

Fiscal Multipliers in China

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Nan Jiang

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Adviser: ChaeWon Baek

Abstract

This paper studies the effect of government spending in China. First, I use province-level national defense spending as a source of exogenous variation in government spending to analyze the output multiplier of China. The “local multiplier” is estimated to be 0.43: output increases by 0.43% in response to a 1% increase in province-level government spending. To relate this to aggregate multipliers, I use an open-economy model calibrated to the Chinese economy. The corresponding aggregate multipliers vary by different tax policies from 0.19 to 0.36 with the Neoclassical model with separable preferences. If the spending is financed by an increase in distortionary taxes in such a way as to maintain a balanced budget period-by-period (as opposed to by lump-sum taxes), the aggregate multiplier falls from 0.36 to 0.19.

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1 Introduction

It is difficult to exaggerate the need for researchers and policymakers to understand the payoff of countercyclical fiscal policies. This is mostly because these fiscal packages are expensive. For instance, in 2010, China announced a 4 trillion RMB (\$586 billion) stimulus package as an attempt to minimize the impact of the Global Financial Crisis, which is nearly 10% of China's GDP in that year. Around the same time, the United States also carried out the same scale of stimulus package called the American Recovery and Reinvestment Act (ARRA) whose total budget is \$840 billion. One apparent question arising here is whether government spending behavior in China is carefully chosen and efficient as in Western countries. Deng et al. (2011) point out that a significant fraction of the 4 trillion stimulus package went to the Chinese housing market and fueled a new housing bubble. To compare the payoff of different stimulus packages, one common measurement is to estimate the effect of government spending on output, which is often summarized by the fiscal multiplier. The goal of my thesis aims to provide the estimation of the fiscal multipliers as a reference to guide policymakers in China.

The question of the effectiveness of fiscal policies has received substantial empirical attention and has been analyzed mostly along two fronts. The first strand of the studies estimates the effect of fiscal shocks on output using time series data at the aggregate level. The results estimated from this approach are often called "Aggregate Multipliers". The advantage of the first approach is that it captures the potential spillover effects and the results can be interpreted directly as consequences of fiscal shocks. The first challenge faced by this approach is that those stimulus packages take place during times of economic distress. To address the potential reverse causality, researchers must identify the exogenous component of the variation in fiscal expenditure. The second challenge comes from policy variables that coincide with or respond to changes in the researcher's measure of fiscal policy, such as monetary policy and other fiscal spending. Another challenge is that the existence of expectations can complicate identification. For instance, when fiscal plans are announced ahead of time, eco-

conomic agents may respond to the news before the actual implementation, making it harder to disentangle the effects of the policy from pre-existing expectations. Thus, the estimated fiscal multiplier from this approach gives the average effect over the behavior of current and future monetary policy and taxes. The results may only serve as a weak reference to guide policymakers under alternative monetary or fiscal regimes.

The second approach is to exploit the cross-sectional variation in government spending to estimate the effect of provincial fiscal policies on local output. This relative effect is often summarized as “Local Multipliers”. One benefit of the second approach is that the inclusion of the time-fixed effects removes the concern that the fiscal policies will be adjusted in response to the recession at the national level. Researchers only need to examine the exogenous source of variation in fiscal spending across regions. Another benefit is that by looking at the regional data, the number of observations can be increased significantly. Consequently, the cross-sectional approach provides a larger scope to construct a statistically strong and conceptually credible instrument. However, the second approach creates opportunities as well as challenges at the same time. One potential challenge is that it informs the policymakers about the “relative” effects of the fiscal policy across the region, but not its aggregate effects.

In my thesis, I adopt the cross-sectional approach to estimate the local fiscal multiplier in China and try to overcome its hurdles. First, I construct a province-level fiscal spending data set in China from 1999 to 2020 and combine it with the corresponding output data. The main concern faced by the cross-sectional approach is that the stimulus package is targeted directly at the areas that are most hit by the recession. Following Nakamura and Steinsson (2014), I resolve this concern by using province-level national defense spending as a source of exogenous variation in government spending to estimate the output multiplier. My identification strategy is based on the fact that defense spending is plausibly exogenous with respect to a nation’s business cycle. In large part, this is because the adjustment of national defense spending is likely driven by international geopolitical factors, rather than local economic conditions. Through cross-sectional analysis, I found that for every 1%

increase in provincial government spending, there is a 0.43% increase in the local output – in other words, the “local multiplier” is 0.43.

My estimate of the local fiscal multiplier is in the range of what previous studies have found using Chinese data or developing countries’ data. For instance, Guo, Liu, and G. Ma (2016) study the effect of earmarked transfers to low-income counties and obtain a county-level multiplier of about 0.6. Similarly, using firm-level data during the 2008–2009 stimulus period, Cong et al. (2019) estimate that a 1 percent increase in credit to firms translates into a 0.3 percent increase in employment. Kraay (2012) employs World Bank project-level disbursement data in a sample of 29 low-income countries and obtains a nation-level fiscal multiplier of 0.5. Ilzetki, Mendoza, and Végh (2013) assemble quarterly data for a sample of 20 developed and 24 developing countries, implement standard VAR-based identification strategies, and also find that the response of output to increases in government consumption is larger in developed than in developing countries.

My estimate is, however, significantly lower than most studies found in the U.S. Nakamura and Steinsson (2014) estimate a multiplier in the range of 1.0–1.4 for military spending in the United States. Serrato and Wingender (2016) estimate a multiplier in the range of 1.7–2 based on federal expenditure reallocations associated with population changes across U.S. counties. Dupor and Guerrero (2021) regress state income growth on own-state spending growth driven by unanticipated shocks to aggregate Medicare spending and report multipliers of about 1.3 in the US. The present study further suggests that the fiscal policy-output nexus in China or in other developing countries is smaller than the ones in the U.S. This may be due to the fact that developing countries often have less developed financial markets, which limits the ability of households and businesses to borrow and invest. As a result, increased government spending may not lead to a significant increase in private-sector spending and investment. The present study further suggests that the fiscal policy-output nexus in China or in other developing countries is smaller than the ones in the U.S. This may be due to the fact that developing countries often have less developed financial markets, which limits the

ability of households and businesses to borrow and invest. As a result, increased government spending may not lead to a significant increase in private-sector spending and investment.

