The Macroeconomic Effects of Government Spending in China

– An Analysis of Government Spending Multipliers and Income Inequality

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Abstract

In this paper, I investigate the macroeconomic effects of government spending shocks on output and income inequality in China. I find that fiscal multipliers for output in China are large: it is 2.08 at the 1-year horizon and 1.55 at the 4-year horizon. These large multipliers are primarily explained by a rise in private consumption in response to increased government spending. I also do not find any evidence that government spending in China tends to significantly crowd out private investment or exports. I consider income inequality measures as well. I find that a rise of 1 more RMB per capita by the government, results in the urban-rural per capita disposable income ratio to fall by 0.79 within 1 year and drop by 0.34 in 4 years; the Gini index also falls by 1.35 and 1.05 in short run and long run, respectively. This provides evidence that fiscal spending in China stimulates the economy while it reallocates the resources appropriately to deal with the income inequality issue, and consequently improves the average welfare of the entire population.

1 Introduction

Government spending is one of the most important fiscal policy tools in the tool kit of policy makers, and has received increased attention, from economists and policymakers alike, as countries around the world have relied on fiscal stimulus during the Great Recession and now during the Covid crisis. Typically, policymakers care about two main aspects of government spending: One is whether it helps to effectively stimulate the economy, i.e. the effects on output. The other is whether it can reallocate the resources of the society to ensure fair distribution of resources. Correspondingly, effects of government spending on output, summarized by spending multipliers, and income inequality levels become the two primary criteria that can be used to evaluate fiscal spending policies.

In this paper, we are interested in the effectiveness of increased government spending in China. There is evidence that government stimulus programs in China may potentially help the economy recover rapidly from a crisis. As an example, China's rapid recovery during the 2008 world financial crisis was due to its aggressive 4-trillion RMB government stimulus program 2008 - 2010. On the other hand, there are concerns that public spending may potentially crowd out investment and consumption from the private sector. Another concern might be that increased government spending might exacerbate inequality in Chinese society. Regional inequality is a remnant of Chinese history, and the gap between urban and rural household incomes in China has been large and contributes substantially to the overall inequality. The ratios of urban and rural household incomes reached historic highs in 2008, 2009, and 2010, and the Gini index shows similar trends as well. Thus, there may potentially be a trade-off between economic growth and inequality.

This paper specifically attempts to do the following: first, quantify the output multipliers of government spending in China, and identify the effects on private investment and consumption in order to understand the main factors driving output multipliers in the Chinese economy; second, it investigates the effects of government spending on both the urban-rural per capita disposable income ratio and Gini coefficients to provide evidence on whether government spending can reduce income inequality in China.

I identify government spending shocks based on spending forecast errors from official Chinese government sources, and apply a local projection instrumental variable (LP-IV) approach to estimate the effects of government spending shocks. In addition, I employ a data set spanning 1978-2019, which is a relatively long sample, particularly in relation to previous literature studying fiscal policy in the Chinese economy. I find large output multipliers in China: the output multiplier is 2.08 at the 1-year horizon and 1.55 at the 4-year horizon. In more detail, I find that these large effects of government spending shocks on output are driven by a largely positive response of consumption. Notably, the consumption multiplier is 0.83 at the 1-year horizon and 0.73 at the 4-year horizon. The response of private investment, however, is insignificant. Meanwhile, as the government authorities spend an additional 1 RMB per capita (i.e. more than 1 billion RMB in total, depending on the population), the urban-rural per capita disposable income ratio will decrease by

0.79 on impact and drop by 0.34 for the first 4 years; Gini coefficient can decrease by 1.35% [1] in the first year and 1.05% in the 4 years horizon. The drop of Gini index indicates a decreasing inequality in income distribution in the economy, usually coming from the transfer to the poorer from richer. This can be partially verified by the effects of government spending on urban (richer category on average) and rural (poorer category on average) income levels. I find that government spending can significantly increase the rural income level while it has an insignificant negative effect on the urban income level on impact and has a barely significant increase in the long run. In summary, increased government spending in China results in high output multipliers and it can reduce income inequality.

The recent related literature on fiscal multipliers has three main approaches for identifying government spending shocks. Blanchard and Perotti (2002) employ structural vector-autoregression (SVAR) for the analysis of fiscal policy and identify spending shocks by imposing recursive restrictions, given long implementation and legislative lags for fiscal decisions. This approach has been used by many subsequent papers, e.g. Perotti (2005), Favero, and Giavazzi (2007). There is also a recent literature that employs this recursive identification in panel SVARs, to study the effects of fiscal policy shocks in several countries together, e.g. in Beetsma and Giuliodori (2011), and Ilzetzki, Mendoza, and Vegh (2013). Notably, Ilzetzki et al. (2013) extend the SVAR model to a new quarterly data set with 44 countries (excluding China). Meanwhile, another strand of literature focuses on finding exogenous variations in government spending based on large U.S. military spending buildups. Building on the original work of Ramey and Shapiro (1998), Ramey (2011) introduces a defense news shocks series based on various news sources. This shock can be used in VARs or in single equations, i.e. as an instrument in a local projection, as in Ramey and Zubairy (2018). Lastly, Ramey (2011) and Auerbach and Gorodnichenko (2012) also show that forecast errors of government spending based on Survey of Professional Forecasters or the Federal Reserve Greenbook can be used to identify government spending shocks.

Most of the aforementioned literature focuses on the United States economy or economies of other developed countries, and only a few studies have looked at China. Some of the papers that focus on the government spending multipliers in China use the VAR method, e.g. Jeong, Kang and Kim (2017) consider China, Japan and Korea, and concludes that the output multiplier is larger than 1 in China employing quarterly data from 1994:1 -2015:2; Wang and Wen (2017) using 1978-2011 annual data and argue that the impact multiplier for output is 2.68, for consumption is 0.54, and for private investment is 1.2; by using the SVAR and annual data 1980-2011, Xu and Yan (2014) suggests that government investment in public goods in China "crowds in" private investment significantly, while government investment in private goods, industry and commerce, mainly through state-owned enterprises, "crowds-out" private investment significantly. Furthermore, there is some related literature in Chinese that adopt different methodologies: The majority of them offer identical results that China has large output multipliers and there is not much evidence of crowding-out

[1] "%" is the unit of the Gini coefficient, and the range of the Gini coefficient is 0% -100%. For instance, Gini index is 50% at the beginning, decreasing 1.35% here means the level of Gini index changes from 50% to 48.65%, which is a -1.35 percentage point change. Then the corresponding percentage change would be -0.027%. The magnitude of inequality multiplier is in line with Furceri, Loungani, and Melina (2018).

effects on private investment and consumption. With provincial data and LP-IV approach, Chen, Ratnovski and Tsai (2019) estimates provincial fiscal multipliers in China. They use the tenure of provincial party secretary, interacted with the fiscal expenditure used in other provinces, instruments for provincial government expenditure growth, and find a fiscal multiplier of 0.75 in 2001-2008 and 1.2 in 2010-2015.

