW framework is only suitable for a large, closed economy as characterised by the USA. Since China has a large export sector (26% of GDP) and a similarly large import sector, one might think that it cannot be modelled as a closed economy. However, China's export and import sector have developed rapidly because of decisions to invest in new infrastructure in cities and transportation; once these decisions were taken, the resulting output of goods were sold on world markets at the prices needed to absorb them. Nevertheless, as there is some degree of price and wage rigidity in China, there will be effects of world demand in the short run. Because the industrial structure is largely dominated by multi-national companies, imports too are closely related to the export volumes. Thus, we would argue that net imports can reasonably be modelled as exogenous processes in China; this is how they enter in the SW model, as an exogenous error process in the goods market-clearing equation whereby output equals demand for goods.

An alternative argument is that the Chinese economy does not function fully as a developed market economy and that the modelling of the economy must include the distortions of a dominant state sector (Zheng, Storesletten and Zilibotti, 2011) that stifles the growth of private enterprise through state capital (Huang, 2008) and distortions in the labour market (Dollar and Jones, 2013) and a controlled banking system (Funke et al., 2015). While there is merit in this argument, we argue that it misses the point of using a model as an analytical aid to think about the determinants of the business cycle. In reality, no economy, developed or otherwise, behaves fully as the SW framework describes. The purpose of using a DSGE model of a variant of the SW framework is to use it to isolate the principal factors that drive the business cycle in China even with distorted markets.

The rest of this paper is as follows: in the next section we set out the model in outline, incorporating the modified Bernanke et al. (1999) framework to the SW model. In the third section, we set out the empirical results for the model. The model is used to analyse the banking crisis and to speculate on the causes of future SES. In the penultimate section we consider how monetary policy could be reformed to minimise the occurrence of SES, independently of the regulative solutions now widely being suggested. Our final section concludes, with some reflections on the implications for China's monetary policy.

## 2 The Model

We utilise the New Keynesian framework as described by SW in our analysis of the Chinese economy including shadow banking. In particular, we use the model developed in Le et al. (2020), which extends the original SW model in the following ways. Firstly, it allows for the final goods and labour being sold and supplied to, respectively, in both perfectly competitive and imperfectly competitive markets. Secondly, it incorporates the financial accelerator mechanism of Bernanke et al. (1999) to allow for the analysis of a banking/financial sector. Lastly, it allows for the effects of open market operations and the increase of intrusive regulation of banks. The full listing of the model is in Appendix 1. In the following, we will present the model's equations that are related to the model's lending activities, regulations, and monetary policy.

There are two types of intermediate-goods producing firms, SOEs (State-owned enterprises) and SMEs (Small and Medium-sized enterprises) that produce using capital ($k_{t-1}^{i}$, where $i = SOE, SME$) and labour ($n_t^i$) and sell their intermediate goods ($y_t^i$) to the final goods retailer at the marginal costs. To finance their capital purchases, they borrow funds from banks. SOEs are assumed to be riskless because of the implicit state guarantee and banks would lend to these firms at the risk-free rate. However, SMEs are riskier firms but more productive than the SOEs. Banks still want to lend to SMEs, but they do so through the off-balance sheet route of supplying wealth management products which effectively place funds in the shadow banking sector. There are many ways that banks can perform this lending channel. One way is to lend at the risk-free rate plus the mark up to high-value individuals or intermediary firms, who then pass it on, together with a slice of their own capital to risky SMEs. These intermediaries share the risks with SME firms to who they are lending. The banks pay a risk-free rate on their savings and lend on risky loans to SMEs. We can think of this as banks charging SMEs a higher premium than the rate at which they lend to SOEs. SMEs could reduce the premium by having a high net worth and/or pledging some of their cash collateral. Since the SMEs can reduce their cost of borrowing by having cash, it would acquire all cash issued by the central bank. In the model, this means that SOEs borrow at a lower rate and SMEs borrow at a higher rate, which is the SOEs borrowing rate plus the external credit premium. The SOE's real cost of funds is $r_t - E_t\pi_{t+1}$, but due to the financial market frictions, the SMEs would have to pay a premium ($s_t$) above the real risk-free rate that the SOEs pay:

$$s_t = \chi(qq_t^{SME} + k_t^{SME} - nw_t^{SME}) - \psi_s m_t + \varsigma_{1t} + epr_t \,, \tag{1}$$

where $nw_t^{SME}$ is the SMEs net worth, $qq_t^{SME}$ is their Tobin q, and $k_t^{SME}$ is their capital stock. Equation (1) shows that the credit premium is reduced with a higher cash collateral ($m_t$) and a higher net worth relative to the gross value of capital ($nw_t^{SME} - (qq_t^{SME} + k_t^{SME})$), and rises with more regulations ($\varsigma_{1t}$) and exogenous shocks ($epr_t$). There is also an assumption that in every period a fixed death rate $1-\theta$ happens so that the stock of firms is kept constant by an equal birth rate of new firms, and the net worth remains below the demand for capital. This means that the SMEs net worth is the past net worth of surviving firms plus their total return on capital minus the expected return (which is paid out in borrowing costs to the bank) on the externally financed part of their capital stock — equivalent to the following in natural logs,

$$nw_t^{SME} = \theta nw_{t-1}^{SME} + \frac{K^{SME}}{NW^{SME}}(cy_t - E_{t-1}cy_t) + E_{t-1}cy_t - \varsigma_{2t} + enw_t, \tag{2}$$

where $\frac{K^{SME}}{NW^{SME}}$ is the steady state ratio of SMEs' capital expenditures to SMEs net worth, $\theta$ is the survival rate of SMEs, $cy_t$ is the SME's return on capital, $\varsigma_{2t}$ is a regulatory specific shock having negative effects on net worth, and $enw_t$ represents all other net worth shock.

The increase in banking regulation raises the cost of lending to firms. In a modelling sense the extra regulation is added as a credit friction in the form of unobserved shocks, $(\varsigma_{1t}, \varsigma_{2t})$. Due to data on regulations being unavailable for our purposes, we merge the exogenous credit shocks and regulations, thus a higher shock in the risk premium equation can be partly due to more regulations on the banking system, and a negative shock to net worth could partly be due to a tightening in collateral conditions by the banks in response to a regulatory call.

We note that while the BGG net worth channel has been used extensively in the literature and is well known, the cash collateral variant requires greater elaboration. The idea of costly state verification is that net worth is all invested in plant, machinery and other capital and thus cannot be recovered at original value and has less value when the firm goes bankrupt because it has become specialised to the firm's activities. It is normal for banks also to request an amount of collateral (e.g., Kiyotaki and Moore, 1997). If this collateral was in terms of cash, i.e., a firm holds some cash on its balance sheet, this can be recovered directly without loss of value and no verification cost. The elimination of the collateral cost helps to bring down the credit premium for a given net worth and it allows firms to increase leverage and so raise their expected returns. It assumes that banks and SME firms have a mutual interest in firms holding as much cash as can be acquired for collateral. The process of cash being used as collateral is as follows. As the central bank issues cash through open market operations to households in exchange for government bonds they hold, households deposit cash with banks, firms want to acquire as much of this cash as possible for their collateral needs (they invest their net worth in cash to the maximum available with the rest going into other collateral and capital). In practice the firms' profits are continuously paid out as dividends to the banks which lend to them, so they have nothing with which to acquire these assets if they do not collaborate with banks. They achieve this balance sheet outcome by agreeing with the banks that, as a minimum counterpart to the credit advanced, they will hold the maximum cash collateral available, which is M0. Thus, all M0 at once finds its way to firm's balance sheet, where it is securely pledged to the banks in the event of bankruptcy[4].

We allow the short-term rate on official lending to the banks to be set by the PBOC in accordance with a Taylor Rule. We assume that the PBOC enforces this rule via open market operations. That is, households hold part of their savings in government bonds and the rest in bank deposits, which pay the short-term interest rate also obtainable on short term government bonds. In order to control the short-term rate, the PBOC would sell/buy the long-term government bond to buy/sell the short-term government bonds to influence the prices of these assets and thus their rates. Cash is issued in this model, but is only held by firms, as households have no use for it and deposit it in banks where it is lent to firms to hold as collateral and affect the credit premium. Putting aside the regulations, the monetary authorities have two instruments, *M0* ($m_t$) and the official bank interest rate ($r_t$):

$$r_t = \rho r_{t-1} + (1-\rho)\left(\rho_\pi \pi_t + \rho_y y_t + \rho_{\Delta y}(y_t - y_{t-1})\right) + em_t \qquad (3)$$

$$\Delta m_t = \psi_2 \Delta M_t + errm_{2t} \qquad (4)$$

where $\pi_t$ is inflation, $y_t$ is real GDP, $\psi_2$ is positive and $M_t$ is the supply of broad money (M2)[5] and $errm_{2t}$ is money supply shock.