Finally, to relate my results to aggregate multipliers, I develop an open-economy New Keynesian model and calibrated it to the Chinese economy. My work, therefore, bridges the gap between the empirical study and theoretical framework in the context of China. Chen, Ratnovski, and Tsai (2021) and Guo, Liu, and G. Ma (2016) only provide an empirical approach to investigating the local multipliers but ignore general equilibrium effects. In contrast to these two studies, I estimate local multipliers using regional-level data and use a structural model to interpret my cross-sectional estimates and examine how they could be different from aggregate multipliers. To achieve this, I closely follow Nakamura and Steinsson (2014).

Local and aggregate fiscal multipliers can be different. First, this is because of spillovers across states. Sources of spillovers might include movements in factors of production or trade in goods, among others. As an example, if government purchases in state X increase the income of state X residents, who in turn import more goods from state Y, then the local multiplier will be a downward-biased estimate of the aggregate multiplier because of a positive spillover. Second, the regional analysis holds constant the reaction of variables that vary at the national level such as common monetary and fiscal policies. In practice, however, changes in government spending entail endogenous responses to tax policies and/or monetary policies, which in turn affects the output.

Therefore, in my model, I consider several different specifications for aggregate monetary and tax policy following Nakamura and Steinsson (2014). Based on this, I first find that the aggregate multiplier is sensitive to the specification of nominal rigidity and monetary policy. This implies that difference in the response of the real interest rate to government spending shocks—caused by a difference in the flexibility of prices—explains the difference in the multiplier across these models. Second, on the contrary, the local fiscal multiplier is completely insensitive to aggregate monetary or tax policy. This is because I “difference out”

aggregate shocks and aggregate policy by including time-fixed effects in the regression. The New Keynesian model yields a local fiscal multiplier of roughly 0.95. This lies far above my empirical estimate of 0.43. However, I was able to generate the local fiscal multiplier of 0.49, similar to my empirical estimates, from the Neoclassical model with separate preferences. Therefore, based on the Neoclassical model, I examine how aggregate multipliers can be different from local fiscal multipliers. My model generates that the corresponding aggregate multiplier varies from 0.19 to 0.36 depending on tax policies. For example, when government spending is financed by an increase in distortionary taxes in such a way as to maintain a balanced budget period-by-period (as opposed to by lump-sum taxes), the aggregate multiplier falls from 0.36 to 0.19.

However, Sun (2011) shows that the degree of price rigidity in China is similar to that in the U.S., which makes the New Keynesian Model the ideal candidate for this study. The failure to reconcile my empirical finding using the New Keynesian Model may be due to the following reasons. First, as suggested in Nakamura and Steinsson (2014), I need to consider different types of preferences like the utility function adopted from Greenwood, Hercowitz, and Huffman (1988). I refer to this utility function as representing GHH preferences. Consumption and labor are complements for households with GHH preferences. Recently, Monacelli and Perotti (2008), Bilbiie (2011), and Hall (2009) have emphasized the implications of consumption-labor complementarities for the government spending multiplier. Second, I need to consider different strategies of calibration in order to match my empirical findings. Lastly, as mentioned in Dupor and Guerrero (2021), I may need to combine heterogeneous agents and a New Keynesian framework. I leave all these experiments to my future work.

The rest of the paper is structured as follows. Section 2 describes the data. Section 3 discusses the empirical analysis. Section 4 set up the model and Section 5 presents the model results. Finally, I present conclusions in Section 6.

Table 1: Data Sources

Variable	Source
GDP	National Bureau of Statistics of China
Government Spending	National Bureau of Statistics of China
Population	National Bureau of Statistics of China
Consumption	National Bureau of Statistics of China
GDP Deflator	World Bank

Note: This table list the source of each variable used for my empirical analysis in Section 3

2 Data

This study employs yearly cross-regional variation in government spending, output, and consumption from China. My source for the panel data set in this study is the electronic database of the National Bureau of Statistics of China. The Bureau published the total fiscal expenditure of each province since 1949 but not its subcategories. After 1999, the data on the components of the total fiscal spending became available, and the components were classified by function, such as education, public welfare, hospitals, health, and transportation. These data are for the province government fiscal year. In order to identify the exogenous component in government spending across provinces, this study uses the data on government spending from 1999 to 2020 in 31 provinces in China. My empirical strategy is related to recent studies that use subnational data to analyze the output effects of fiscal expenditure (Ramey and Shapiro, 1998; Nakamura and Steinsson, 2014; Acconcia, Corsetti, and Simonelli, 2014; Chen, Ratnovski, and Tsai, 2021; Guo, Liu, and G. Ma, 2016). My measure of province output is the GDP by province, which is available since 1949. I use the data on province-level total retail sales of consumer goods as an index for the total consumption in each province, which is also available for the studied period. I obtain the data on the GDP deflator in China from the World Bank in order to transform the nominal values into real values. I also use the total population by the province to generate per capita terms.

3 Estimates of the Local Fiscal Multiplier

3.1 Empirical Specification and Identification

To estimate the effect of local government spending on output, I use the following specification at the province level:

$$\frac{Y_{it} - Y_{it-2}}{Y_{it-2}} = \alpha_i + \gamma_t + \beta \frac{G_{it} - G_{it-2}}{G_{it-2}} + \epsilon_{it} \quad (1)$$

where Y_{it} is per capita output in province i in year t , G_{it} is per capita government spending in province i in year t , and α_i and γ_t represent province and year fixed effects. The inclusion of province-fixed effects allows me to control for the province-specific time trends in output and government spending. The time-fixed effects remove the concern of endogenous fiscal response at the national level. For example, time-fixed effects absorb any monetary response or changes in other fiscal variables. Therefore, I only need to find out the exogenous variation in government spending across provinces to identify the effect of government spending on output. All variables in the regression are measured in per capita terms, and are “realized” using the GDP deflator from World Bank. I regress the two-year changes in output on two-year changes in government spending, to account for the dynamics between government spending and output. I use annual panel data on province output and fiscal expenditure from 1999 to 2020 and cluster the standard errors at the province level. The coefficient of interest here is β in equation (1), which I refer to as the “local fiscal multiplier”.