The relationship between fiscal spending and income inequality for both developing and developed countries are also of rising interest. Using a panel regression with global country-level observations, Ali (2007) and Ali (2012) examine the effects of military spending on inequality controlling for possible determinants. Ma (2018) investigates the effects of economic policies (including government spending policy) on income inequality in the U.S.; Furceri, Loungani, and Melina (2018) constructs unanticipated government spending shocks by using forecasted government spending for 103 developing countries, for 1990-2015, including China, and studies their effects on income distribution and concludes that unanticipated fiscal consolidations lead to a long-lasting increase in income inequality. Cevik and Correa-Caro (2015) uses international tourist arrivals as an instrument (for real GDP per capita), and finds that government spending significantly reinforces the income inequality for China. Although there is not much literature in English about the Chinese government spending effects on the regional income inequality are not much, there is related literature in Chinese: Using the additive nonparametric model, Qian and Fang (2012) show that different items of government spending have different directions and levels of impacts on the income gap between urban and rural residents; Lv and Zhao (2007) verifies that government spending can reduce the urban-rural income gap.

Compared with the existing literature, there are three contributions in this paper. First, there is a methodological contribution for studying the effect of government spending in China, as no existing paper applies the LP-IV method to estimate government spending effects with country level data in China. Relative to the SVAR approach, LP-IV estimation results do not suffer from potential bias, arising from the contemporaneous relationship between variables as long as we consider a strong exogenous IV. In a most commonly used SVAR models for government spending shocks, because of recursive identification assumption, the order of variables should be treated with caution. Even worse, due to the limitation of reliable and publicly available high frequency data, government spending multiplier analyses for China are usually based on annual data in most cases. It is not easy to convince others to believe the recursive identifying assumption is valid within a year. In addition, the LP-IV approach provides the flexibility to estimate the two aspects of the policy in a unified methodology with parsimonious models. Notably, I can obtain consistent and comparable results to comprehensively evaluate the contributions of fiscal expenditures, thus proving that fiscal spending in China can both boost economic growth and reduce inequality.

Second, the instrument I use to identify government spending shocks in China is novel. I construct this government spending shock series as a forecast error for government spending based on the official forecast values in the annual government reports.

Third, the sample covers a relatively long period. Compared with the existing related literature, I consider the longest sample for China to date, to quantify fiscal multipliers. This allows me to explain the average effects of government spending with much more precision as I exploit a larger sample period. In further studies, I expect to estimate time-varying effects of government spending based on the state of the economy, and this longer time series provides the foundation for such analysis.

The paper proceeds as follows: Section II introduces the econometric methodology. Section III presents the data description, from the brief introduction of the dataset to the elaborate measures of policy shocks and income inequality. Section IV reports the empirical results and gives a concise analysis. Section V conducts robustness checks for the baseline results and Section VI summarizes the main findings.

2 The Econometric Methodology

In this study, I analyze the macroeconomic effects resulted from one unit change in government spending. It is worth mentioning that, for the effects on income inequality, the previous papers generally explore the relationship between the percentage change of government spending and the percentage change of the inequality index with the logarithm of variables. Instead, I measure the level change of the income inequality index, say one RMB per capita change in government spending will lead to how much level change in income inequality index, which employs the same gauge as the other macroeconomics effects.

For the impacts on the output, private investment, or consumption, the earlier papers usually calculate the government spending multipliers in different ways. [2] According to the standard definition of the multiplier in Economics is the change in Y responses to the change in X, and here Y could be output (or other macroeconomic variables) as X is government spending, and the change of both variables X and Y should combine all the changes in the same time horizon. Multipliers should be calculated as the integral responses of the macroeconomic variables divided by the integral responses to government spending (to a fiscal shock) in a specified period. Throughout this study, the obtained government spending multipliers aim to measure the cumulative targeted macroeconomic variables' changes relative to the cumulative government spending's changes during a given period. Mountford and Uhlig (2009), Fisher and Peters (2010), and Ramey, and Zubairy (2018) also compute the integral multipliers.

Following the former papers Auerbach and Gorodnichenko (2013), and Ramey and Zubairy (2018), I use LP-IV method to estimate impulse responses of GDP (or other macroeconomic variables) to government spending shocks and further obtain the multipliers. Take the output multiplier for an example. Local projection method simply requires estimation of a series of regressions for each

[2]The original Blanchard and Perotti (2002) paper defines the multiplier as the ratio of the peak of the output responses to the initial government spending shock. The following papers have used the same definition, or variations, such as the average of the output response to the initial government shock, e.g. in Auerbach and Gorodnichenko (2012), Auerbach and Gorodnichenko (2013).

horizon h for each variable. The linear model looks as follows:

$$x_{t+h} = \alpha_h + \Psi_h(L)z_{t-1} + \beta_h shock_t + quadratictrend + \epsilon_{t+h}, h = 0, 1, 2, 3 \cdots \quad (1)$$

x contains the variables of interest – real government spending and GDP per capita, z is a vector of control variables. In the baseline model, z contains logs of real per capita GDP and government spending in lags. Ψ_h is a polynomial in the lag operator, and $shock_t$ is the identified shock divided by the nominal GDP from the previous period. Here $shock_t$ is in fact the instrument in this system. In addition, I do not include lags of the shocks variable. $\Psi(L)$ is a polynomial of optimal order chosen by BIC, the order for government spending is 2, for other variables are 1. The coefficient β_h gives the response of x at time $t+h$ to the shock at time t. Thus, one constructs the impulse responses functions as a sequence of the β_h's estimated in a series of single regressions for each horizon. Finally, the cummulative output multiplier can be calculated by $\frac{\sum_{j=0}^{h} \beta_h^{GDP}}{\sum_{j=0}^{h} \beta_h^{GOV}}$ for each horizon, because the left-hand side variables x are defined as:

$$(Y_{t+h} - Y_{t-1})/Y_{t-1};$$

$$(G_{t+h} - G_{t-1})/Y_{t-1}$$

The two variables can be rewritten as:

$$(Y_{t+h} - Y_{t-1})/Y_{t-1} \approx lnY_{t+h} - lnY_{t-1};$$

$$(G_{t+h} - G_{t-1})/Y_{t-1} \approx (lnG_{t+h} - lnG_{t-1}) * G_{t-1}/Y_{t-1}$$

When calculating the multipliers, many previous papers usually use an average GDP to government spending ratio to transform the estimated results from elasticity to multipliers, because the estimated results explore the relationship between the percentage change of government spending and the percentage change of the interested macroeconomic variables due to the logarithm of variables. However, applying the average ratio of the sample after the model estimation might lead to a biased multiplier when the variation of ratio is large, which is the situation in China. On average this ratio for China is 5.5, but it is time-varying from 3 to 9 across the entire. From the transformation here, this method can take care of the transformation requirement period by period and directly have the multipliers.