Before moving on to the estimation of the model, a few words about the conduct of monetary policy and the Taylor rule in China is warranted. The policy objective of the PBOC is 'price stability, economic growth, and financial stability' (Klingelhöfer and Sun, 2019)[6]. The PBOC instruments of monetary control are a mixture of open market operations (OMO), required reserve ratio (RRR) changes, interest rate changes, and central bank lending to alter the stock of base money. These are often supplemented with direct credit controls in the form of loan-to-deposit caps, and window guidance. The PBOC exerts influence on market rates by setting benchmark rates on various maturities, allowing banks to set rates within a band.

While the benchmark rates exert a direct influence on market rates, the combination of OMO, RRR, and credit controls will exert indirect influence. Recently Shan et al. (2020) from the PBOC research department estimate a

[4] There are many ways that money can be brought into a model such as this. The way we have done it in the spirit of the credit channel where cash is pledged as collateral and serves to reduce the risk premium. A real-world feature is the availability of liquidity to the financial system which reduces interest rates and spreads.

[5] In the model this is measured as total bank credit plus shadow bank credit, rather than the official measure of M2. The underlying assumption is that shadow banks in China do not create new credit and are effectively extensions of the conventional banks.

[6] The latter objective is met by using direct credit controls (window guidance) and exchange rate stability (within specified bands) using controls and interventions with offsetting sterilisation policies.

Taylor rule 'in line with China's reality', confirming the notion that while the PBOC does not operate on the rate of interest alone to meet its inflation and growth objectives, its many alternative instruments can be captured in a Taylor rule specification.

## 3. Model Estimation and Implications

The model that integrates the banking sector and money is estimated using the method of Indirect Inference as set out in Le et al. (2011)[7] for the 1991–2015 period using unfiltered quarterly data. The approach employs an auxiliary model that is completely independent of the theoretical one to produce a description of the data against which the performance of the theory is evaluated indirectly.

Indirect Inference has been widely used in the estimation of structural models (e.g., Smith, 1993, Gregory and Smith, 1991, 1993, Gourieroux et al., 1993, Gourieroux and Monfort, 1995 and Canova, 2005). The common element is the use of an auxiliary time series model[8]. In estimation the parameters of the structural model are chosen such that when this model is simulated it generates estimates of the auxiliary model like those obtained from the actual data. The optimal choices of parameters for the structural model are those that minimise the distance between a given function of the two sets of estimated coefficients of the auxiliary model.

In model evaluation the parameters of the structural model are taken as given. The aim is to compare the performance of the auxiliary model estimated on simulated data derived from the given estimates of a structural model — which is taken as a true model of the economy, the null hypothesis — with the performance of the auxiliary model when estimated from the actual data. If the structural model is correct then its predictions about the impulse responses, moments and time series properties of the data should statistically match those based on the actual data. The estimated model is tested against the data using the main macroeconomic variables, output, inflation, and the interest rate. The method tests whether the model can jointly match the time series properties of the data.

A word about the data, before moving on to a discussion of the results. As is often the case with China, some strong assumptions are made to move a theoretical model to an empirical framework. The data for real GDP output, inflation and the interest rate are obtained from the IMF data bank. Total annual investment data, and private investment data is obtained from the China Bureau

[7]For an in depth look at the benefits of using the method see Le et al. (2016a).

[8] This is not the first model of the Chinese economy to take this approach. Le et al (2014) use Indirect Inference to estimate a more aggregative structure than that proposed in this paper, and Dai et al (2015) test the method of Indirect Inference on a DSGE model.

of Statistics and interpolated for quarterly figures[9]. Private investment is assumed to be the investment of the SMEs and SOE investment is assumed to be the residual. The share of private sector output is obtained as annual data from 2000-2015 and interpolated for quarterly estimates and spliced back to 1991 as a constant proportion the 2000 share. Again, private sector output is assumed to be generated by the SME sector. Table 1 below provides a summary of the data used.

**Table 1: Summary Statistics of Key Variables**

| | Descriptive Statistics | | | |
|---|---|---|---|---|
| Variable | Mean | Std. Dev | Min | Max |
| Consumption (log real per capita)*100 | 1897 | 61.15 | 1793 | 2000 |
| Investment (log real per capita)*100 | 1906 | 102.8 | 1741 | 2075 |
| Output (log real per capita)*100 | 1985 | 70.18 | 1869 | 2094 |
| Labour (log employment rate)*constant | 1582 | 0.43 | 1581 | 1582 |
| Inflation (% quarterly) | 0.99 | 1.55 | -1.01 | 6.52 |
| Wage (log average wage/Price) | 502.69 | 74.05 | 387.51 | 619.51 |
| Interest Rate (% quarterly) | 1.19 | 0.67 | 0.68 | 2.61 |
| Return on Capital (SOE) (% quarterly) | 1.75 | 0.52 | 1.09 | 3.02 |
| Net Worth (log real per capita Shanghai capital)*100 | 1941.6 | 164.33 | 1415.5 | 2161.2 |
| Premium (% quarterly) | 0.56 | 0.20 | 0.02 | 1.04 |
| Lending Rate (% quarterly) | 1.75 | 0.52 | 1.09 | 3.02 |
| Real M0 (log M0/CPI)*100 | 1907.1 | 57.81 | 1801.7 | 1990.8 |
| Real M2 (log M2/CPI)*100 | 2607.7 | 121.42 | 2387.1 | 2822.9 |
| Price (CPI) | 4.60 | 0.21 | 3.96 | 4.90 |
| Private Investment (log real per capita)*100 | 1824.1 | 127.93 | 1629.1 | 2028.2 |
| Other Investment (log real per capita)*100 | 1844. | 81.43 | 1701. | 1976. |
| Shadow Banking Credit (log real pc)*100 | 1898. | 177.95 | 1635. | 2205. |

[9] Time series data on private sector investment are obtained directly from *China Statistical Yearbooks* up to 2015. The ownership structure of China's enterprises has changed dramatically since the early 1980's, and the definition of the term 'private' is not a constant. To resolve uncertainties regarding the construction of a private investment data series, China's National Bureau of Statistics published in 2012 an instruction document on its definition for China. For the early years where the private investment data are unavailable, we follow the instruction to construct the data series. Clearly due to the complexity of the ownership change situation, the private investment data might have non-negligible measurement errors hence can at best be viewed as a close proxy to the true level of investment.

The Indirect Inference testing and estimation found a version of the model that fit the data with the Wald statistic having a p-value of 0.053 showing that the model is not rejected at the conventional level of significance. Table 2 displays the parameter estimates.

