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A financial CGE model analysis: Oil price shocks and monetary policy responses in China

Jing-Yu Liu [a], Shih-Mo Lin [b], Yan Xia [a,*], Ying Fan [a], Jie Wu [a]

[a] Center for Energy and Environmental Policy Research, Institute of Policy and Management, Chinese Academy of Sciences, Beijing, China
[b] Department of International Business and Center for Applied Economic Modeling, Chung Yuan Christian University, Taiwan

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ABSTRACT

Most CGE models are real and cannot be easily used to study monetary policies. This paper develops a financial CGE model with interaction between real and financial side of the Chinese economy and applies the model to study oil price shocks and monetary policy responses. Unlike macro models in the current literature, the financial CGE model can be implemented to look into industrial details of effects of oil shocks, the responding interest rate and reserve ratio policy. We then identify the optimal monetary policies aiming at each inflation target. We found that when tolerance for inflation is high, it is best to implement interest rate policy alone. On the other hand, when tolerance for inflation is low and the government is more focused on social stability and household welfare, reserve ratio policy should also be implemented in addition to interest rate policy. In a scenario where world oil price increases by 100% and the inflation rate is to be targeted at below 2%, the monetary authority should raise the interest rate and reserve ratio by 2.5 percentage points and 3.0 percentage points, respectively.

1. Introduction

Most CGE models are real and cannot be easily used to study monetary policies. This paper develops a financial CGE model with financial flows, interest rates, monetary aggregates and other financial variables. We apply the model to study oil price shocks and monetary policy responses.

Crude oil is the essential energy to most economic activities. Both the production of goods and the provision of services involve a substantial use of oil in their day-to-day operations. Consequently, shocks resulting from a sudden rise in oil prices or an unexpected shortage of oil supply will bring significant negative effects to the economy. In fact, a large number of studies have reported that most sudden and lasting oil price increases have been accompanied by economic recessions and high inflation (e.g., Brown and Yücel, 2002).

The most recent oil price shock occurred in 2007–2008, where it reached a record high of over $140 per barrel. Countries all over the world suffered from such a sharp price increase. Despite being a fast-growing economy, China is not immune to this shock. During this period, its economic growth rate declined and inflation increased. This drew the attention of the Chinese government. A sequence of policy actions followed, including its immediate monetary actions and follow-up fiscal stimulations.

Oil price hikes will almost always transmit to the prices of downstream industry and final consumption goods. Inflationary forces result to an increased transactions demand for money. Monetary authorities would have to infuse money to the economy to meet this sudden increase in demand. However, monetary authorities can not deviate from their overarching mission, which is to cope with interfering factors of economic activities and to offset price fluctuations. As a result, they will inevitably face a dilemma of implementing policy measures that might have differential effects on inflation and economic growth.

During a period of sharp rise in oil price, commodity prices tend to increase across the board. Household real income decreases and household welfare suffers. The effects of unequal wealth distribution are magnified. If inflation goes up and wages are adjusted accordingly, spiraling inflation occurs and the economic condition exacerbates. Price volatility adds to the uncertainty and raises the risks. If borrowing is easy or if borrowing cost is low, it might further encourage blind expansions of production, making the operation of economic activities even more risky.

On the other hand, if inflation caused by oil shocks is addressed with tightened monetary policies, it is likely that consumption, investment and exports will slow down simultaneously. Tightened domestic liquidity might stimulate foreign capital inflows and affect the equilibrium of balance of payments. In the case of China, as the managed floating exchange rate system has been adopted for Renminbi (RMB), foreign capital inflows might not help the tightening of liquidity, but to offset some anti-inflation effects of monetary policies. Therefore, we can conclude that in the short to medium term, contractionary monetary policies aimed at fighting inflation might actually contradict the three other goals of monetary authority: economic growth, high employment and

* Corresponding author at: Institute of Policy and Management, Chinese Academy of Sciences, 15 Zhongguancun Beiyitiao, 100190 Beijing, China. Tel.: +86 10 59358809.
E-mail address: xiayan@casipm.ac.cn (Y. Xia).

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equilibrium of balance of payments. Thus, in the face of oil shocks, it is urgent for policymakers to be prepared in making optimal choices to balance these different goals.

The possible causal relations between oil shocks and monetary policies have been researched for decades. Recently, Krichene (2006) found a two-way relationship between oil prices and interest rates. Aastveit (2013) found that the central bank usually reacts differently to demand and supply shocks. Ali Ahmed and Wadud (2011) studied the relation among volatility of oil prices, monetary policies and the macro economy for Malaysia. The cause of economic recessions after oil shocks is another interesting topic that has attracted a great deal of research. These studies normally distinguish between the effects of the oil shock itself and that of the monetary policies responding to the oil shock. (Leduc and Sill, 2004, 2007; Lee and Song, 2009; Lee et al., 2001; Medina and Soto, 2005; Rahman and Serletis, 2010) With regard to the target of monetary policy, Kamps and Pierdzioch (2002) claimed that it is essential to distinguish between alternative price indices. Carlstrom and Fuerst (2006) compared several monetary policies in trading-off output and inflation. Montoro (2010) thought partially stabilizing the effects of oil price shocks on inflation is necessary. Kormilitsina (2011) asserted that the optimal policy during the oil price shock would be to raise inflation and interest rates above those in the past. The above-mentioned studies have largely relied on two major research tools: VAR (Vector Autoregressive) and extended VAR models (Aastveit, 2013; Ali Ahmed and Wadud, 2011; Lee et al., 2001; Rahman and Serletis, 2010), and general equilibrium models, especially DSGE (Dynamic Stochastic General Equilibrium) models which take New Keynes as the core.