Alternatively and advanced, as mentioned in Ramey and Zubairy (2018), take the shock series as the instrument and the cumulative multipliers and the standard errors can be estimated in one step by using 2SLS of the following equation:

$$\sum_{j=0}^{h} y_{t+j} = \gamma_h + \Psi_h(L)z_{t-1} + m_h \sum_{j=0}^{h} g_{t+j} + quadratictrend + \omega_{t+j}, h = 0, 1, 2, 3 \cdots \quad (2)$$

Where $\sum_{j=0}^{h} g_{t+j}$ and $\sum_{j=0}^{h} y_{t+j}$ are the summation of the transformed GDP and government spending variable (transformed as variable x defined in equation 1) from t to $t+h$. And here

$shock_t$ is the instrument for $\sum_{j=0}^{h} g_{t+j}$.

In the results Section IV, I will report the short-term and the relatively long-term multipliers which are the first-year multipliers (impact multipliers) and the four-year accumulative multipliers. I choose to report the four-year multipliers because most of the impulse response functions of the converted government spending variables become insignificant in the fifth year and have the wide range of 95$\%$ confidence interval.

3 Data description

In this study, the historical series used are annual data from 1978 to 2019. The raw database is comprised by Actual Gross Government Spending, Estimated Gross Government Spending, Nominal GDP, the Total Household Consumption, the Gross Fixed Capital Investment from private funds (from 1981-2017), Import and Export, GDP index (1978=100), Consumer Price Index (1978=100), Population, rural/urban per capita disposable income, and Gini index, etc. The GDP deflator is calculated by the Nominal GDP and GDP index based on 1978 price level. And I transform the nominal data to real level by using GDP deflator or CPI. Moreover, the aggregate data are converted into the per capita ones.

The main sources of the historical series are the CEInet statistics database, the National Bureau of Statistics of the People's Republic of China (NBS). And specially, it is worth highlighting that the government spending data, especially the forecasted government spending data, are from the annual government reports: for each year, *the Communique of the Standing Committee of the National People's Congress of the People's Republic of China*; *Report on the Execution of the Central and Local Budgets for the last year and Report on the Central and Local Draft Budgets for the current year*, for example: *Report on the Execution of the Central and Local Budgets for 2016 and on the Central and Local Draft Budgets for 2017, Report on the Central and Local Final Accounts*. I pick the actual and estimated gross government spending data manually from those reports, then subtract estimated data from the actual one to get the government spending "forecast" shock series, and the details are in the following part. In addition, the Gini indices are from the Standardized World Income Inequality Database (SWIID).

3.1 The new measure of unexpected fiscal shock

I choose to identify the unexpected (exogenous) changes in government spending in order to instrument government spending and then estimate the effects of fiscal expenditure on macroeconomics by using these exogenous changes (shocks). The measure for unexpected fiscal shocks is one of the key contributions of this paper. Enlightened by the narrative method, my method is to get shocks from information provided by the annual government reports.

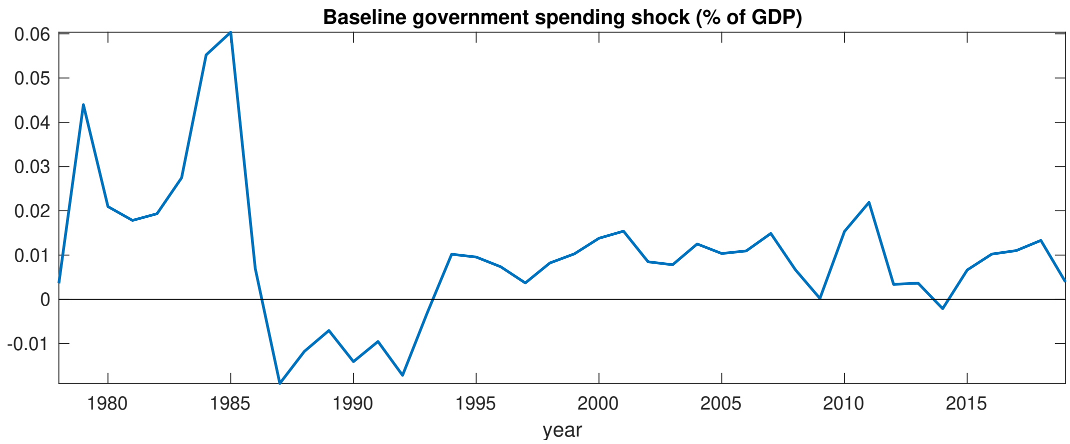
Every year in March, the Ministry of Finance provides a document about the Execution of the Central and Local Budgets for last year and the Central and Local Draft Budgets for the current year to the Standing Committee of the National People's Congress of the People's Republic of China. In this report, I could get the information that the government budget on government's proposed revenues and spending for the ensuing (current) financial year. [3] The proposed spending is the total of the central and local proposed spending including education expenditures, foreign affairs-related expenditures, national defense spending, public security expenses, etc., and the central and local spending is made up by each department in the economy separately. This proposed government spending arrangement is more like the estimation of the anticipated government expenditures for the current year from the authorities, mainly based on the historical information of government budgeting and the full consideration of current and future international and domestic economic conditions. It is complicated to stimulate government spending in such a detailed way in an econometric model. In other words, this proposed spending data might be one of the most accurate forecasts for China's government spending. In statistics, the residual, which is the difference between forecast and actual data, could be defined as a shock. Therefore, by using the forecast government spending series to subtract the actual series [4], I could obtain the unexpected forecast government spending shocks. Figure 1 plots the instrument series: government spending shocks as the percentage of last period GDP during 1978-2019. In Figure 1, there exist more positive shocks than negative ones, which indicates that the forecast government spending by the authorities tends to be underestimated most of the time.

The brief story which explain the characteristics of 1980s versus the 1990s in Figure 1: In the early years of the Economic Reform and Opening-up (1978-1985), China was in the process of transition from the planned economy to the market economy. During this period, on the one hand, instead of the government, the market gradually played a dominant role in allocating the social resources; on the other hand, the rapid development of immature market still needed the support from the government. The economic environment was too complicated to predict, in particular, under the outdated traditional government budget system. At that time, it was difficult for the government to catch up with the rapid development of social and economic conditions and predict accurately the

[3]There is no official report directly offering the Central and Local Draft Budgets for 1978, I calculate the total draft budgets for 1978 by the infrastructural draft budgets of 1978 and its exact portion of total central and local draft budgets found in *the Execution of the Central and Local Budgets for 1978 and the Central and Local Draft Budgets for 1979*.

[4]About actual government spending. Every year from May to July, the Ministry of Finance provides a report on the Central and Local final accounts for the last year. In some early years, such as 1980, this report could be gathered into the report I mentioned in the first step. In this report, I could get the official data of the actual government spending in a year. Usually, it will be a little different from the execution report in March due to the modification of the latest information update. At the same time, the CEInet statistics database and National Bureau of Statistics of the People's Republic of China also have the data of government spending, identical to each other. However, their figures are a little different from the government report. According to their explanations, unlike the historical government reports that can only provide the fixed and unchangeable numbers, they can always update their data by corrections and modifications for the historical data because of solid reasons, for example, the new statistical approach, to make their data more accurate. Obviously, it might be the most accurate figure for actual government spending.