A common challenge to identifying the effect of government spending on output is that fiscal expenditure is likely to be endogenous. Similarly, in my case, it is possible that government spending increases more in those areas that were hit harder during the recession. To address this endogeneity, I need to identify the exogenous component of government spending that is not correlated to the local business cycle. Therefore, I use an instrument approach to estimate equation (1). Among all the components of total government spending, National

Defense spending seems to be the most promising candidate for my instrument. Following Nakamura and Steinsson (2014), I use province-level national defense spending as a source of exogenous variation in government spending to analyze the output multiplier of China. There is a particularly powerful argument for using a nation’s defense spending as a source of exogenous variation in government spending. Defense spending is plausibly exogenous with respect to a nation’s business cycle because it is more likely driven by international geopolitical factors, rather than an endogenous counter-cyclical stimulus policy. The case is also valid in China. The left panel in Figure 1 plots the one-year change in the ratio of the national defense spending relative to the total government spending for Fujian and Henan from 1999 to 2020. The right panel in Figure 1 shows the corresponding one-year change in GDP for two provinces during the same time period. By combining the information from the graphs, “changes” in defense spending in these two regions are not very correlated with their economic conditions. This study uses this variation in national defense spending relative to the total government spending across geographic locations to identify the effect of government shocks on output. My identifying assumption is that the variation in national military spending is exogenous to the local business cycle. Therefore, my empirical method for estimating equation (1) is to instrument for province total government spending using province national spending. The “first stage” in the two-stage least squares interpretation of this procedure is to regress changes in province total spending on changes in province national spending and fixed effects.

I estimate the effects of government spending on consumption using an analogous approach. For consumption, the regression is analogous to equation (1) except that the left-hand-side variable is $(C_{it} - C_{it-2})/C_{it-2}$, where C_{it} is the per capita consumption in province i and year t .

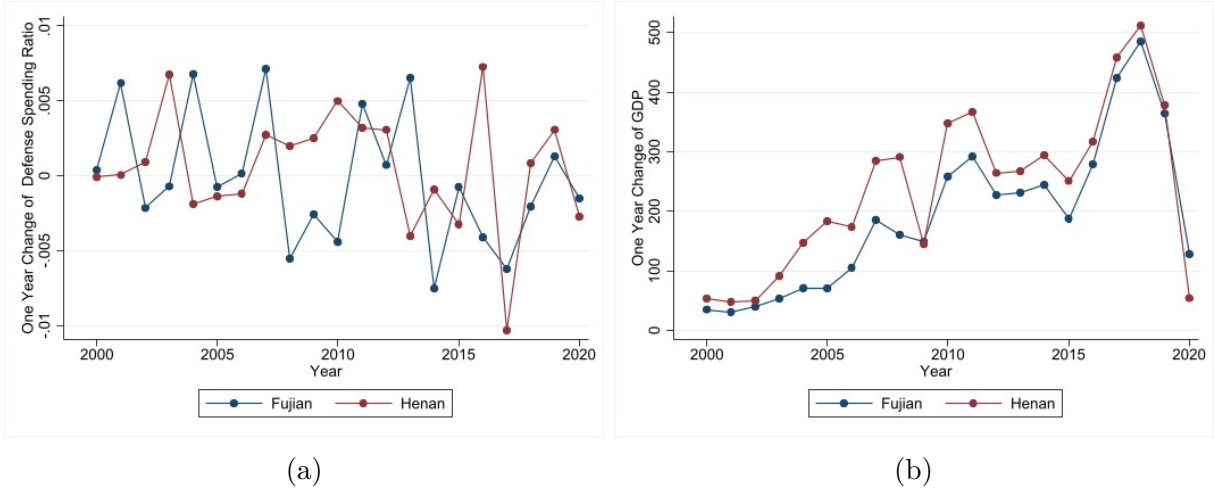


Figure 1: One-Year Change in Defence Spending Ratio and GDP in Fujian and Henan

Note: The left panel in Figure 1 plots the one-year change in the ratio of the national defense spending relative to the total government spending for Fujian and Henan from 1999 to 2020. The right panel in Figure 1 shows the corresponding one-year change in GDP for two provinces during the same time period. The source of the data is from the National Bureau of Statistics of China

3.2 The Effect of Government Spending Shocks

The first row of Table 2 reports the fiscal multiplier β in regression (1) for my instrument approach. Standard errors are in parentheses and are clustered by province. The point estimate of β for output regression is 0.43, which is significant at 5% level. It can be interpreted as output increases by 0.43% in response to a 1% increase in province-level government spending. The local fiscal multipliers I estimate are smaller than those found in most previous studies using the US data. For example, Nakamura and Steinsson (2014), Acconcia, Corsetti, and Simonelli (2014), and Suárez Serrato and Wingender (2016) have estimated local fiscal multipliers of well above 1.5 based on sub-national data in the US. The current estimates, by contrast, are in line with other estimates that used either Chinese data or other developing countries' data. Kraay (2012) identifies nation-level fiscal multipliers of approximately 0.5 using a panel of 29 developing countries. Guo, Liu, and G. Ma (2016), more related to the context of China, study the effect of earmarked transfers to low-income counties and obtain a county-level multiplier of about 0.6 in China.

The point estimate of β for consumption regression is -0.41. Although it is not statis-

tically significant, the negative effect of government spending on consumption aligns with the study of Ramey and Shapiro (1998), which finds that exogenous increases in defense spending decrease private consumption. In the Neoclassical model with a constant money supply, prices immediately jump up and begin falling. This implies that the real interest rate rises on impact (because prices are falling) and crowds out private spending. Similarly, a stylized New Keynesian Model may also generate a negative consumption response to government spending shocks. For concreteness, consider a transitory positive shock to government spending in one province. Compared with other provinces, the fiscal shock in this province leads to an immediate rise in relative prices and expectations of further increases in the short term. This lowers the relative short-term real interest rate. However, since a transitory shock to spending does not lead to a permanent change in relative prices and the exchange rate is fixed within the monetary union, any short-term increase in prices in one region relative to the other region must be undone by a fall in relative prices in that region later on. In fact, after their initial jump, relative prices are anticipated to fall more in the long run than they are anticipated to rise further in the short run. This implies that the relative long-term real interest rate actually rises slightly in the province where the positive government spending shock takes place. Despite the short-run fall in the real interest rate, the relative consumption falls. This is because households anticipate high real rates in the future—equivalently, they face a high current long-term real interest rate—and therefore cut their consumption.