**Table2: Key Coefficient Estimates (1991Q1–2015Q4)**

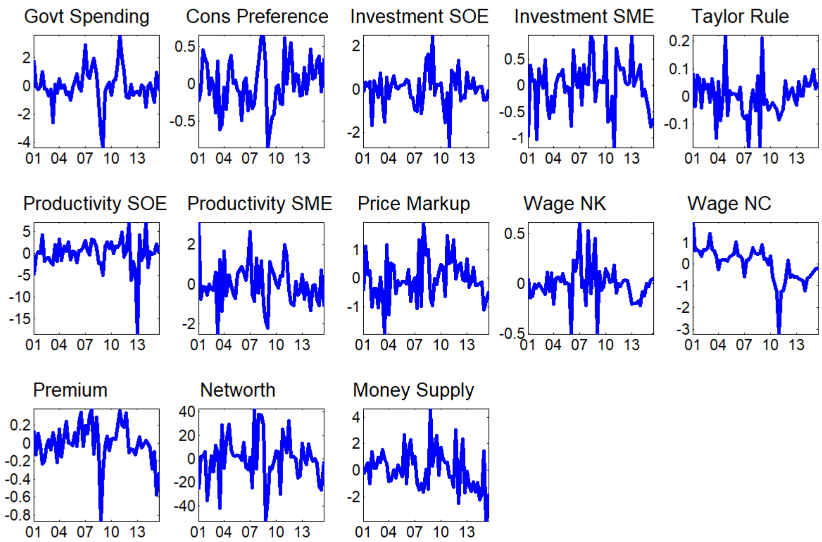
| | | |
|---|---|---|
| $\sigma_c$ | Elasticity of consumption | 1.1351 |
| $\phi$ | Steady-state elasticity of capital adjustment | 9.8529 |
| $\lambda$ | External habit formation | 0.0004 |
| $\sigma_l$ | Elasticity of labour supply | 1.1919 |
| $\xi_p$ | Probability of not changing prices | 0.7497 |
| $\iota_p$ | Price indexation | 0.0254 |
| $\xi_w$ | Probability of not changing wages | 0.6178 |
| $\iota_w$ | Wage indexation | 0.1679 |
| $\varepsilon$ | Substitution between demand for SOE and SME intermediate goods | 2.5428 |
| $\chi$ | Elasticity of the premium with respect to leverage | 0.0105 |
| $\psi_s$ | Elasticity of the premium to M0 | 0.0408 |
| $\psi_m$ | Monetary response | 0.0030 |
| $\rho$ | Interest rate smoothing | 0.9621 |
| $\rho_\pi$ | Taylor Rule response to inflation | 2.9494 |
| $\rho_y$ | Taylor Rule response to output | 0.1471 |
| $\rho_{\Delta y}$ | Taylor Rule response to change in output | 0.0558 |
| $\omega_\pi$ | NK weight on inflation | 0.7058 |
| $\omega_w$ | NK weight on wage | 0.8925 |
| | Wald | 18.3356 |
| | Trans | 1.5546 |
| | p-value | 0.053 |

We find that in China the labour and product markets are strongly competitive. The coefficient of wage indexation is 17% and price indexation for the SMEs is 2.5%. If one had to place China along the New Keynesian-New Classical spectrum it would therefore be closer to the New Classical end, with less nominal rigidity.

The estimated model and unfiltered data imply the structural residuals. Except for the productivity process, all residuals are assumed to be stationary or trend stationary and follow the AR(1) process. Therefore, their error terms are interpreted as the shocks that hit the Chinese economy (Figure 1). Now we consider the period of the GFC in China and check the sources of its economic fluctuations. There are many shocks hitting the Chinese economy during the crisis period. Most of the major shocks are international but lead to domestic counterpart shocks. The spike in investment by SOEs in 2009 coincides with

China's equivalent of QE in the form of infrastructure expenditure, where the Chinese authorities responded by ordering banks to lend for investment projects[10]. This also coincides with negative spikes in the Taylor Rule and the premium, and a positive spike in the money supply. We go on to analyse the period of the GFC in China[11]. There is also a reaction to the crisis in government spending which with net exports constitutes the exogenous demand shock.

**Figure 1: Innovations**




The variance decomposition (Table 3) for the crisis episode can tell us about the contribution of different shocks in explaining the business cycle movements. We find that only 38% of the output variance is due to financial shocks (here essentially macroprudential policy — Taylor Rule, and microprudential policies — net worth, premium and the M0 shock[12]). The main effect of the financial shocks is on investment by the SMEs. This is because it operates by disturbing the supply of credit; thus, for investment by the SMEs the share of financial

[10] QE Chinese style was different from QE operated by other central banks. The PBOC balance sheet was expanded to allow for an increase in lending to the banks and money base but banks were expected to increase credit and accept commercial paper as collateral. Therefore, the credit increase came from commercial bank activity rather than directly from the PBOC (Deng and Todd, 2016).

[11] As this is only a model of China, we cannot identify the causality of any international ramifications. These international effects will show up in the shocks. The commodity price shocks that enter through the 'price mark-up' here are themselves responding to the crisis. Also, the exogenous demand shock, which consists of government spending and net exports, contains the international downturn in world trade.

[12]We include the M0 error among the banking shocks because it parallels the behaviour of the credit premium shock in the US which was clearly a financial shock but also later embodied a strong policy response in the form of bank bailout. In China the credit premium shock was small because the banks are largely state banks with little perceived credit risk.

shocks is very high (72%) and for investment by SOEs is 54%. This large effect doesn't fully carry over to GDP because interest rates react to them. What is clear from the variance decomposition is that financial shocks are much more important for the SME sector than for the SOE sector through its effect on investment. While investment for the SOE sector is also heavily influenced by financial shocks, the transmission works through a crowding out/in effect on SME investment. The overall effect on aggregate output is dampened by SOE investment working in the opposite direction to SME investment. However, what we have found is that financial shocks do play a role in China for this episode, but most of the variation comes from the other shocks. Most notably SME productivity, and SOE investment. Generalising from these results we can say that regulatory shocks that influence collateral conditions for the SMEs borrowing and shocks to the premium account for one-quarter of the variance decomposition of output, whereas monetary policy (money supply and interest shocks) account for around 10%. It seems that the financial shocks have a considerable role in the movement of major macroeconomic variables during the crisis period.

**Table 3: Variance Decomposition (2006 Q1-2015 Q4)**

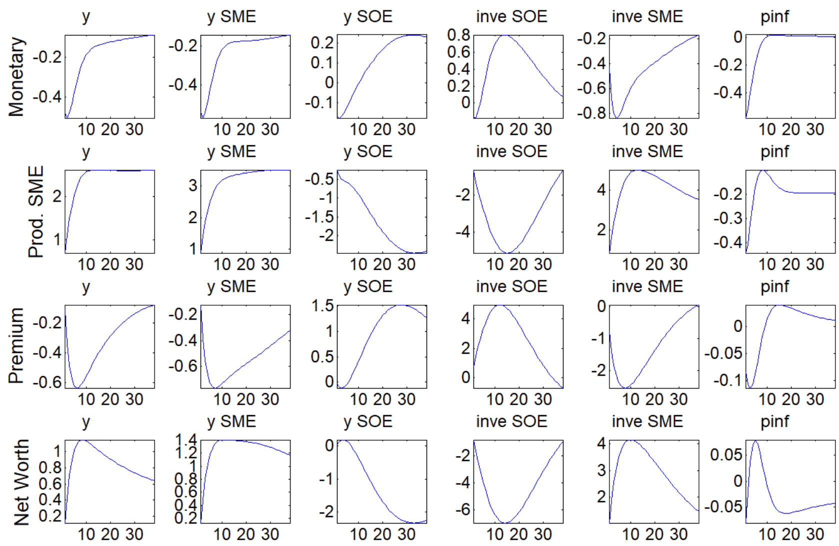
| | Y | y SME | y SOE | inv | inv SOE | inv SME |
|---|---|---|---|---|---|---|
| Govt Spending | 2.01 | 1.67 | 0.59 | 0.70 | 1.49 | 0.24 |
| Cons Preference | 3.14 | 1.82 | 1.57 | 5.46 | 3.66 | 1.97 |
| Investment SOE | 7.50 | 4.65 | 3.22 | 9.63 | 3.73 | 3.91 |
| Investment SME | 0.20 | 0.16 | 0.02 | 0.21 | 0.09 | 0.17 |
| Taylor Rule | 1.17 | 1.00 | 0.12 | 0.99 | 0.31 | 0.87 |
| Productivity SOE | 4.64 | 1.16 | 69.46 | 2.49 | 29.67 | 0.39 |
| Productivity SME | 43.80 | 43.60 | 3.77 | 22.38 | 7.12 | 20.98 |
| Price Mark-up | 0.25 | 0.22 | 0.04 | 0.22 | 0.09 | 0.21 |
| Wage NK | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Wage NC | 0.15 | 0.11 | 0.01 | 0.09 | 0.02 | 0.04 |
| Premium | 4.82 | 6.82 | 6.97 | 8.48 | 16.50 | 13.21 |
| Net worth | 22.74 | 28.31 | 12.16 | 33.06 | 31.51 | 41.73 |
| Money Supply | 9.58 | 10.48 | 2.07 | 16.30 | 5.82 | 16.27 |
| Financial Shocks | 38.31 | 46.61 | 21.33 | 58.82 | 54.13 | 72.08 |

## 4. Policy Implications and Reforms

### *4.1. Financial Regulatory policies*

Given the important role of financial shocks, we can use the estimated model to analyse and understand the impact of these different shocks on the economic outcomes by looking at the IRFs. We interpret these shocks as macroprudential or monetary policy shock (interest rate shock and money supply shock) and microprudential policy shock (net worth and credit premium) for the reason that the former affects all borrowers initially, while the latter targets only one segment. We are interested in responses of the whole economy, as well as the SOE (borrowing at risk free rate) and SME (borrowing at the external financial rate) sectors. There is an implication to the shadow banking sector activities.