Fig. 1. Government spending shocks



NOTES: Figure 1. plots the government spending shock series used as instrument. It is converts the level value of government spending shocks to unit as percentage of GDP during 1978-2019 scaled by GDP_{t-1}.

unanticipated cost and expenses on both regularity of and support in the new market economy at the beginning of each year. As a result, positive budget gaps always result from the government expenditure higher than the calculated and expected draft. Moreover, the GDP was in relatively low during that period, therefore any little level gaps can transform to huge percentage of GDP ratio gaps.

From 1985 to the 1990s, there were many governmental reforms: in 1985-1987, the government implemented the disarmament policy, the size of the armed forces shrank to 3 million from more than 4 million by the end of 1987; in 1988, with the implementation of the institutional reform of the State Council, the government started to downsize its organizations; in the Report on the Work of the Government in 1990, the prime minister emphasized the policy about streamlining government departments and agencies and the National People's Congress rectified various social organizations and institutions. The policy of "better troops and simpler administration" might be the main reason that could account for the negative government spending shock around the late 1980s and early 1990s — expecting to spend 100 at the beginning of the year, actually only spending 90 because of simplifying structure in the middle of the year.

The Budget Law of the People's Republic of China, the initial establishment of a government budget system that applies to the new market economy, was put into force in 1995. And accompanying the accounting standards published by the Ministry of Finance, China has reformed and enfored its government budgetary accounting system in 1998. The more advanced and complete modern government budget system helps the authorities to predict more accurately and keep the forecasting shock small and consistently positive since then.

3.2 Exogeneity of the identified shocks series

The constructed ”forecast” shocks seem unexpected or unanticipated literally, which indicates that its exogeneity might be accepted intuitively. Next, I need to formally prove the shock constructed is exogenous.

Following the Coibion (2012), I check whether the constructed shocks series is exogenous by:

$$shock_t = c + \sum_{i=0}^{I} \beta_i x_{t-i} + v_i$$

with null is βs equal to zero and shocks are exogenous. x can be the transformed macroeconomic variables, including GDP, the private investment (INV), the private consumption (CON), the export (EXP), the per capita disposable income of urban residence(URBANINCOME) and of rural residence (RURALINCOME), the urban-rural disposable income ratio (URBAN-RURAL RATIO) and Gini index (GINI). $I = 1$ since I may use 1 lag for all these variables. Table 1 has the T-test and F-test results for the exogeneity test.

Table 1: Exogeneity tests results: P-values for T-test and F-test

	Current	1-lag	For joint test
GDP	0.742	0.702	0.816
INV	0.920	0.891	0.837
CON	0.504	0.488	0.642
EXP	0.914	0.877	0.772
URBANINCOME	0.587	0.571	0.637
RURALINCOME	0.844	0.826	0.756
URABAN-RURALRATIO	0.146	0.247	0.248
GINI	0.256	0.525	0.484

NOTES: Table 1 reports P-values for each regression for each variable. Although in most cases, P-value for constant is smaller than 0.1, I ignore the constant since it is irrelevant that the constant is significantly different from zero or not.

The results clearly show that it can't reject the null at least 90% confidence level for all the variables, in other words there is no strong evidence that the shock series has the endogeneity problem.

3.3 The measurement of income inequality

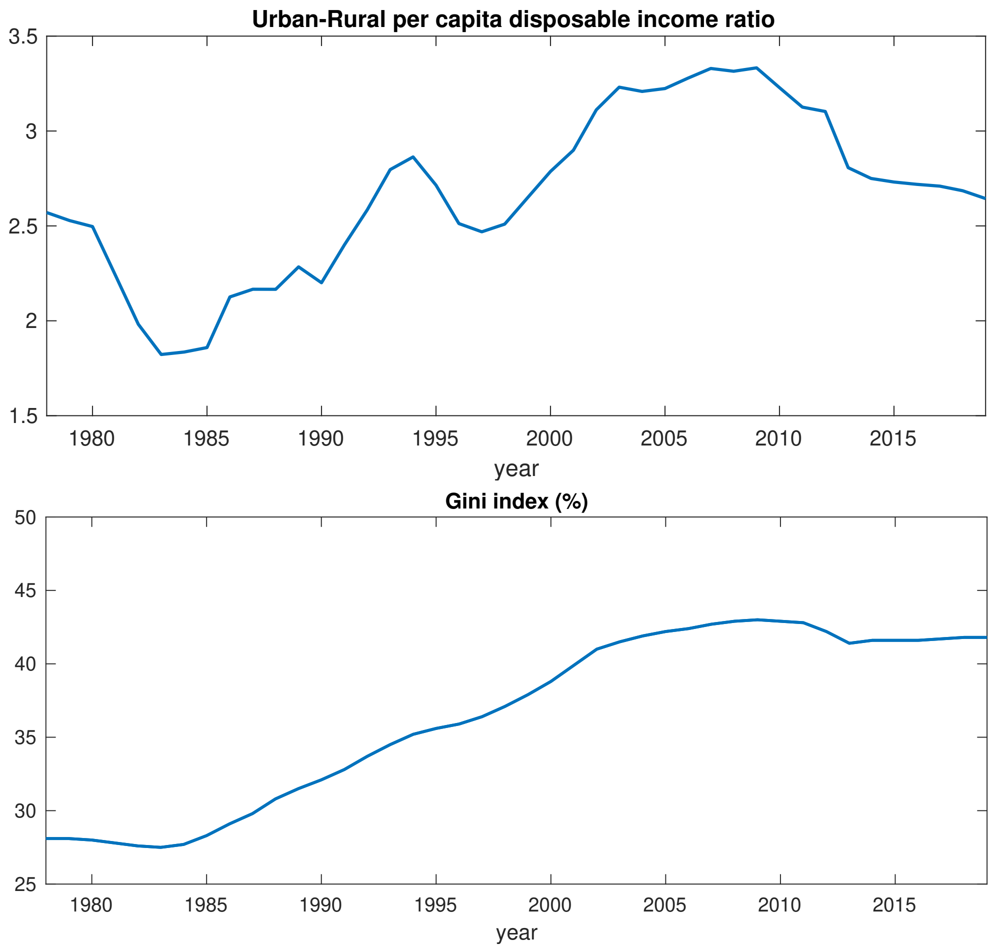
I adopt two indices, the urban-rural per capita disposal income ratio and the Gini index, to measure the income inequality. Figure 2 describes the information for the historical income ratio series.