4 Model

In this section, following Nakamura and Steinsson (2014), I use a framework to help to interpret the “local fiscal multiplier” that I estimate in Section 4 and relate it to the “aggregate multiplier”. I then use the parameter values from the study of Y. Ma and Li (2015) and calibrate the model to the Chinese economy. The local fiscal multiplier only informs the

Table 2: The Effect of Government Spending Shocks

	Output	Consumption
Government Spending	0.426** (0.192)	-0.414 (0.287)
Province F.E.	Yes	Yes
Year F.E.	Yes	Yes
Observations	620	620
First-Stage F-stat	23.56	23.56

Note: This table reports results from estimating the equation (1) with different dependent variables. The dependent variable in the second column is the two-year change in province-level GDP in per capita term. The dependent variable in the third column is the two-year change in province-level consumption in per capita term. The last row includes the F statistics in the first stage of my two-stage least square estimation. The standard errors are given in parentheses. One, two, and three stars denote significance at the 10%, 5%, and 1% levels, respectively.

”relative” effect of government shocks on output, which describes that if one region in a currency union faces an exogenous fiscal shock, how much will the output in this region respond compared to other regions in the same union? However, the aggregate multiplier can be different from the local fiscal multiplier. This is because of spillovers across regions. Sources of spillovers might include movements in factors of production, trade in goods, common monetary policy, or common fiscal policy, among others. As an example, if government purchases in state X increase the income of state X residents, who in turn import more goods from state Y, then the local multiplier will be a downward-biased estimate of the aggregate multiplier because of a positive spillover. In addition, the central bank cannot raise interest rates in some provinces relative to others, and national tax policy is common across provinces in the union. Therefore, the aggregate fiscal multiplier could be different from the local fiscal multiplier.

The model consists of two regions that belong to a monetary and fiscal union. I refer to the regions as “home” and “foreign.” Think of the home region as the region in which the

government spending shock occurs—a province in China or a small group of provinces—and the foreign region as the rest of the economy. The population of the entire economy is normalized to one. The population of the home region is denoted by n . Household preferences, market structure, and firm behavior take the same form in both regions. Below, I describe the economy of the home region.

4.1 Households

The home region has a continuum of household types indexed by x . A household's type indicates the type of labor supplied by that household. Home households of type x seek to maximize their utility given by

$$E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{1-\sigma^{-1}}}{1-\sigma^{-1}} - \chi \frac{L_t(x)^{1+v^{-1}}}{1+v^{-1}} \right) \quad (2)$$

where β denotes the household's subjective discount factor, C_t denotes household consumption of a composite consumption good, v denotes the Frisch-elasticity of labor supply, and σ denotes the Inter-temporal elasticity of substitution, $L_t(x)$ denotes household supply of differentiated labor input x . In this utility specification, consumption and labor enter separably. They are therefore neither complements nor substitutes. There are an equal (large) number of households of each type.

The composite consumption good in expression (2) is an index given by

$$C_t = [\phi_H^{\frac{1}{\eta}} C_{Ht}^{\frac{\eta-1}{\eta}} + \phi_F^{\frac{1}{\eta}} C_{Ft}^{\frac{\eta-1}{\eta}}]^{\frac{\eta}{\eta-1}} \quad (3)$$

where C_{Ht} and C_{Ft} denote the consumption of composites of home and foreign-produced goods, respectively. The parameter $\eta > 0$ denotes the elasticity of substitution between home and foreign goods and ϕ_H and ϕ_F are preference parameters that determine the household's relative preference for home and foreign goods. It is analytically convenient to normalize $\phi_H + \phi_F = 1$. If $\phi_H > \phi_F$, household preferences are biased toward home-produced goods.

The subindices, C_{Ht} and C_{Ft} , are given by

$$C_{Ht} = \left[\int_0^1 c_{ht}(z)^{\frac{\theta-1}{\theta}} dz \right]^{\frac{\theta}{\theta-1}} \quad \text{and} \quad C_{Ft} = \left[\int_0^1 c_{ft}(z)^{\frac{\theta-1}{\theta}} dz \right]^{\frac{\theta}{\theta-1}} \quad (4)$$

where $c_{ht}(z)$ and $c_{ft}(z)$ denote consumption of variety z of home and foreign-produced goods, respectively. There is a continuum of measuring one of the varieties in each region. The parameter $\theta > 1$ denotes the elasticity of substitution between different varieties.

Goods markets are completely integrated across regions. Home and foreign households thus face the same prices for each of the differentiated goods produced in the economy. I denote these prices by $p_{ht}(z)$ for home-produced goods and $p_{ft}(z)$ for foreign-produced goods. All prices are denominated in a common currency called ‘‘RMB.’’

Households have access to complete financial markets. There are no impediments to trade in financial securities across regions. Home households of type x face a flow budget constraint given by

$$P_t C_t + E_t[M_{t,t+1} B_{t+1}(x)] \leq B_t(x) + (1 - \tau_t) W_t(x) L_t(x) + \int_0^1 \Xi_{ht}(z) dz - T_t \quad (5)$$

where P_t is a price index that gives the minimum price of a unit of the consumption good C_t , $B_{t+1}(x)$ is a random variable that denotes the state contingent payoff of the portfolio of financial securities held by households of type x at the beginning of period $t + 1$, $M_{t,t+1}$ is the stochastic discount factor that prices these payoffs in period t , τ_t denotes a labor income tax levied by the government in period t , $W_t(x)$ denotes the wage rate received by home households of type x in period t , Ξ_{ht} is the profit of home firm z in period t and T_t denotes lump sum taxes. To rule out Ponzi schemes, household debt cannot exceed the present value of future income in any state of the world.