**Figure 2: IRFs for Key Variables**




The IRFs are revealing. Figure 2 shows the IRFs for output by the SMEs, and SOEs respectively, investment by the two types of firms, and inflation. The first row shows the effect of a monetary tightening (an increase in nominal interest rate). Both output of the SMEs and SOEs decline driven by a fall in investment which is more pronounced for the SME sector. We interpret this as evidence of procyclicality in commercial bank credit and shadow bank credit. Tighter monetary policy reduces bank credit but has a stronger effect on shadow bank credit through its effect on the premium, which has a sharper impact on SME investment and output, than the SOE equivalent. The dynamics are also of interest. Investment in the SME sector generates a crowding out/in effect on investment in the SOE sector. The second row shows a positive shock to productivity in the SME sector[13]. Aggregate output increases even though there is a crowding out effect on SOE output. The third row shows a shock to the premium, which has an effect not dissimilar to the monetary shock, except that SOE investment and output is initially unaffected, because SOEs borrow at the risk-free rate. However, SME investment and output declines, while there is a crowding in effect on SOE investment. However, the overall effect is to depress

[13] Note that this is a non-stationary shock, so has permanent effects.

total output. The fourth row shows a positive shock to net worth, which leaves SOE output unaffected initially as only SMEs need to pledge networth and there is a rise in SME investment and output. This creates a crowding out effect on SOE investment and output, but overall output rises.

Based on the IRFs analysis the model implies that microprudential regulatory shocks that directly aim to restrict credit to the SME sector, i.e. curbing the shadow banking activities, would cause a rise in the premium and/or a reduction in net worth which would have a negative effect on aggregate output.

These results contrast with Gao et al. (2018) who argue that a negative monetary shock causes the banking system in China to substitute from bank credit to shadow bank credit. As monetary policy tightens, banks shift their assets off-balance sheet so as to avoid capital constraints and to meet increased funding costs from the tightening monetary policy. Therefore, a tightening of monetary policy causes a decrease in commercial bank lending and an increase in shadow bank lending. They argue that shadow bank credit is countercyclical to commercial bank credit and therefore dampens the effect of monetary shocks, whereas the results above suggest shadow bank credit reinforces monetary policy through its effect on the premium.

Though we build our model based on historical data before 2016, our predictions largely resemble events thereon. If the government desists from microprudential policies to manipulate the economy due to their negative effects, we are interested in the question of whether, and how, it will try to use the macroprudential policy or monetary policy to stabilise the economy.

*4.2. Monetary Policies*

During the GFC the Chinese government used both a direct fiscal response in the form of higher government spending and a credit-direction response in which banks were directed to lend for investment. While the fiscal response was effective and, when we simulated it in repeated samples, caused a dampening of output fluctuations, the credit/investment response caused dangerous instability in the form of rising excess capacity — this was the major finding of LMMMX. We now look, using our model with both money and credit, at whether the Chinese authorities could have made more effective use of monetary policy to dampen the impact of the GFC.

The monetary policy instruments in this question are Base money (Quantitative Easing, Open Market Operations) and interest-rate setting via a Taylor Rule. We assume in this model that the instruments can be independently chosen. Open market operations supply Base money (M0) in exchange for government bonds of all types, so setting the credit premium by affecting the supply of collateral. Interest rates are set by selling or buying short government bonds for long.

The impact of the GFC here for China is different from that in the literature for developed economies. In Le et al. (2016) for the US, the impact of the GFC was a severe interruption in output growth, a large part of which was permanent; it was also a financial crisis in which there was a collapse of the financial sector. However, the history of the period of China we take for our analysis has never experienced what would constitute a recession (2 quarters of negative growth) let alone a crisis in terms of a permanent fall in output for China. Indeed, the average growth rate for the estimation period for the model is more than 9% per year. Bootstrapping the shocks even for the period of the GFC will generate very few instances of negative growth. Therefore, the impact of GFC can be shown to be a severe economic slowdown (SES) where SES may be interpreted in the relative sense of growth falling below some target much lower than the historical average of the time on which the government will have been basing its plans. From the perspective of maintaining consensus behind the government's policies for growth and market liberalisation the avoidance of SES, in this sense of growth disruption, is of key importance, as clearly revealed in the Chinese government's strong response to the GFC. Thus, we are interested in knowing how monetary policy could be conducted to reduce the frequency of episodes of unexpectedly low growth.

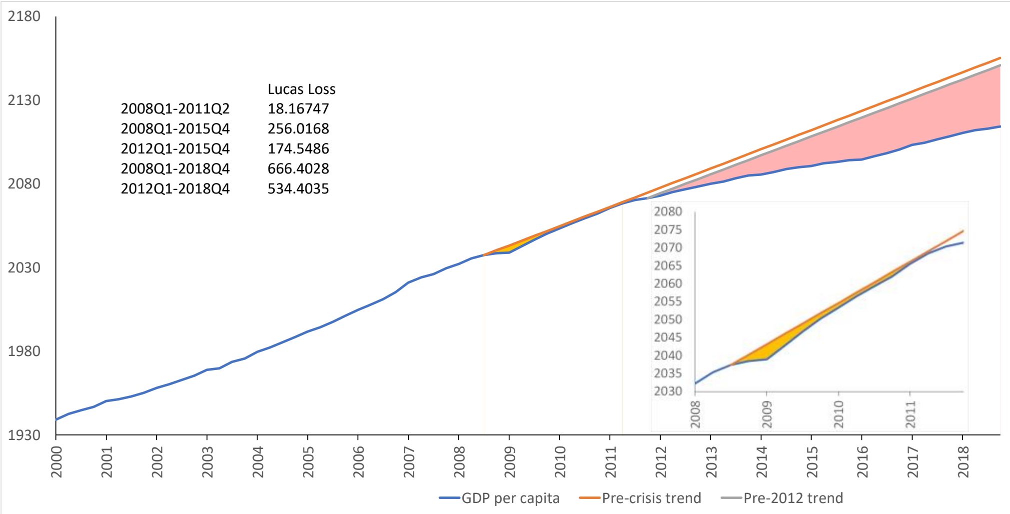
To define the extent and seriousness of an SES we measure the size of the disruption to GDP compared with the government's aims, assumed to be based on the prior growth trend. In Figure 3 we have plotted GDP during the revealing period from the start of the GFC. We can measure the cumulative loss of GDP compared with some baseline growth trend, representing what the government at the time would have regarded as normal. In this way the GFC period produced a cumulative loss (CL) of 18% (i.e. a loss of output equal to 18%); this loss was kept down by active government policy to counter the slowdown. After GDP almost returned to the pre-crisis trend, we can see that the Chinese government could no longer keep GDP growing at that rate, and there was a slowdown in GDP growth to approximately 6%. Taking the period from 2012Q1 to 2015Q4 (the end of our sample) we get a CL of 175%; we can think of this episode as exemplifying a very serious disruption of the government's growth objectives, on a par with The Great Recession in the US, whereas the earlier disruption in the GFC period itself was quite modest, on a par with what in the US would be treated as a recession. We use this information to define various degrees of SES: a CL of 15-30% ('recession'), 60-100% ('bad slowdown') and 175-225% ('Great Recession').

Bootstrapping the shocks 1000 times we can identify the number of instances an SES of these different sizes occur under current Chinese monetary policies. Table 4 shows that if we classify SES episodes in this way then we find that a 'recession' CL of between 15-30% occurs once every 69 years[14],

[14]This figure is obtained by defining the balanced growth path of the economy to 6% rather than the historic 9%.

whereas CLs of between 60-100% (bad slowdown) and 175-225% (Great Recession) occur once every 93 and 182 years, respectively.

**Figure 3: GDP and SES**




This leads to the question of whether alternative monetary policies could stabilise the economy better than the existing ones.

The Great Recession showed that an economy with inflation targeting alone struggled to cope with big shocks to the economy and might have even contributed to instability (Beckworth, 2014) because monetary policy was too tight (and may have been too loose in the boom that led up to it). In this section, we discuss some possible changes to the monetary regime that could improve economic stability, compared with the baseline regime (embedded in the model) of inflation targeting, minimal regulation and an accommodative M0 response to the money supply. Our focus with these alternative regimes is their capacity to reduce the number of SES of varying degrees.