Most of current studies used interest rates to depict the relative tightness of monetary policy. The authors left little room for discussing the reserve ratio policies. They also failed to provide clear and quantitative recommendations for policy makers. Financial CGE models could be used to discuss impacts of oil shocks in more detail, together with monetary policies, at the industry level. Also, financial CGE models can describe the transmission channels of macro policies into industry productivity at length. These cannot be easily done with a VAR model or DSGE model. There have been CGE models with financial channels since the 1980s (Bourguignon et al., 1989, 1991; Easterly, 1990; Rosensweig and Taylor, 1990; Lewis, 1992; Yeldan, 1997; Thissen and Lensink, 2001; Mansury, 2002; Naastepad, 2002; Khan, 2007). However, none of the above has examined the role that monetary policy plays in responding to oil shocks.

This study attempts to fill the above voids. We build a financial CGE model with financial variables to investigate the trade-off monetary policy choices that the central bank faces during sharp rises in oil price. We also provides quantitative interest rate and reserve ratio policy package recommendations aiming at different inflation targets. We perform counterfactual simulations of tightened monetary policies after an oil shock, and examine their effects on the macro economy and production at the industry level. We examine the effects on economic activities of packages of tightening interest and reserve ratio policy. For each anti-inflation initiative, we aim to find out the monetary policy package that yields the optimum macroeconomic indicators.

2. The financial CGE model of China

2.1. The data

The basic data sets of the financial CGE model are financial social accounting matrix (FSAM) with financial sectors of China. Accounts in our FSAM are: 42 production sectors,[1] current accounts of institutions, financial accounts of the same institutions, commercial bank, central bank, and financial asset accounts (deposit, loan, enterprise bond, government bond, foreign asset, FDI, foreign lending, etc.). The schematic FSAM and the aggregate data are shown as Table 1.

This paper uses the data for China in 2007 for calibration. The data in accounts 1 to 16 use data obtained from the Chinese real SAM of 2007. The accounts from 11 to 17 represent new debts or new assets of institutions, where the consistency between real and financial accounts is maintained. Data in accounts 11 to 17 is obtained from flow of fund table and balance sheet of 2007 from the Central Bank of China, along with a balance of payments table.

2.2. Key features of the model

The specification of the real side of the model follows that of the standard CGE model developed by IFPRI in 2002. Readers can refer to Löfgren et al. (2002) for a detailed description of the model specification. And we make some modification on the production function. Besides labor and capital, we also consider four kinds of energy (crude oil, petroleum, coal and electricity) as input factors. Since the substitution effect may be significant during an oil shock, we take into account the finite substitutions among different kinds of energy, as well as among energy and other input factors.

Fig. 1 demonstrates the Schematic diagram of the financial CGE model. The modeling of financial sectors in our model is described briefly as follows. We will focus on the major functioning of institutions, including income and expenditure functions of institutions where financial investment and financing are considered, while the list of equations and variable definitions are provided in Appendix A and B, respectively.

Financial decisions of institutions (i.e., household, enterprises, government, ROW) include real investment, financial investment, financing decisions, and so on. Household's rate of saving is positively correlated to real interest rate. The higher the real interest rate, the lower the household consumption saving ratio will be. Household saving plus household loan equals household total investment. Household loan is assumed to be directly proportional to household saving. Household investment includes real investment and financial investment on money, deposit, and bond. The ratio of real investment and financial investment in the household sector is set to be a function of average yield rate of financial investment. The higher the yields, the less the household invests in real economy. The amount of currency household is holding is decided in a money demand function, where money demand is directly proportional to nominal GDP, but inversely proportional to real interest rate. Deposit share to the sum of deposit and bond depends on the relative interest rates between deposit and bond. Raising the deposit rate of commercial bank, household will invest more in deposit instead of in bonds.

Enterprise uses its retained earnings to invest in real economy, apart from a certain amount of working capital in the form of deposit in commercial banks. Investment demand of each industry is decided by capital cost and profit rate of investment. Investment is comprised of public investment from government and private investment from household and enterprise. If public investment increases, private investment would be crowded out. Disposable capital of enterprise is not always enough to meet the demand for real investment. So enterprise explores every means to borrow money. We have four ways of financing in the model: loan from commercial banks, issuing bonds, borrowing from foreign countries or seeking FDI. FDI is a fixed share of enterprise investment. The share variable of enterprise loan to the total three means of financing (loan, foreign borrowing and bond) depends on the relative interest rate of loan and the other two means. Foreign borrowing share to the sum of foreign borrowing and enterprise bond depends on the relative interest rate of these two assets. In our model specifications, due to the equilibrium of balance sheet of commercial bank, a correlation exists between loan and deposit. It means that the amount of loan from commercial bank depends on the deposit it gathered. So

[1] For display convenience, we demonstrate 15 aggregate industries, which are agriculture, coal, crude oil, paper, petroleum, chemicals, cement, metal smelting, construction, traffic, light industries, mining, heavy industries and service.