Households face a decision in each period about how much to spend on consumption, how many hours of labor to supply, how much to consume of each differentiated good produced in the economy, and what portfolio of assets to purchase. The optimal choice regarding

the trade-off between current consumption and consumption in different states in the future yield the following consumption Euler equation:

$$\left(\frac{C_{t+1}}{C_t}\right)^{-\sigma^{-1}} = E_t\left(\frac{M_{t,t+1}}{\beta}\right)\frac{P_{t+1}}{P_t} \quad (6)$$

as well as a standard transversality condition. Subscripts on the function u denote partial derivatives. The optimal choice regarding the intratemporal trade-off between current consumption and current labor supply yields a labor supply equation:

$$\chi L_t(x)^{v-1} C_t^{\sigma^{-1}} = (1 - \tau_t) \frac{W_t(x)}{P_t} \quad (7)$$

Households optimally choose to minimize the cost of attaining the level of consumption C_t . This implies the following demand curves for home and foreign goods and for each of the differentiated products produced in the economy:

$$C_{Ht} = \phi_H C_t \left(\frac{P_{Ht}}{P_t}\right)^{-\eta} \quad \text{and} \quad C_{Ft} = \phi_F C_t \left(\frac{P_{Ft}}{P_t}\right)^{-\eta} \quad (8)$$

$$c_{ht} = C_{Ht} \left(\frac{p_{ht}(z)}{P_{Ht}}\right)^{-\theta} \quad \text{and} \quad c_{ft} = C_{Ft} \left(\frac{p_{ft}(z)}{P_{Ft}}\right)^{-\theta} \quad (9)$$

where

$$P_{Ht} = \left[\int_0^1 p_{ht}(z)^{1-\theta} dz\right]^{\frac{1}{1-\theta}} \quad \text{and} \quad P_{Ft} = \left[\int_0^1 p_{ft}(z)^{1-\theta} dz\right]^{\frac{1}{1-\theta}} \quad (10)$$

and

$$P_t = \left[\phi_H P_{Ht}^{1-\eta} + \phi_F P_{Ft}^{1-\eta}\right]^{\frac{1}{1-\eta}} \quad (11)$$

As I noted above, the problem of the foreign household is analogous. I, therefore refrain from describing it in detail here. It is, however, useful to note that combining the home and foreign consumption Euler equations to eliminate the common stochastic discount factor

yields:

$$\left(\frac{C_t^*}{C_t}\right)^{-\sigma^{-1}} = Q_t \quad (12)$$

where $Q_t = P_t^*/P_t$ is the real exchange rate. This is the “Backus-Smith” condition that describes optimal risk-sharing between home and foreign households (Backus and Smith, 1993). For simplicity, I assume that all households—in both regions—initially have an equal amount of financial wealth.

4.2 Government

The economy has a central government that conducts fiscal and monetary policy. Total government spending in the home and foreign regions follows exogenous AR(1) processes. Let G_{Ht} denote government spending per capita in the home region. Total government spending in the home region is then nG_{Ht} . For simplicity, I assume that government demand for the differentiated products produced in each region takes the same CES form as private demand. In other words, I assume that

$$g_{ht}(z) = G_{Ht} \left(\frac{p_{ht}(z)}{P_{Ht}}\right)^{-\theta} \quad \text{and} \quad g_{ft}(z) = G_{Ft} \left(\frac{p_{ft}(z)}{P_{Ft}}\right)^{-\theta} \quad (13)$$

The government levies labor income and lump-sum taxes to pay for its purchases of goods. My assumption of perfect financial markets implies that risk associated with variation in lump-sum taxes and transfers across the two regions is undone through risk-sharing. Ricardian equivalence holds in this model.

The central government operates a common monetary policy for the two regions. This policy consists of the following augmented Taylor rule for the economy-wide nominal interest rate:

$$\hat{r}_t^n = \rho \hat{r}_{t-1}^n + (1 - \rho)(\phi_\pi \hat{\pi}_t^{ag} + \phi_y \hat{y}_t^{ag} + \phi_g \hat{g}_t^{ag}) \quad (14)$$

where hatted variables denote percentage deviations from steady state. The nominal interest

rate is denoted \hat{r}_t^n . It responds to variation in the weighted average of consumer price inflation in the two regions $\hat{\pi}_t^{ag} = n\hat{\pi}_{tt} + (1 - n)\hat{\pi}_t^*$, where $\hat{\pi}_t$ is consumer price inflation in the home region and $\hat{\pi}_t^*$ is consumer price inflation in the foreign region. It also responds to variation in the weighted average of output in the two regions $\hat{y}_t^{ag} = n\hat{y}_t + (1 - n)\hat{y}_t^*$. Finally, it may respond directly to the weighted average of the government spending shock in the two regions $\hat{g}_t^{ag} = n\hat{g}_t + (1 - n)\hat{g}_t^*$.

4.3 Firms

There is a continuum of firms indexed by z in the home region. Firm z specializes in the production of differentiated good z , the output of which I denote $y_{ht}(z)$. In my baseline model, labor is the only variable factor of production used by firms. Each firm is endowed with a fixed, non-depreciating stock of capital. The production function of firm z is

$$y_{ht}(z) = L_t(z)^a \tag{15}$$

The production function is increasing and concave. It is concave because there are diminishing marginal returns to labor given the fixed amount of other inputs employed at the firm. Labor is immobile across regions. The model yields very similar results to a model in which labor and capital are assumed to be equally mobile and the government spending shock is to per capita spending. I follow Woodford (2003) in assuming that each firm belongs to an industry x and that there are many firms in each industry. The goods in industry x are produced using the labor of type x and all firms in industry x change prices at the same time.

Firm z acts to maximize its value,

$$\max_{p_{ht}(z)} E_t \sum_{j=0}^{\infty} \{ \alpha^j [M_{t,t+j} (p_{ht}(z) y_{ht+j}(z) - W_{t+j}(x) L_{t+j}(z))] \} \tag{16}$$

Firm z must satisfy the demand for its product. The demand for the firm z 's product comes from three sources: home consumers, foreign consumers, and the government. It is given by

$$y_{ht+j} = (nC_{Ht+j} + (1-n)C_{Ht+j}^* + nG_{Ht+j})\left(\frac{p_{ht}(z)}{P_{Ht+j}}\right)^{-\theta} \quad (17)$$

Firm z is therefore subject to the following constraint:

$$(nC_{Ht} + (1-n)C_{Ht}^* + n * G_{Ht})\left(\frac{p_{ht}(z)}{P_{Ht}}\right)^{-\theta} \leq L_t(z)^\alpha \quad (18)$$

Firm z takes its industry wage $W_t(x)$ as given. The optimal choice of labor demand by the firm is given by

$$W_t(x) = \alpha L_t(z)^{\alpha-1} S_t(z) \quad (19)$$

where $S_t(z)$ denotes the firm's nominal marginal cost (the Lagrange multiplier on equation (18) in the firm's constrained optimization problem).