We test whether supplementing the Taylor Rule with a powerful Friedman type money supply rule could help stabilise the economy. The reason for testing this is because prior to the financial crisis inflation expectations were strongly anchored by the inflation target, and so inflation did not respond to the substantial expansion of money and credit that was seen in the run-up to the Great Recession.

This suggested monetary reform takes the following form[15]

[15]The best value of $\rho_m$ turned out to be zero and equation (5) translates to a simple monetary target rule, however a drift factor can be attached to it without any change to the results to produce a Friedman rule of a constant rate of growth of money.

$$m_t = m_{t-1} + \rho_m y_{t-1} + errm_{2t} \quad (5)$$

We repeat our bootstrap simulation exercise incorporating this rule and compute the frequency of SES as defined above. The results are shown in Table 4 below. The results do not improve much on existing policies. A recession CL of between 15-30% now occurs once every 67 years, while a CL of 60-100% (bad slowdown) occurs once every 87 years, and a CL between 175-225%, a Great Recession, arrives every 207 years.

Following the decrease of interest rates, to close to the zero lower bound, in most developed economies there has been a renewed interest in price level targeting (PLT) as a better alternative monetary policy that can achieve price stability while also reducing the impact of the zero lower bound (Wolman, 2005; Vestin, 2006; Nakov, 2008; and Dib et al, 2008; for a recent survey see Hatcher and Minford, 2013). Under PLT, inflation expectations adjust to stabilise the economy: if an unanticipated shock pushes the price level below the target, people will expect higher than average inflation in the future to bring the price level back to the target. PLT has two advantages over inflation targeting. First, due to the automatic adjustment in inflation expectations, the central bank does not need to move interest rates aggressively in response to shocks (Cover and Pecorino, 2005), thus it reduces the likelihood of hitting the zero bound. Second, PLT can generate positive inflation expectations in a deflationary situation, lowering real interest rates even at the zero bound, and so strengthen recovery. While China has not experienced a zero-lower bound, similar mechanisms work outside the zero bound: when the economy grows strongly pushing up the price level, inflation expectations fall sharply, so powerfully raising real interest rates; and when the economy is weak, pushing prices down, inflation expectations rise sharply, lowering real interest rates and promoting recovery.

The PLT rule is specified as follows:

$$r_t = \rho_1 r_{t-1} + (1-\rho_1)\left[\rho_\pi(p_t - \bar{p}) + \rho_y(y_t - y^*)\right] + \rho_{\Delta y}[(y_t - y^*) - (y_{t-1} - y^*)] + er_t \quad (6)$$

Where $\rho_1$ is a smoothing coefficient and $y^*$ is potential output. Under the zero-inflation steady state, the steady state price level is assumed constant here and normalised as $\bar{p} = 0$.

We are looking for an optimal PLT specification that provides the least frequency of SES under our bootstrap simulations. It turns out that the following PLT rule reduces the frequency of SES further (Table 4).

$$r_t = 0.43 r_{t-1} + (1-0.43)[0.11 p_t + 0.98(y_t - y^*)] + 0.67(y_t - y_{t-1}) + er_t \quad (7)$$

Another alternative rule that has been suggested in the literature is a rule that targets the level of nominal GDP (NGDP), rather than either a monetary aggregate or inflation (Sumner 2011, Nunes and Cole 2013). A similar proposal was made some time ago in a series of papers by McCallum (1988) and McCallum and Nelson (1999) who suggested a rule setting interest rates in response to deviations of nominal GDP growth from a target rate. McCallum argued that this rule would be superior to monetary targeting because of the large and unpredictable changes in payments technology and financial regulations. Compared with the later Taylor Rule McCallum's rule has interest rates responding as strongly to output growth deviations as to inflation deviations. However, the authors above suggest targeting the level of NGDP rather than its growth rate; the reasons are like those for PLT, except that in this case an expected future interest rate stimulus is triggered also by output falling below its trend (McCallum, 2011). A concern about this is that with a stochastic productivity trend monetary policy would be affected by permanent shifts in productivity; thus, the NGDP rule we use here allows for changes in the model's productivity trend — since this is hard for the central bank to estimate, the results for the NGDP rule shown here are 'best case'. Nevertheless, if this best case can be assumed, the NGDP rule generates expectations of very strong monetary responses in conditions of prolonged recession — analogous to Roosevelt's 1930s abandonment of the Gold Standard (Carney, 2012 and Woodford, 2012).

Implementing the NGDP target, the central bank would specify an intermediate target for the official interest rate. The rule might be written as follows:

$$r_t = \rho_1 r_{t-1} + \rho_y(p_t + y_t - \bar{y}_t - \bar{p}) + er_t \tag{8}$$

where $\bar{y}_t + \bar{p}$ is the target for NGDP, where $\bar{p}$=0 and $\bar{y}_t$ follows the trend path in real output generated by productivity.

Given this general rule, we bootstrap our model and implied shocks to see whether implementing the NGDP targeting regime could help to stabilise the economy. We found that the rule in the form below also dramatically reduces the frequency of SES (Table 4):

$$r_t = 0.89 r_{t-1} + 4.94(p_t + y_t - \bar{y}_t) + er_t \tag{9}$$

To summarise our results, by following a nominal GDP target rule, output variability is dramatically dampened, with the frequency of small SES falling to once every 75 years, of the medium 'bad slowdown' to once a century, and of the very worst Great Recession falling to just once every two and a half centuries; results for a PLT rule also improve on existing policies but not quite so dramatically. Using these rules would also mean that there is no need for the authorities to use heavy-handed and distortionary regulative controls on banks to avoid financial crisis.

Here we refer to the deleveraging policy the Chinese authorities have been following since the second half of 2016. While the financial regulators have been tightening supervision and regulations, the PBOC has been hiking up interest rates to curb liquidity. Other regulators have imposed regulations to clamp down on shadow bank lending and eliminate the P2P lending platforms in China (Hsu et al, 2020). The resulting increase in the cost of debt to the private sector has increased corporate debt default risk (Chen et al, 2020) and hit productive SMEs along with Zombie enterprises. The results of our model suggest that tightening monetary policy affects the supply of shadow bank credit even more than conventional bank credit, disproportionately hurting SMEs and the private sector more than SOEs. Microprudential policy aimed at curbing shadow bank activity hurts the SMEs while having minimal effect on the SOEs who can access funds from the banks at the risk-free rate. The combination of both policies will have a negative effect on output.

Table 4: Frequency (years) of SES arrival under different monetary regimes, assuming a 6% balanced growth path

| | Crisis Definition (size of Cumulative Loss (%)) | | |
|---|---|---|---|
| | 15-30 | 60-100 | 200+ |
| Original | 68.889 | 92.814 | 182.353 |
| Money Reform | 66.524 | 86.592 | 206.667 |
| NGDPT | 74.879 | 103.333 | 246.032 |
| PLT | 65.401 | 123.016 | 212.329 |

## 5 Conclusions

This paper presents the results of an investigation into the behaviour of the Chinese economy over the period of the recent GFC with the aid of the well-known Smets-Wouters DSGE model, as modified by Le et al. (2011, 2016b) to allow for greater heterogeneity in price/wage behaviour and including the banking/financial accelerator model of Bernanke et al. (1999). Furthermore, we have modified the Bernanke et al. (1999) model to allow for the role of money, replacing net worth as collateral with the firm's holding of cash (M0) and the cash-conversion. This allows the model to generate monetary behaviour.

The methodology of this paper distinguishes itself from the conventional approach to modelling the Chinese economy, which is to apply Bayesian methods to a DSGE framework, where priors are imposed untested on the model. Instead, we use the method of Indirect Inference under which the model is rigorously tested against the data behaviour. Here, the method of Indirect Inference is used to estimate the model using unfiltered data, allowing for non-stationary shocks. The model was not rejected by the data and a variance decomposition was conducted to establish what a typical SES generated by these shocks would be caused by. The decomposition focussed specifically on the GFC period and showed that about one-third of output variance is generated by banking (financial) shocks and over 40% sourced to productivity shocks in the SME sector.

The model also tells us that China is not exempted from the disruptive SES episodes that are regular occurrences in developed economies, and that she frequently will have as their by-product financial turmoil in the sense that the premium rises sharply. These SES will occur despite there being no extreme financial shocks such as occurred in the recent episode; so serious financial shocks are not required for SES to happen. Furthermore, extreme financial shocks on their own of the type identified in this sample do not cause SES; all they do is cause temporary recessions. Thus, both SES and financial turmoil result from non-financial shocks; naturally, financial shocks if extreme enough will add an extra layer of recession.