Gini index is widely used to measure income inequality in the academic world, but I treat the estimation based on this index as the complimentary evidence in addition to the estimation based on the regional inequality ratio. Because the reliable and consistent official source of the historical Gini index for China is rarely available. From the World Income Inequality Database (WIID) and the NBS, I can find the consecutive Gini index since 1978, but I still have serious issues that can never be solved. First of all, for each year, there are multiple indices. For example, there are 3 different resources with 3 very different 2012 Gini indices (all population): the World Bank (42.16), the NBS (47.4), and China Family Panel Study (48), taking the average may not be an excellent choice. Next, the entire 1978-2019 historical Gini index series is not available from any single resource included in WIID, not even the NBS. NBS introduced a new statistical standard to calculate the Gini index in 2013 and only provides the recalculated historical index starting from 2003, therefore the Gini index before 2003 is not comparable.

The Gini indices of disposable income used in this paper are from SWIID. These Gini indices are collected, estimated, and generated to be comparable across the countries over time by incorporates data from many resources: the OECD Income Distribution Database, the Socio-Economic Database for Latin America and the Caribbean generated by CEDLAS and the World Bank, Eurostat, the World Bank's PovcalNet, the UN Economic Commission for Latin America and the Caribbean, national statistical offices around the world, and academic studies. They are not directly calculated from microdata.

In the meantime, the urban-rural per capita disposal income ratio is consistently reported by the NBS from 1978, and in the statistical yearbook (2017) the ratio, together with the Gini coefficient, is designated as the indicator for the index of the income or wealth inequality under "the National Economic and Social Development — Ratio and Performance Indicators" section. The urban-rural income ratio has the urban income at the numerator, therefore it is always larger than 1, and the data show the ratios range from 1.82 (1983) to 3.33 (2009).

Fig. 2. Income inequality indices



NOTES: Figure 2 shows the two income inequality indices series. The upper plot is for historical urban-rural income ratio series 1978-2019. The income ratio has the urban income at the numerator, therefore it is always larger than 1, and the data show the ratios range from 1.82 (1983) to 3.33 (2009). The lower plot is for historical Gini index series 1978-2019.

4 Results

4.1 The output effects and the stimulation for the economy

4.1.1 The impulse responses to the government spending

Before getting to multipliers, allow me to introduce the impulse responses functions for the key macro-variables to the government spending shocks. Plugging each pair of the appropriately converted variables — GDP and government spending, private consumption and government spending, the private investment and government spending — on the left-hand side of equation 1, I could obtain the impulse response functions of the government spending, GDP, private consumption and private investment to a fiscal shock. [5]

Figure 3 shows the responses of government spending, output, private consumption, and investment to a fiscal shock and its corresponding 95% confidence interval. I standardize the responses by the first period responses of government spending so that I can easily observe the impact multipliers for output, private consumption, and investment by reading the first period value.

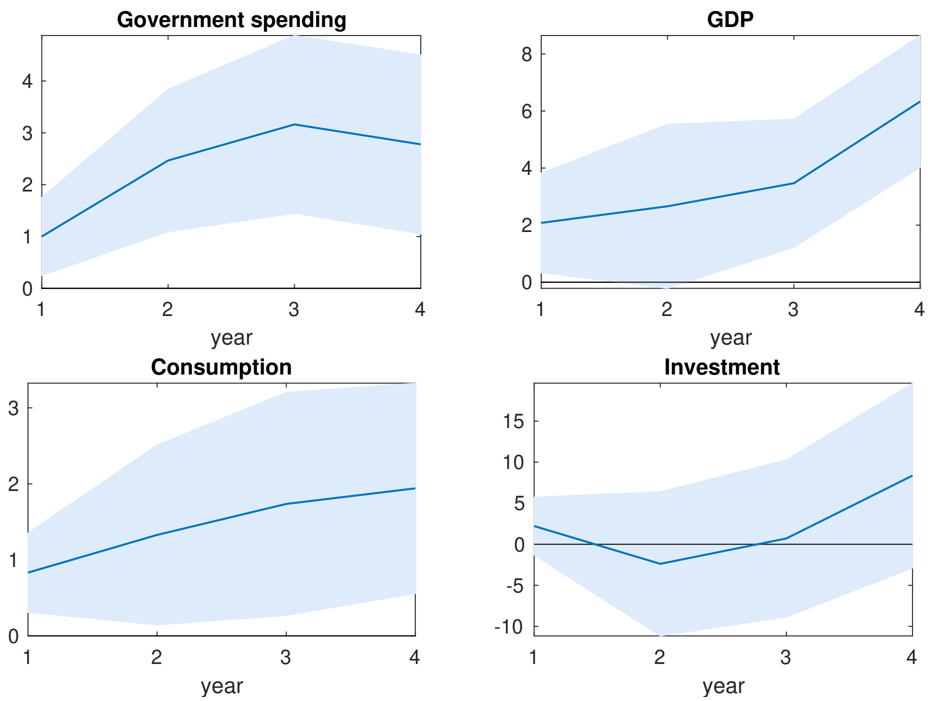
Pictures in figure 3 present that the response of an expansionary shock can lead to the positive impact impulse responses of GDP, private consumption, and investment. Be specifically, the first panel is GDP responses. After a fiscal shock, at least four years (including the shock year) positive increasing output responses mean that a positive shock will certainly boost the output growth rate in the short-run as well as in the long run. [6] At the same time, the government spending responses are also significantly positive during the 4 years' period, will become insignificant in the 5th year. The second row of Figure 3 reveal that the positive shock induces the Chinese people to consume and invest. However, effects on investment are not significant for the first 3 years.

Remember that due to the transformation of the variables and standardization of responses, the

[5] As mentioned in Section II, the transformed government spending series in each pair varies a little because of the different denominators, thus it may demonstrate the slightly different impulse responses. For each pair of key variables other than the GDP and government spending pair, I stay G still and replace Y with the key variables correspondingly for the left-hand side variables. For example, for private consumption, I transformed the left hand side variables x as: Transformed C : $(C_{t+h} - C_{t-1})/C_{t-1}$ and Transformed G : $(G_{t+h} - G_{t-1})/C_{t-1}$, so that the IRFs for private consumption to government spending shock is the percentage change of consumption. From doing this, the IRFs for each variable to government spending shock represent the percentage change of itself and can be comparable after the standardization of IRFs of government spending. Especially, for the income inequality indices variables. But the disadvantage is the IRFs of government spending are not identical for all pairs of variables, because the transformed government spending variable is not the same for each pair of variables. In the paper, I only report IRFs for government spending as percent of GDP. I report the IRFs for each pair of variables to government spending shock including government spending responses in the appendix, in which you can observe the slightly different IRFs of government spending.

[6] The positive responses of GDP are not exploded forever, in the end, it will converge back to zero in the 10-year horizon. The result is attached in the Appendix.