Firm z can re-optimize its price with probability $1-\alpha$ as in Calvo (1983). With probability α it must keep its price unchanged. Optimal price setting by firm z in periods when it can change its price implies

$$p_{ht}(z) = \frac{\theta}{\theta-1} E_t \sum_{j=0}^{\infty} \frac{\alpha^j M_{t,t+j} y_{ht+j}(z)}{E_t \sum_{j=0}^{\infty} \alpha^j M_{t,t+j} y_{ht+j}(z)} S_{t+j}(z) \quad (20)$$

Intuitively, the firm sets its price equal to a constant markup over a weighted average of current and expected future marginal cost.

4.4 Parameters Value

In this paper, I adopt the Bayesian estimation from Y. Ma and Li (2015) for parameter values in the model. Y. Ma and Li (2015) use quarterly data for the Chinese economy over the period from 1992:Q1 to 2013:Q4, which is highly overlapped with the studied period

Table 3: The Estimated Parameters in the US and China

	US	China
Inter-temporal elasticity of substitution	1	1.332
Calvo prices stickiness	0.75	0.743
Frisch-elasticity of labor supply	1	2.012
Curvature of production function	0.67	0.569
Elasticity of substitution between home and foreign goods	2	1.5
Elasticity of substitution between varieties	7	10
Inflation response in Taylor Rule	1.5	1.262
Output response in Taylor Rule	0.5	0.539
Lagged dependence in Taylor Rule	0.8	0.912
Persistence of government spending shock	0.933	0.773

Note: The estimated parameters in the US is from Nakamura and Steinsson (2014), and the estimated parameters in China is from Y. Ma and Li (2015)

in my empirical analysis. Their data series are obtained from the central bank of China (People’s Bank of China, PBoC) and the National Bureau of Statistics of China. Table 3 reports Bayesian estimates of the model parameters for the Chinese economy, as well as the parameters for the US economy from Nakamura and Steinsson (2014).

The estimated intertemporal elasticity of substitution (IES), σ , is 1.332, close to the estimate in the study of Sun (2011). The estimate of the Frisch-elasticity of labor supply, v , is 2.012, which is quite high compared with the US economy. implying a relatively smaller elasticity of labor supply in the Chinese economy. I set the subjective discount factor equal to $\beta = 0.99$, the elasticity of substitution across varieties, θ , equal to 10, and the elasticity of substitution between home and foreign goods to $\eta = 1.5$. Larger values of η yields more expenditure switching between regions in response to regional shocks and thus lower open economy relative multipliers.

I assume the production function $y_{ht}(z) = L_t(z)^a$ and set $a = 0.569$, which is generally consistent with the vast literature on the Chinese business cycle study (Suárez Serrato and Wingender, 2016). Regarding the frequency with which firms can change their prices, I consider two cases: $\alpha = 0$ (i.e., fully flexible prices) and $\alpha = 0.743$, which is generally consistent with the estimates found in advanced economies. Rigid prices imply that relative

prices across regions respond sluggishly to regional shocks. I set the size of the home region to $n = 0.1$. The value of the open economy relative multiplier in my model is relatively insensitive to the size of n . I set the steady state value of government purchases as a fraction of output to 0.2, which is close to the average share of government spending out of GDP based on my data set.

I have so far calibrated the “fundamentals”—i.e., preferences and technology for my model economy. I leave a detailed description of government policy in the next section.

5 Model Results

In this section, I analyze the effects of government spending shocks in the model presented in Section 5. I consider several different specifications for aggregate monetary and tax policy. In the Neoclassical (flexible price) versions of the model, money is neutral, implying that the specification of monetary policy is irrelevant. Tax policy is, however, important. Following Nakamura and Steinsson (2014), I consider two specifications for tax policy described below. In the New Keynesian (sticky price) versions of the model, monetary policy is important and I consider two specifications of monetary policy within the class of interest rate rules described by equation (14).

The monetary policies I consider are (i) an augmented Taylor rule policy and (ii) a “fixed real-rate” policy. These policies are designed to imply successively less “leaning against the wind” by the central bank in response to inflationary government spending shocks. The augmented Taylor rule is an extension of the original Taylor rule, which is a widely used guideline for central banks to set their interest rates based on inflation and output gaps. The augmented Taylor rule takes into account additional factors that may affect monetary policy, such as government spending shocks. In this case, I adopt the estimation from Y. Ma and Li (2015) and set the parameters in equation (14) to $\rho = 0.912$, $\phi_\pi = 1.262$, $\phi_y = 0.539$, and $\phi_g = 0$. This specification of monetary policy implies that the monetary authority

aggressively raises the real interest rate to curtail the inflationary effects of a government spending shock. Under the “fixed real-rate” policy, the central bank maintains a fixed real interest rate in response to government spending shocks. However, to guarantee price-level determinacy, the central bank responds aggressively to the inflationary effects of all other shocks.

Following Nakamura and Steinsson (2014), I consider two specifications for tax policy. My baseline tax policy is one in which government spending shocks are financed completely by lump-sum taxes. Under this policy, all distortionary taxes remain fixed in response to the government spending shock. The second tax policy I consider is a “balanced budget” tax policy. Under this policy, labor income taxes vary in response to government spending shocks such that the government’s budget remains balanced throughout:

$$nP_{Ht}G_{Ht} + (1 - n)P_{Ft}G_{Ft} = \tau_t \int W_t(x)L_t(x)dx \quad (21)$$

This policy implies that an increase in government spending is associated with an increase in distortionary taxes. I assume that the government spending shocks follow an AR(1) process and Y. Ma and Li (2015) suggest that the persistence of this process in China is lower than the one in the US, which yields an AR(1) coefficient of 0.773.

I present results for both the aggregate multiplier that has been studied in much of the previous literature and the local relative multiplier that I provide estimates for in Section 4.