We build on the results of an earlier paper which found that the Chinese government's response to the GFC in the form of mandated credit provision across the economy risked generating severe excess capacity and consequent instability. In this paper we looked at alternative monetary responses to those in the prevailing regime. We found that a Friedman rule fared no better than a Taylor inflation target rule in stabilising output and avoiding recessions. However, we found that an interest rate rule with a nominal GDP target, and to a lesser extent a price level target, would have greatly stabilised the Chinese economy, reducing SES to a minimum.

The policy conclusion of this paper is that financial regulative responses to the instability of the economy, are misplaced because they cause market distortions and are also unnecessary, since monetary policy can do the job, if properly calibrated. This echoes the policy conclusion of Le et al. (2016b) for the US. In this respect, as in many others, the behaviour of the Chinese economy does not appear to be qualitatively different from that of the US economy. A simple interest rate reaction to a price level target or nominal GDP target that operates on the macro-economy is more efficient than other rules in terms of minimising the frequency of SES and is preferable to regulatory restrictions that create microeconomic distortions.

In this final conclusion, our work directly addresses the current policy of deleveraging undertaken by the Chinese authorities. We argue that shadow banking, rather than acting as an absorbing buffer against monetary shocks, augments these shocks, raising the cost of credit to SMEs and the private sector more than the state-owned sector. Consequently, policies designed to tame lending to the SMEs and the private sector through regulation have a stronger negative effect on output than an offsetting loosening of monetary policy. Our results suggest that a continuance with such a policy is likely to create more damage than good by starving the high growth areas of the Chinese economy of much needed finance.

**References**

Beckworth, D. (2014). Inflation Targeting: A monetary Policy Regime Whose Time Has Come and Gone, Memo. ***Mercatus Center George Mason University***.

Bernanke, B. S., Gertler, M., Gilchrist, S. (1999). The financial accelerator in a business cycle framework, ***Handbook of Macroeconomics***, vol. 1, edited by J.B. Taylor and M. Woodford, ch. 21, 1341–1393, Elsevier.

Boutler, J. (2018). ***China's Supply-side Structural Reform***, Reserve Bank of Australia Bulletin.

Carney, M. (2012). Guidance, Speech in front of CFA Society Toronto.

Chan, S. (2018). China's Recent Deleveraging: A Panacea for Its Financial Ills? ***East Asian Policy***, 10(2), 65–78.

Chen, K., Guo, W., Kang, Y., and Wang, J., (2020), Does deleveraging policy increase the risk of corporate debt default: Evidence from China, ***Emerging Markets, Finance, and Trade***, doi.org/10.1080/1540496X.2020.1809376

Chen, K., Ren, J., & Zha, T. (2018). The Nexus of Monetary Policy and Shadow Banking in China. ***American Economic Review***, 108(12), 3891–3936.

Christiano, L. J., Trabandt, M., & Walentin, K. (2010). DSGE Models for Monetary Policy Analysis. In ***Handbook of Monetary Economics***, pps. 285–367.

Christiano, L. J., Eichenbaum, M. S., & Trabandt, M. (2018). On DSGE Models. ***Journal of Economic Perspectives***, 32(3), 113–140.

Chow, G. (2007). ***China's Economic Transformation***. Blackwell Publishing.

Chow, G. (2011). Lessons from studying a simple macroeconometric model for China. ***Economic Letters***, 112, 233–235.

Coase, R., Wang, N. (2012). ***How China became Capitalist***, Palgrave Macmillan.

Cover, J., Pecorino, P. (2005). Price and Output Stability under Price-Level Targeting, ***Southern Economic Journal***, 72(1), 152–166.

Del Negro, M., Giannoni, M. P. and Schorfheide, F. (2015). Inflation in the Great Recession and New Keynesian Models, ***American Economic Journal: Macroeconomics***, 7(1), 168-196.

Deng, K., and Todd, W., (2016), Is the US quantitative easing more effective than China's? A second thought, ***China Economic Review***, 38, 11-23

Dib, A., Mendicino, C., Zhang, Y. (2008). Price level Targeting in a Small Open Economy with Financial Frictions: Welfare Analysis, ***Bank of Canada Working Paper*** 2009–17.

Dollar, D., Jones B. F. (2013). China: An Institutional View of an Unusual Economy. ***NBER Working Paper Series*** WP 19662.

Elliott, D. and Yan K. (2013). The Chinese Financial System: An Introduction and Overview, ***John L. Thornton China Center Monograph Series, The Brookings Institution***.

Elliott, D., Kroeber, A., Qiao, Y. (2015). Shadow Banking in China: A Primer, ***Economic Studies, The Brookings Institution***.

Fernandez-Villaverde, J, Rubio-Ramirez, J and F Schorfheide (2017), Solution and Estimation Methods for DSGE Models, In ***Handbook of Macroeconomics***, Vol 2, Edited by John B. Taylor and Harald Uhlig, North Holland.

Funke, M., Mihaylovski, P. and H. Zhu (2015). Monetary policy trans-mission in China: A DSGE model with parallel shadow banking and interest rate control, ***Bank of Finland Discussion Paper***, 9/2015.

Gao, R., Chen, C., Zeng, H. and Gong, L., (2018). Credit Constraint, Shadow Banking and Monetary Policy Transmission in China, ***Economic Research Journal***, 12, 68–82 (in Chinese).

Gourieroux, C., Monfort, A. (1995). ***Simulation Based Econometric Methods***. CORE Lectures Series, Louvain-la-Neuve.

Gourieroux, C., Monfort, A., Renault, E. (1993). Indirect Inference. ***Journal of Applied Econometrics*** 8, S85–S118.

Hatcher, M. H., Minford, P. (2013). Stabilization policy, rational expectations and price-level versus inflation targeting: S survey., Cardiff working paper E2013/14, ***Cardiff University, Cardiff Business School, Economics Section***. Also, CEPR discussion paper No 9820, ***CEPR***, London.

Hsu, S., Li, J., and Bao, H., (2020), P2P lending in China: Role and prospects for the future, ***Manchester School***, (in press) DOI: 10.1111/manc.12332

Huang Y. (2008). ***Capitalism with Chinese Characteristics: Enterpreneurship and the State***. Cambridge University Press.

Jian Z-H., Li, S., Zheng J-Y. (2010), Impact of Oil Price Shocks on China's Economy: A DSGE-based Analysis, 17th International Conference on Management Science & Engineering, Melbourne Australia.

King, R.G., Plosser, C.I. ,Rebelo, S.T. (1988). Production, growth, and business cycles: I. The basic neoclassical model, ***Journal of Monetary Economics***, 21(2-3), 195–232.

Klingelhöfer, J., and Sun, R., (2019), Macroprudential policy, central banks, and financial stability: Evidence from China, ***Journal of International Money and Finance***, 93, 19-41

Kollmann, R., Pataracchia, B., Raciborski, R., Ratto, M., Roeger, W. and Vogel, L. (2016). The post-crisis slump in the Euro Area and the US: Evidence from an estimated three-region DSGE model, ***European Economic Review,*** 88, 21-44.

Le, V.P.M., Meenagh, D., Minford, P., Wickens, M. (2011). How much nominal rigidity is there in the US economy — testing a New Keynesian model using Indirect Inference. ***Journal of Economic Dynamics and Control,*** 35(12), 2078–2104.

Le, V.P.M., Matthews, K., Meenagh, D., Minford, P., Xiao, Z., (2014). Banking and the Macroeconomy in China: A Banking Crisis Deferred? ***Open Economies Review***, 2014, 25, (1), 123–161.

Le, V.P.M., Meenagh, D., Minford, P., Wickens, M., Xu, Y., (2016a). Testing macro models by Indirect Inference: A survey for users. ***Open Economies Review***, 2016, 27, (1), 1–38.

Le, V.P.M., Meenagh, D., Minford, P. (2016b). Monetarism rides again? US monetary policy in a world of Quantitative Easing. ***Journal of International Financial Markets, Institutions and Money***, vol 44, pp. 85–102.

Le, V.P.M., Matthews, K., Meenagh, D., Minford, P., Xiao, Z., (2020), China's market economy, shadow banking and the frequency of growth slowdowns, (in press) *Manchester School* doi.org/10.1111/manc.12318

Li B and Liu Q (2017). On the choice of monetary policy rules for China: A Bayesian DSGE approach. ***China Economic Review***, 2017, 44, 166-185

Li, C. & Meng, X., (2006). China's economic fluctuation: An analysis based on the New Keynesian monopolistic competition model. ***Economic Research Journal***, 10, 72–82.