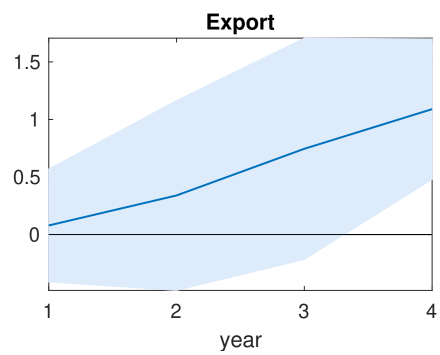
Fig. 3. IRFs of government spending, GDP, consumption and investment



NOTES: Figure 3 shows the responses of government spending, output, private consumption and investment to a fiscal shock and its corresponding 95% confidence interval for the 4-year horizon. The X-axis shows years, and Y-axis is the impulse responses (percentage change) of each variable to 1 unit change of shock. The impluse responses are standarized by the first period responses of government spending for all following IRFs' figures.

numerical values of the impulse response functions for each variable are not straightforward to explain. Take the first panel as an example, the impact response for government spending is 1, and GDP is around 2, it does not simply mean when there is 1 unit change of shock, there will be 1 unit change of government spending and 2 unit change of GDP. It should be interpreted as: When there is 1 unit change of shock (1% change of government spending shock with respect to output), after the standardization, the government spending will change 1% with respect to output, while the GDP will increase 2%. The ratio between 2% and 1%, is exactly the impact multiplier of GDP to government spending because of the data transformation. For private consumption, when there is 1 unit change of shock (1% change of government spending shock with respect to output), consumption will 0.83% after standardized 1% change of government spending with respect to consumption on impact, and the impact multiplier of consumption is 0.83. As a result, for IRFs in this paper, the directions of the responses should be the main point.

Fig. 4. IRFs of government spending and export



NOTES: Figure 4 shows the responses of government spending and export to a fiscal shock and its corresponding 95% confidence interval for the 4-year horizon. The X-axis shows years, and Y-axis is the impulse responses (percentage change) of each variable to 1 unit change of shock.

As we know that, China has more and more export to the world, export is 19% of GDP on average during 1978-2019 according to the World Bank, peaked at 36% at 2006. It would be helpful if considering an open economy, in other words, it would be useful to analyze international trade changes after a government spending shock if one wants to check the channels leading to the large and positive GDP responses under the open economy.

As a result, I plot Figure 4 to show the IRFs of export. The reason that I do not report import or net export is that the impulse response functions of the import and export data are not reasonable when using 1978-2019, on account of multiple extreme changes during these years. [7]

[7] For the import in local currency, the change between 1984-1985 is larger than 100%, and the change between 1993-1994 is 66%. For net export, 1981-1982 it changes from a very small negative to a large positive value, and the change rate is more than 40000%. And multiple years have more than 100% change relative to previous year. Ignoring all these abnormal values will lead to a too short sample starting 2006.

Traditional open economy theory argues that additional fiscal spending which might lead to demand increase will finally cause appreciation pressure on local currency through an exchange rate channel. Thus the country will export more and import less, and summing them together, government spending increase crowds out net export, and finally lead to a smaller output multiplier. However, if the exchange rate is fixed, then the crowding out of net export will not happened, and the output multiplier should be larger. China has a relatively fixed exchange rate, which means money authority will try to balance the local currency appreciation caused by government spending increase. Therefore, the export will not drop, further, may expect net exports will not be crowded out. Figure 4 verifies that this is the situation in China. In the first 3 years, the export does not significantly change after government spending shock. In year 4, the positive significant response of export might come from the other channel related to government spending other than exchange rate channel.

4.1.2 The government spending multipliers and effects

Table 2: Government spending Multipliers

	Impact multipliers	4-year integral multipliers
GDP	2.08	1.55
	(0.31)	(0.78)
CON	0.83	0.73
	(0.49)	(0.43)
INV	0.84	0.82
	(1.72)	(2.76)
EXP	0.07	0.28
	(0.52)	(0.54)

NOTES: Table 2 reports the government spending multipliers for output, private consumption, private investment and exports, and the values in brackets under the multipliers are the corresponding standard errors.

Table 2 reports the government spending multipliers for output, private consumption, private investment and exports, and the values in brackets under the multipliers are the corresponding standard errors. The impact output multiplier is 2.08 and the 4-year integral multiplier is 1.55, both are far in excess of 1, which indicates that an increase of 1 RMB in government spending in China will add 2.08 RMB output for within 1-year horizon and still can create 1.55 RMB output in 4-years horizon. The large spending multipliers imply that the GDP growth rate can be pulled up by the government expenditures in China.

Further, the second row of Table 2 shows that government spending can significantly encourage private consumption, 0.83 within 1 year and 0.73 for a longer period. And in the third and fourth row of table 2, there is no evidence that government spending crowds out the private investment since the positive multipliers are low and insignificant all the way. Finally, the last row is a simple reference for open economy analysis which verifies that government spending does not crowd out exports in China. In short, the government spending is harmless in the Chinese economy. And the crowded in private consumption contributes to the large output multipliers.

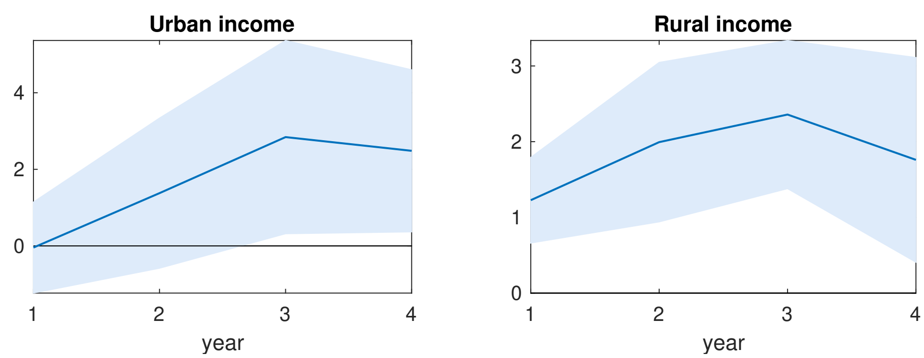
4.2 The income effects and the reduction of the inequality

4.2.1 The effects on urban and rural income

According to the historical urban-rural per capita disposal income data, the urban-rural income ratios are more than 3 during 2002-2012, giving China one of the highest urban-rural income ratios in the world. Can the government spending relieve the severe regional income inequality while it can multiply the average income level in the society?

To find out the answer, I begin with checking the urban and rural income effects separately, then investigate the regional income inequality effects indicated by the urban-rural per capita disposal income ratio. In the results section IV, I investigate the naive income (GDP per capita) effects indicated by output multipliers in the first place, then in this sub-section I focus on the regional household income effects indicated by the rural or urban per capita disposal income. The latter effects are more accurately and closely linked with the government spending policy and real welfare of individuals in urban and rural areas. Hence, they should be given equal or even more attention than the naive output multipliers.

Fig. 5. IRFs of government spending, urban and rural income



NOTES: Figure 5 shows the responses of urban and rural income to a fiscal shock and its corresponding 95% confidence interval for the 4-year horizon. The X-axis shows years, and Y-axis is the impulse responses (percentage change) of each variable to 1 unit change of shock.