5.1 The Aggregate Fiscal Multipliers

I define the closed economy aggregate multiplier as the response of the total output (combining home and foreign production) to total government spending, i.e., β in the regression,

$$\frac{Y_t^{agg} - Y_{t-2}^{agg}}{Y_{t-2}^{agg}} = \alpha + \beta \frac{G_t^{agg} - G_{t-2}^{agg}}{Y_{t-2}^{agg}} + \epsilon_t \quad (22)$$

Table 4: Government Spending Multiplier

	Aggregate Fiscal Multiplier	Local Fiscal Multiplier
<i>Panel A. Sticky Price</i>		
Augmented Taylor Rule	0.37	0.95
Constant Real Rate	1.00	0.94
<i>Panel B. Flexible Price</i>		
Constant Income Tax Rates	0.36	0.49
Balanced Budget	0.19	0.49

Note: The table reports the government spending multiplier for output deflated by the regional CPI for the model presented in the text with the separable preferences specification. Panel A presents results for the model with sticky prices, while panel B presents results for the model with flexible prices. The first two rows differ only in the monetary policy being assumed. The third and fourth rows differ only in the tax policy being assumed.

where Y_t^{agg} denotes aggregate output and G_t^{agg} denotes aggregate government spending. This regression is identical to the one I use to measure the local fiscal multiplier—equation (1)—except that I am using aggregate variables and have dropped the time-fixed effects. I calculate this object by simulating quarterly data from the model described in Section 5, time-aggregating it up to an annual frequency, and running the above regression on this data.

The first column of Table 4 reports results on the aggregate fiscal multiplier. These results indicate that the aggregate multiplier is highly sensitive to aggregate monetary and tax policy. In the New Keynesian model with an augmented Taylor rule, it is quite low—only 0.37. The low multiplier arises because the monetary authority reacts to the inflationary effects of the increase in government spending by raising real interest rates. This counteracts the expansionary effects of the spending shock. For monetary policies that respond less aggressively to inflationary shocks, the closed economy multiplier can be substantially larger. For the constant real-rate policy, the multiplier is one. Intuitively, since the real interest rate remains constant rather than rising when spending increases there is no “crowding out” of consumption, implying that output rises one-for-one with government spending.

The second panel of Table 4 presents results for the Neoclassical model. These results clearly indicate that the closed economy aggregate multiplier also depends on the extent

to which government spending is financed by contemporaneous distortionary taxes. If the spending is financed by an increase in distortionary taxes in such a way as to maintain a balanced budget period-by-period (as opposed to by lump-sum taxes), the multiplier falls from 0.36 to 0.19.

It is useful to pause for a moment to consider why price rigidity—the feature that distinguishes the New Keynesian and Neoclassical models I consider—matters so much in determining the effects of government spending. For example, consider a transitory shock to government spending at the zero lower bound. This shock puts pressure on prices to rise. In the Neoclassical model with a constant money supply, prices immediately jump up and begin falling. This implies that the real interest rate rises on impact (because prices are falling) and crowds out private spending. In the New Keynesian model, however, prices rise only gradually since many are rigid in the short run. This implies that the real interest rate falls on impact and thus boosts private spending. It is this difference in the response of the real interest rate to government spending shocks—caused by a difference in the flexibility of prices—that explains the difference in the multiplier across these models.

5.2 The Local Fiscal Multipliers

The local fiscal multiplier is reported in the second column of Table 4. The open economy relative multiplier is calculated by estimating equation (1) using the regional data from the model. For the two specifications of monetary policies, the local fiscal multipliers are close to each other. The local multiplier for the augmented Taylor rule is 0.95 while the one for the constant real rate is 0.94. The New Keynesian model here does not successfully reproduce the local multiplier I estimated in my empirical analysis. Furthermore, the Panel B of Table 4 presents results for the different specifications of tax policy in the Neoclassical model and illustrates that the local fiscal multiplier is also completely insensitive to aggregate tax policy. Notice that the local fiscal multiplier for the flexible price regime I derive from the model is highly close to the one estimated in Section 4. However, according to an estimation of Sun

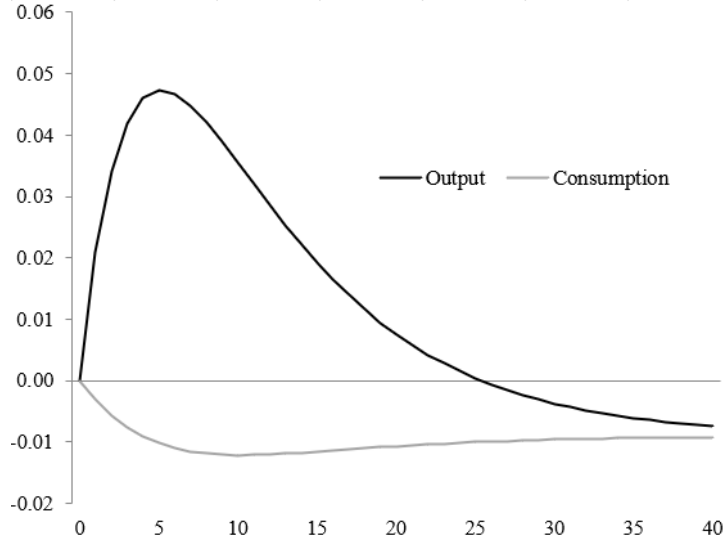


Figure 2: Impulse Response after a positive fiscal shock

Note: The figure plots the relative consumption and the relative output in the two regions for the model with separable preferences after a positive government spending shock to the home region.

(2011), the Calvo price stickiness in China is even higher than the one in the U.S., suggesting that the Neoclassical model is not a valid fit for the Chinese economy. The mismatch between the empirical and model findings suggests that we need to find a model that is more tailored to the Chinese economy.

Intuitively, the open economy relative multiplier is independent of aggregate policy because I “difference out” aggregate shocks and aggregate policy by including time-fixed effects in the regression. In a monetary union, the monetary authority cannot respond to a shock in one region by making monetary policy tighter in that region alone. The relative monetary policy between the two regions is, therefore, held fixed by the monetary union in a very precise way, regardless of the aggregate monetary policy.

Since the relative nominal interest rate is constant in response to a regional government spending shock, it is tempting to think that this situation is analogous to the zero lower bounds, where the nominal interest rate is fixed at zero in response to government spending shocks. As in the zero lower bound cases, an increase in relative government spending in the home region can raise expected inflation, lowering relative short-term real interest rates. However, unlike the zero lower bound cases, the relative long-term real interest rate does not

fall in response to a fiscal shock. The fiscal shock leads to an immediate rise in relative prices and expectations of further increases in the short term. This lowers the relatively short-term real interest rate. However, a transitory shock to spending does not lead to a permanent change in relative prices. Figure 5 shows what happens to consumption in the home region relative to the foreign region after a government spending shock. Despite the short-run fall in the real interest rate, consumption falls. This is because households anticipate high real rates in the future and therefore cut their consumption. This is also consistent with the negative effect of government spending on consumption I estimated in Section 4.