Lin, L., Cao, Y. and Xiao, H., (2016). The Fragility of Financial System under the Growing Shadow Banking System in China, ***China Economic Quarterly***, 15(3), 1113–1136 (in Chinese).

Liu, X., Hao, Y. and Tian, Y., 2014, Comparative Study on China's Monetary Policy Rules under Dual Structure of Shadow Banking and Formal Finance, ***Journal of Finance and Economics***, 29(1), 15-26, (in Chinese).

Liu, Y., 2018, From Deleverage to Stabilizing Leverage: Annual Review of Chinese Financial System, ***Twenty-first Century Economic Reports***, December 29 Issues, http://www.21jingji.com/2018/12-29/4NMDEzODBfMTQ2NDY4Ng.html (in Chinese).

Ma, Y., (2016). China's monetary and fiscal policy regime and its macroeconomic stability effects. ***China Economic Quarterly***, 15(1), 173–195.

McCallum, B.T. (1988). Robustness Properties of a Rule for Monetary Policy,

***Carnegie-Rochester Conference Series on Public Policy,*** 29: 173–204.

McCallum, B. T., Nelson, E. (1999). Nominal Income Targeting in an Open-Economy Optimising Model, ***Journal of Monetary Economics***, vol 43(3), pp. 553–578.

McCallum, B.T. (2011). Nominal GDP Targeting, ***Shadow Open Market Committee***, October 21.

Minford P, (2016). Testing Macro models for policy use: An insurrection in applied modelling, ***Manchester School***, 84(S1), 42-55

Minford, P, Theodoridis, K, Meenagh, D. (2009). Testing a model of the UK by the method of Indirect Inference. ***Open Economies Review***, 20(2), 265–291.

Nakov, A. (2008). Optimal and Simple Monetary Policy Rules with Zero Floor on the Nominal Interest Rate, ***International Journal of Central Banking***, 4(2), 73–128.

Nunes, M., Cole, B.M. (2013) ***Market Monetarism- roadmap to economic prosperity***, Kindle books, Amazon.

Pozsar, Z., Adrian, T., Ashcraft, A. and Boesky, H. (2013). Shadow Banking, ***Economic Policy Review***, 19(2), 1-16.

Qin, D., Cagas M –A., Ducanes, G., He, X., Liu, R., Liu, S., Magtibay-Ramos, N., Quising, P (2007), A Macroeconometric Model of the Chinese Economy. ***Economic Modelling***, 24, 814–822.

Qiu, X. and Zhou, Q. (2014). Shadow Banking and Monetary Policy Transmission, ***Economic Research Journal***, 5, 91–105. (in Chinese)

Shan, Q., Jinzhong, L.V., Wang, W., and Huang, N., (2020), Taylor rule construction and rule interest estimation in China, ***Journal of Financial Research***, 9, 20-39 (in Chinese).

Smets, F., Wouters, R. (2007). Shocks and Frictions in US Business Cycles: A Bayesian DSGE Approach. ***American Economic Review,*** 97, 586–606.

Sun, R., (2013). Does monetary policy matter in China? A narrative approach. ***China Economic Review***, 26, 56–74.

Smith, A., (1993). Estimating nonlinear time-series models using simulated vector autoregressions. ***Journal of Applied Econometrics,*** 8, S63–S84.

Sumner, S. (2011). The case for NGDP targeting — lessons from the Great Depression, ***Adam Smith Institute***.

Sun, X., Zhang, J., Shao, Y., Yang, X. (2009), Chinese Small-scale Quarterly Macroeconomic Model under Indirect Regulation of Monetary Policy. 2009 International Joint Conference on Computational Sciences and Optimization, IEEE Conference Publication Vol 2.

Vestin, D. (2006). Price level versus inflation targeting, ***Journal of Monetary***

***Economics***, 53, 1361–1376.

Williamson, S. (2013), Liquidity, Monetary Policy, and the Financial Crisis: A New Monetarist Approach. ***American Economic Review***, 102(6), 2570–2605.

Wolman, A.L. (2005). Real Implications of the Zero Bound on Nominal Intrest Rates, ***Journal of Money, Credit and Banking***, 37, 273–296.

Woodford, M. (2012). Methods of Policy Accommodation at the Interest Rate Lower Bound, Jackson Hole, Wyoming.

Wu, G. & Lian, F. (2016). A study on the transition of China's monetary policy: An exploration based on hybrid rules of quantity and price instruments. ***The Journal of World Economy***, 3, 3–25.

Xi, J. & He, Y. (2010). The welfare losses of China's monetary policy and the selection of intermediate target: A new Keynesian DSGE model. ***Journal of Finance and Economics***, 36(2), 89–98(in Chinese).

Xu, G. (2019). New Ideas on Deleveraging. ***China Reform***, March Issue.

Zheng, S., Storeslatten, K., Zilibotti, F. (2011). Growing Like China. ***American Economic Review***, 101(1), 196–233.

**Appendix 1: Model Listing**

Table A1: Variable definition

| Variable Name | Variable Definition |
|---|---|
| $c$ | Household consumption |
| $inn$ | Investment |
| $inn^{SOE}$ | Investment by SOEs |
| $inn^{SME}$ | Investment by SMEs |
| $qq^{SOE}$ | Tobin's Q of SOE |
| $qq^{SME}$ | Tobin's Q of SME |
| $k$ | Capital |
| $k^{SOE}$ | Capital of SOE |
| $k^{SME}$ | Capital of SME |
| $mpk^{SOE}$ | Marginal product of capital of SOE |
| $mpk^{SME}$ | Marginal product of capital of SME |
| $pW_t^{SOE}$ | Wholesale price of SOE |
| $pW_t^{SME}$ | Wholesale price of SME |
| $w$ | Real wage |
| $\pi$ | Inflation |
| $l$ | Total hours worked |
| $n^{SOE}$ | SOE labour |
| $n^{SME}$ | SME labour |
| $y$ | Output |
| $y^{SOE}$ | Output of SOEs |
| $y^{SME}$ | Output of SMEs |
| $r$ | Nominal interest rate |
| $s$ | External credit premium |
| $cy$ | Return on capital |
| $nw^{SME}$ | Net worth of SME |
| $c^e$ | SME consumption |
| $m$ | M0 |
| $M$ | M2 |
| $eg$ | Government spending |
| $eb$ | Preference shock |
| $ea^{SOE}$ | Productivity shock of SOE |
| $ea^{SME}$ | Productivity shock of SME |
| $einn^{SOE}$ | Investment shock of SOE |
| $einn^{SME}$ | Investment shock of SME |
| $epr$ | Premium shock |
| $enw$ | Net worth shock |
| $em$ | Monetary shock to the Taylor Rule |
| $errm$ | Shock to M0 |
| $ew$ | Wage mark-up shock |
| $ep$ | Price mark-up shock |
| $elab$ | Shock to labour supply |

Table A2: Fixed Parameters

| | | |
|---|---|---|
| $\delta$ | Depreciation Rate | 0.025 |
| $\beta$ | Discount Rate | 0.9948 |
| $\varphi_w - 1$ | Steady-state Labour Market Mark-up | 1.5 |
| $\varphi_p - 1$ | Share of Fixed Cost in Production | 1.5 |
| $\varepsilon_p$ | Kimball Goods Market Aggregator | 10 |
| $\varepsilon_w$ | Kimball Labour Market Aggregator | 10 |
| $\mu$ | Ratio of M0 to Credit (M2) | 0.07 |
| $\nu$ | Ratio of Net Worth to Credit (M2) | 0.25 |
| $\alpha^{SOE}$ | Share of Capital in SOE Production | 0.5 |
| $\alpha^{SME}$ | Share of Capital in SME Production | 0.5 |

Consumption Euler equation

$$c_t = \frac{\lambda}{1+\lambda} c_{t-1} + \frac{1}{1+\lambda} E_t c_{t+1} + \frac{(\sigma_c - 1)\frac{W_* L_*}{C_*}}{(1+\lambda)\sigma_c} (l_t - E_t l_{t+1}) - \left(\frac{1-\lambda}{(1+\lambda)\sigma_c}\right)(r_t - E_t \pi_{t+1}) + eb_t$$

where $\frac{W_* L_*}{C_*}$ is steady state ratio of labour income to consumption.