The Figure 5 shows the responses urban and rural per capita disposable income to a fiscal shock and the 95% confidence interval. The pictures illustrate that the response of expansionary shock

Table 3: Government spending effects on urban and rural income

	Impact effects	4-year integral effects
URBANINCOME	−0.04	0.94
	(2.32)	(0.48)
RURALINCOME	1.23	0.72
	(0.57)	(0.35)
URBAN-RURAL RATIO	−0.79	−0.34
	(0.37)	(0.12)
GINI	−1.35	−1.05
	(0.70)	(0.54)

NOTES: Table 3 reports the government spending effects on urban and rural income, urban-rural income ratio and Gini index. The numbers in brackets are the corresponding standard errors.

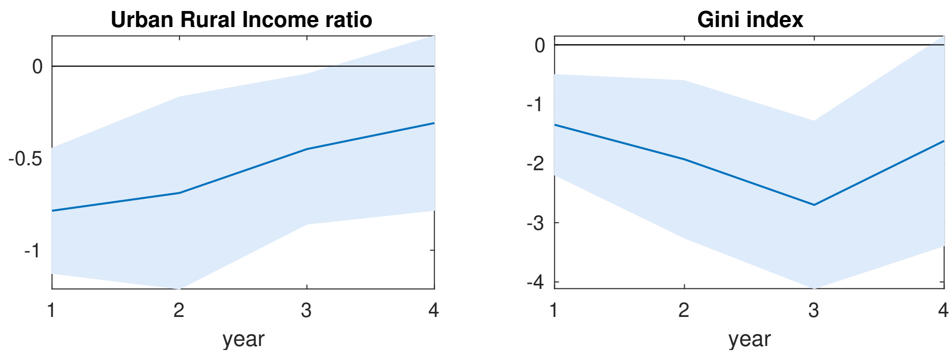
can lead to the positive impulse responses of income of urban and rural residences for at least 4 years, except for an insignificant small and negative impact on urban residences' income. The first two rows of Table 3 give the government spending effects on the urban and rural per capita disposable income: 1 more RMB per capita spending by the government will finally benefit urban residence by 0.94 RMB and rural residence by 0.72 RMB earning during 4 years. To sum up, a positive fiscal shock significantly increases the income in the countryside all the time, while it significantly increases the income in town in the long-term – a solid evidence that the government spending can improve the people's living standards in both areas in the long run.

4.2.2 The effects on the regional income inequality and national income inequality

The left plot of figure 6 presents the responses of urban-rural per capita disposable income ratio to a fiscal shock. The impulse responses in the first 3 years of the pictures reflect that an expansionary shock can lead to the negative responses of the ratio which means it can redress the regional income inequality for many years, even though the negative impact response in the fourth year is not significant. Then, turn to the second to last row of Table 3. Government spending generates significant negative effects on the ratio: 1 more RMB spending per capita by the government will reduce the regional income ratio by 0.79 on impact and by 0.34 for 4-year horizon. To summarize, the government spending can significantly address the regional inequality problem.

Since people may argue that the population mobility between urban and rural areas might affect the urban and rural income level, and make the urban-rural income ratio not consistently comparable over time. I choose to use an estimated Gini index variable to represents national income inequality and investigate if government spending also can reduce national income inequality. Figure 6 also

Fig. 6. IRFs of government spending and urban-rural income ratio



NOTES: Figure 6 shows the responses of urban-rural income ratio and Gini index to a fiscal shock and its corresponding 95% confidence interval for the 4-year horizon. The X-axis shows years, and Y-axis is the impulse responses (percentage change) of each variable to 1 unit change of shock.

shows the responses the Gini index to a fiscal shock on the right-hand side plot. And from Table 3, 1 more RMB spending per capita by the government will reduce the Gini index by 1.35 on impact and around 1 in the long run. The Gini index is usually standardized between 0 to 1 without a unit. The unit of Gini index from SWIID I used is "%", correspondingly, the range of Gini index is 0% -100%. Dropping 1.35 of Gini index means a -1.35 percentage point change of Gini coefficient. If considering Gini index is 50% at the beginning, the -1.35 percentage point change is changing from 50% to 48.65% which would be -0.027 percentage change. And this percentage change will be larger in absolute value if the base Gini index is smaller. There is not much previous literature that calculates the inequality multipliers especially for China. In the most related paper, Furceri, Loungani, and Melina (2018), by using a pooled sample with 103 developing courtiers including China, they conclude that the cumulative 5-year inequality multipliers is around -1 under different model specifications [8]. And the persistent significantly negative responses of the Gini index confirm that fiscal spending in China reduces inequality.

4.3 Discussion

A well-known American economist Arthur Okun in his 1975 book *Equality and Efficiency: The Big Tradeoff*, argues that pursuing equality must injure efficiency. And the empirical and analytical results for many countries have proved this viewpoint, and taking America as an example, by using the similar econometric methodology, the economists demonstrate that the U.S. government spending can reduce inequality (Ma (2018)) but it lacks efficiency when the multipliers are smaller than 1 as in Ramey and Zubairy (2018). However, in my study, the evidence from China breaks

[8] Note that their defination is not identical to my paper. Their defination: A cumulative decrease in government spending of 1 percent of GDP over 5 years is associated with a cumulative increase in the net Gini coefficient over the same period of about 1 percentage point.

this conservation law, and proves that government spending still can be a win-win policy in China.

To explain the success of the government spending policies in China, I can briefly give following potential explanations: Firstly, Chinese government chooses to invest or subsidize the fields that are not so attractive to the market investors: infrastructure construction, education, science and technology, medical system and other social security and insurance system. These fields either require a large amount of investment to attain the optimal return of scale, or have the low or/and long-period return on investment (ROI). Thus, the vacancy filling government spending can become indispensable and efficient. The composition of the government spending partially supports my argument. From data between 1950 to 2006, infrastructure construction (category name: Investment in Capital Construction) accounts for at least around 30% of fiscal expenditures on average. There still are some infrastructure expenditures accounted in other subcategories and difficult to identify. From 2007-2016 data [9], we can have: on average national government expenditure on Education is 15%, on General public is 11%, on Social Safety Net and Employment is 11%, on Agriculture, Forestry and Water Conservancy is 9%, on Defense is 6%, on Transportation is 6%, on Public Security is 6%, on Science and Technology is 4%; and during this period, the government spending on Urban and Rural Community Affairs changes from 6% to 10%, Medical and Health Care from 3% to 7%, etc. In addition, the insignificant crowd-out effects on private investment confirm my argument from another perspective.

Secondly, the central and local governments always pay attention to the agriculture, rural areas and farmers in China ever since the early 1950s, and named them as the "Three rural issues" in 2002. Data from 1950-2006 reflect that expenditure on Agriculture and Support Agriculture is at least around 15% of national fiscal expenditure, and since 2007, this number is at least around 9% on average. Therefore, the public expenditures tend to support agriculture to improve farmers' income in China. As a result, the problem of regional income inequality is moderated because of the policy advantages.

Finally, rule of thumb consumers, sticky price and complementary relationship between public investment and private investment and relatively fixed exchange rate might be the theoretical reasons behind large significantly positive private consumption responses, small insignificantly positive investment responses and small insignificantly export responses to government spending. The theoretical mechanism may be studied in another article in the future.