The open economy relative multiplier is smaller than one for a wide range of parameters in my model. This is most easily seen by considering the “Backus-Smith” risk-sharing condition $(\frac{C_t^*}{C_t})^{-\sigma^{-1}} = Q_t$. An increase in home government spending will increase the relative price of home goods and therefore decrease the “real exchange rate” (Q_t). By the Backus-Smith condition, this implies that home consumption must fall relative to foreign consumption. In other words, government spending “crowds out” private spending in relative terms implying a local multiplier is smaller than one.

Summing up our results thus far, it has been discovered that the aggregate multiplier exhibits sensitivity to nominal rigidity and monetary policy specifications. This finding suggests that variations in the real interest rate response to government spending shocks, attributable to differences in price flexibility, account for the discrepancy in the multipliers across models. Conversely, the local fiscal multiplier remains unaffected by aggregate monetary or tax policy, as the inclusion of time-fixed effects in the regression allows for the “differencing out” of aggregate shocks and policies.

The estimates of equation (1), based on the defense spending data, yield a local fiscal multiplier of roughly 0.43. The New Keynesian model produces a local fiscal multiplier of approximately 0.95, significantly higher than the empirical estimate of 0.43. In contrast, the Neoclassical model with separate preferences generates a local fiscal multiplier of 0.49, closely aligning with empirical data. The Neoclassical model also reveals that aggregate

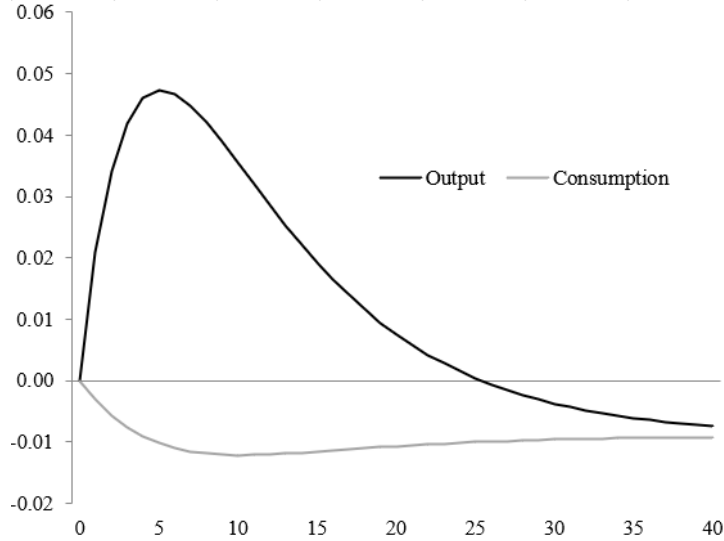


Figure 3: Impulse Response after a positive fiscal shock

multipliers can differ from local fiscal multipliers, with the corresponding aggregate multiplier ranging between 0.19 and 0.36 based on tax policy variations. For instance, when government spending is financed by increasing distortionary taxes to maintain a balanced budget period-by-period, the aggregate multiplier decreases from 0.36 to 0.19.

Sun (2011) indicates that the New Keynesian model is well-suited for this study, as the degree of price rigidity in China resembles that of the U.S. However, the model’s failure to correspond with empirical findings may stem from several factors. First, it is necessary to explore alternative preferences, such as the utility function adopted by Greenwood, Hercowitz, and Huffman (1988). I refer to this utility function as representing GHH preferences. Consumption and labor are complements for households with GHH preferences. Recently, Monacelli and Perotti (2008), Bilbiie (2011), and Hall (2009) have emphasized the implications of consumption-labor complementarities for the government spending multiplier. Second, different calibration strategies should be considered to better match empirical data. Finally, as suggested by Dupor and Guerrero (2021), the integration of heterogeneous agents with the New Keynesian framework may prove beneficial. These avenues for investigation will be the focus of future research.

6 Conclusion

I exploit regional variations in defense spending in China to estimate the effect of government spending on output in a monetary union. I use the fact that defense spending is plausibly exogenous with respect to a nation's business cycle because it is more likely driven by international geopolitical factors, rather than an endogenous counter-cyclical stimulus policy. I find that when relative spending in a state increases by 1 percent of GDP, relative state GDP rises by 0.43 percent. At first glance, this multiplier estimate may seem quite small. However, it pertains to a different object than the conventional "aggregate multiplier," in that, it measures the effect of a relative change in government spending in two different states on the relative change in output. For starters, it is important to recognize why local and aggregate multipliers might differ. This is because of spillovers across regions. Sources of spillovers might include movements in factors of production, trade in goods, common monetary policy, or common fiscal policy, among others. As an example, if government purchases in province X increase the income of province X residents, who in turn import more goods from province Y, then the local multiplier will be a downward-biased estimate of the aggregate multiplier because of a positive spillover.

To relate my local results to aggregate results, I use a stylized monetary union model following Nakamura and Steinsson (2014). My findings indicate that the aggregate multiplier is sensitive to nominal rigidity and monetary policy, while the local fiscal multiplier is insensitive to these factors. This study is able to generate a local fiscal multiplier estimate of 0.49 from the Neoclassical model with separate preferences, which is more in line with my empirical estimate than the New Keynesian model's estimate of 0.95. Based on the Neoclassical model, the aggregate multipliers vary from 0.19 to 0.36 depending on the tax policies considered. Despite the New Keynesian model's potential applicability to the Chinese context, as Sun (2011) demonstrates the degree of price rigidity in China to be similar to that in the U.S., my model was unable to accurately capture the empirical estimate of the local fiscal multiplier.

Moving forward, there are several avenues for future research to better align the New Keynesian model with the empirical results. First, the adoption of different types of preferences, such as GHH preferences, should be considered. Second, alternative calibration strategies may help to reconcile the model with empirical findings. Lastly, the incorporation of heterogeneous agents within the New Keynesian framework, as suggested by Dupor and Guerrero (2021), could provide valuable insights. By pursuing these potential improvements, future research can further refine our understanding of the relationship between fiscal multipliers, aggregate monetary and tax policies, and nominal rigidity. This will ultimately contribute to more informed policy decisions in order to effectively manage economic fluctuations and promote sustainable growth.

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