Labour composite

$$l_t = \frac{N^{SOE}}{N} n_t^{SOE} + \frac{N^{SME}}{N} n_t^{SME}$$

where $\frac{N^{SOE}}{N}$ and $\frac{N^{SME}}{N}$ are the steady state shares of SOE and SME labour.

SOE production function

$$y_t^{SOE} = \alpha^{SOE} k_{t-1}^{SOE} + (1 - \alpha^{SOE}) n_t^{SOE} + ea_t^{SOE}$$

SOE Labour demand

$$n_t^{SOE} = pW_t^{SOE} + y_t^{SOE} - w_t$$

SOE Tobin Q equation (capital demand in SOE sector)

$$qq_t^{SOE} = \frac{1-\delta}{1-\delta+R_*^{K,SOE}} E_t qq_{t+1}^{SOE} + \frac{R_*^{K,SOE}}{1-\delta+R_*^{K,SOE}} (y_{t+1}^{SOE} - k_t^{SOE} + pW_{t+1}^{SOE}) - (r_t - \pi_{t+1})$$

where $R_*^{K,SOE}$ is the steady state value of the return on capital for SOEs.

SOE Marginal product of capital

$$mpk_t^{SOE} = y_t^{SOE} - k_{t-1}^{SOE} + pW_t^{SOE}$$

Investment SOE Euler equation

$$inn_t^{SOE} = \frac{1}{1+\beta} inn_{t-1}^{SOE} + \frac{\beta}{1+\beta} E_t inn_{t+1}^{SOE} + \frac{1}{(1+\beta)\phi} qq_t^{SOE} + einn_t^{SOE}$$

SOE Capital Accumulation equation

$$k_t^{SOE} = (1-\delta)k_{t-1}^{SOE} + \delta inn_t^{SOE} + \delta(1+\beta)\phi(einn_t^{SOE})$$

SME production function

$$y_t^{SME} = \alpha^{SME} k_{t-1}^{SME} + (1-\alpha^{SME})n_t^{SME} + ea_t^{SME}$$

SME Labour demand

$$n_t^{SME} = pW_t^{SME} + y_t^{SME} - w_t$$

SME Tobin Q equation (capital demand in SME sector)

$$\begin{aligned} qq_t^{SME} = {} & \frac{1-\delta}{1-\delta+R_*^{K,SME}} E_t qq_{t+1}^{SME} \\ & + \frac{R_*^{K,SME}}{1-\delta+R_*^{K,SME}} (y_{t+1}^{SME} - k_t^{SME} + pW_{t+1}^{SME}) \\ & - (r_t - \pi_{t+1} + s_t) \end{aligned}$$

where $R_*^{K,SME}$ is the steady state value of the return on capital for SMEs.

SME Marginal product of capital

$$mpk_t^{SME} = y_t^{SME} - k_{t-1}^{SME} + pW_t^{SME}$$

Investment SME Euler equation

$$inn_t^{SME} = \frac{1}{1+\beta} inn_{t-1}^{SME} + \frac{\beta}{1+\beta} E_t inn_{t+1}^{SME} + \frac{1}{(1+\beta)\phi} qq_t^{SME} + einn_t^{SME}$$

SME Capital Accumulation equation

$$k_t^{SME} = (1-\delta)k_{t-1}^{SME} + \delta inn_t^{SME} + \delta(1+\beta)\phi(einn_t^{SME})$$

Investment composite

$$inn_t = \frac{INV^{SOE}}{INV} inn_t^{SOE} + \frac{INV^{SME}}{INV} inn_t^{SME}$$

where $\frac{INV^{SOE}}{INV}$ and $\frac{INV^{SME}}{INV}$ are the steady state shares of SOE and SME investment.

Premium

$$s_t = E_t cy_{t+1} - (r_t - E_t\pi_{t+1}) = \chi(qq_t^{SME} + k_t^{SME} - nw_t^{SME}) - \psi_s m_t + epr_t$$

Net worth

$$nw_t^{SME} = \frac{K^{SME}}{NW^{SME}}(cy_t - E_{t-1}cy_t) + E_{t-1}cy_t + \theta nw_{t-1}^{SME} + enw_t$$

SME consumption

$$c_t^e = nw_t^{SME}$$

Monetary policy

$$r_t = \rho r_{t-1} + (1-\rho)\left(\rho_\pi \pi_t + \rho_y y_t + \rho_{\Delta y}(y_t - y_{t-1})\right) + em_t$$

M0

$$\Delta m_t = \psi_m \Delta M_t + errm_{2t}$$

M2

$$M_t = (1 + \nu - \mu)k_t + \mu m_t - \nu nw_t^{SME}$$

Wage setting equation

$$w_t = \omega_w \begin{bmatrix} \frac{\beta}{1+\beta}E_t w_{t+1} + \frac{1}{1+\beta}w_{t-1} + \frac{\beta}{1+\beta}E_t\pi_{t+1} - \frac{1+\beta\iota_w}{1+\beta}\pi_t \\ + \frac{\iota_w}{1+\beta}\pi_{t-1} - \frac{1}{1+\beta}\left(\frac{(1-\beta\xi_w)(1-\xi_w)}{\left(1+\varepsilon_w(\varphi_w - 1)\right)\xi_w}\right) \\ \left(w_t - \sigma_l l_t - \left(\frac{1}{1-\lambda}\right)(c_t - \lambda c_{t-1})\right) + ew_t \end{bmatrix} + (1-\omega_w)(y_t - l_t)$$

Final Price setting equation

$$\pi_t = \omega_\pi \left[\frac{\beta}{1+\beta\iota_p}E_t\pi_{t+1} - \frac{\iota_P}{1+\beta\iota_p}\pi_{t-1} + \left(\frac{1}{1+\beta\iota_p}\right)\left(\frac{(1-\beta\xi_p)(1-\xi_p)}{\xi_p\left((\varphi_p - 1)\varepsilon_p + 1\right)}\right)\left(\frac{Y^{SME}}{Y}pW_t^{SME} + \frac{Y^{SOE}}{Y}pW_t^{SOE}\right) + ep_t\right] + (1-\omega_\pi)\left[E_{t-1}\pi_t + \sigma_l l_t + \left(\frac{1}{1-\lambda}\right)(c_t - \lambda c_{t-1}) + elabs_t\right]$$

where $\frac{Y^{SME}}{Y}$ and $\frac{Y^{SOE}}{Y}$ are the steady state shares of SOE and SME output.

Market Clearing condition in goods market

$$y_t = \frac{C}{Y}c_t + \frac{I}{Y}inn_t + c_y^e c_t^e + eg_t$$

where $\frac{C}{Y}$ is the steady state consumption to output ratio, $\frac{I}{Y}$ is the steady state investment to output ratio, and $c_y^e$ is the consumption to output ratio of the SME.

Final Output

$$y_t = \frac{Y^{SOE}}{Y}y_t^{SOE} + \frac{Y^{SME}}{Y}y_t^{SME}$$

Demand for output from SOE

$$y_t^{SOE} = -\varepsilon \times pW_t^{SOE} + y_t$$

Demand for output from SME

$$y_t^{SME} = -\varepsilon \times pW_t^{SME} + y_t$$

**Appendix 2: Data Description and Source**

| Variable | Description | Source |
|---|---|---|
| Consumption | Household Final Consumption Expenditure | National Bureau of Statistics of China |
| GDP | Gross Domestic Product | OECD Quarterly National Accounts |
| Labour | Employment | Oxford Economics |
| CPI | Consumer Price Index | OECD Economic Outlook |
| Wages | Average Overall Wages for Staff and Workers in Urban Units | Ministry of Human Resources and Social Security, China |
| Interest Rate | Discount Rate | IMF – International Financial Statistics |
| Lending Rate | Lending Rate | IMF – International Financial Statistics |
| Net Worth | Shanghai Stock Exchange Stock Market Capitalisation | Shanghai Stock Exchange |
| M0 | Money Supply M0 | The People's Bank of China |
| Total Credit | Credit to Private Non-Financial Sector | Bank for International Settlements |
| Shadow Credit | Shadow Banking Credit | Goldman Sachs and Moody's |
| M2 | Total Credit + Shadow Credit | |
| Total Investment | Total Investment | National Bureau of Statistics China |
| Private Investment | Private Fixed Investment | National Bureau of Statistics China |
| Population | Population | World Bank |