[9] According to NBS: Compared with the previous years, the classifications of revenue and expenditure accounts have been adjusted largely in 2007, the relative data are not comparable. Expenditure of Government has adopted New statistical classification since 2007. There is no infrastructure construction category (Investment in Capital Construction) since 2007, and infrastructure expenditure are separated in different subcategories so that hard to calculate.

5 Robustness Checks

5.1 SVAR shocks with LP-IV estimation

5.1.1 The basic model

In this part, I use an alternative shock series and the same econometric methodology as in the previous part, expecting to check the robustness of the estimation results. In order to realize the alternative series, I decide to construct a recursive SVAR model similar to Wang and Wen (2017) and the basic model looks as follows:

The structural form VAR(p) model:

$$B_0 y_t = B_1 y_{t-1} + ... + B_p y_{t-p} + \omega_t = BY_{t-1} + \omega_t$$

Where $Y'_{t-1} \equiv [y'_{t-1}, ..., y'_{t-p}]$, $B \equiv [B_1, ..., B_p]$, and $\omega_t \sim N(0, \Sigma_\omega)$. Its corresponding reduced form:

$$y_t = A_1 y_{t-1} + ... + A_p y_{t-p} + u_t = AY_{t-1} + u_t$$

Where $A \equiv [A_1, ..., A_p] = B_0^{-1} B$, and $u_t = B_0^{-1} \omega_t$, with $u_t \sim N(0, \Sigma_u)$.

Moreover, y_t is a vector (with k-dimention) including the logarithm form of Government Spending, Output, Consumption and Investment in order. Here I choose the same variables and orders as the Wang and Wen's paper in their VAR model, pick P=1 by BIC and involve a linear-quadratic time trend. But I plug the gross investment that contains the government and private investment instead of only the private investment because the latter series can only be found since 1981. [10] And the identification assumptions are similar to other traditional recursive SVAR. Then, my alternative shock series is the residuals from the reduced formed VAR(p) model as shown in first pannel of Figure 7. The correlation between two shock series is 0.4.[11]

5.1.2 Estimation results for SVAR shocks with LP-IV estimation

[10] In Wang and Wen (2017), they use the 1978 -2011 annual data including "the aggregate investment variable by gross private fixed capital formation" which comes from the National Bureau of Statistics of China (China Statistical Yearbook, 2012), without offering the detailed variable statistics information. According to the findings, there is not any variable that can indicate the 1978-1981 Private Fixed Capital Formation in China Statistical Yearbook, but there are only variables that can indicate the Total Fixed Capital Formation. I finally find the variable Gross Fixed Capital Investment from private funds starting in 1981, and take it as the indicator of the private investment variable in my baseline model.

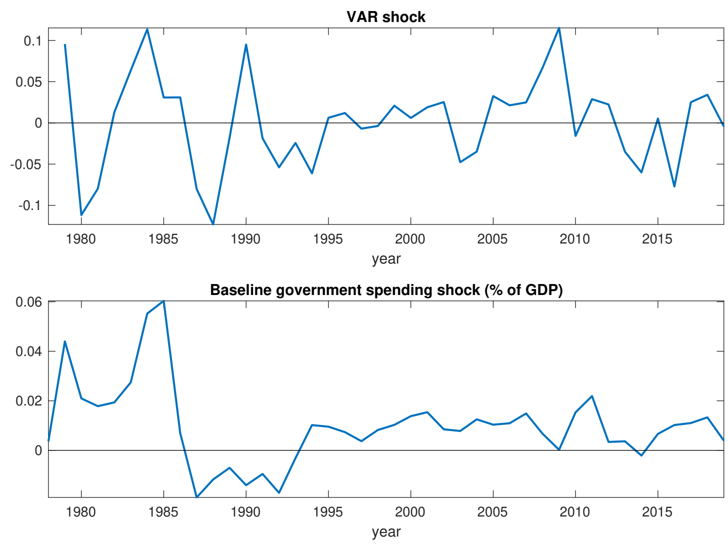
[11] when using private investment instead of total investment, the correlation between constructed VAR shock series and baseline shock series is 0.5.

Table 4: SVAR shocks with LP: Government spending mulitpliers and effects

	Impact multipliers (effects)	4-year integral multipliers (effects)
GDP	1.49	1.04
	(0.43)	(0.44)
CON	0.24	0.56
	(0.14)	(0.10)
INV	0.06	0.64
	(0.33)	(0.50)
EXP	0.17	0.87
	(0.33)	(0.93)
URBANINCOME	0.22	0.67
	(0.42)	(0.22)
RURALINCOME	0.81	0.55
	(0.11)	(0.08)
URBAN-RURAL RATIO	−0.23	−0.09
	(0.10)	(0.10)
GINI	−1.38	−0.82
	(0.10)	(0.10)

NOTES: The values in this table are preliminary, may be updated later. Two versions of codes provides different results, further check is needed. But both of them have similar characteristics.

Fig. 7. SVAR shocks and baseline shocks



Taking VAR shock series [12] as the instrument of equation 3, I can easily find the multipliers and effects of the government spending.

Table 4 shows the new results. Similar to the baseline model estimates, the higher than 1 short-run and long-run output multipliers indicate fiscal spending is good for domestic production. In addition, 1 RMB government spending per capita increase can make the urban-rural ratio and Gini coefficient significantly decreases in 1-year horizon, and in 4-year horizon, the effect is still negative although insignificant. The government spending effects on other variables have the same attributes: the crowd-in effect on private consumption, crowd-in but not significant on private investment; remarkably increasing the earnings for both urban and rural residences.

Nevertheless, the degree of most of the effects are smaller than the baseline model. The reasons for the differences could be that: the simple VAR shocks may still contain remaining information which can affect current period or future period macroeconomic variables through the channel other than government spending. Hence, the VAR shocks may have a different impact on macroeconomic variables comparing to baseline shocks.

5.2 Baseline shocks with SVAR estimation

In another robustness check, I insert the constructed baseline shock series into a SVAR model and estimate the impulse response functions and then transform them into multipliers by multiplying

[12]Transformed from % of government spending into the % of previous period output

with the corresponding ratios. [13] [14] In this new SVAR model, I order baseline shock series first, then Government Spending, Output, Consumption and Investment subsequently in order. [15]

Table 5: Baseline shocks with SVAR: Government spending mulitpliers

	Impact multipliers	4-year integral multipliers
GDP	2.32	1.72
CON	0.88	0.92
INV	0.72	0.63

Table 5 shows the multipliers for output, consumption and investment. As it can be seen in table 5, impact and 4 years output multipliers have a similar magnitude as large as baseline point estimates in Table 2, 2.32 and 1.72 respectively. From Table 5, crowding in effects are shown in private consumption and investment, while they mainly come from private consumption.[16] Those results are in line with baseline model.

[13]The GDP to government spending ratio is 5.5; consumption to government spending ratio is 2.5; and investment to government spending ratio is 1.94.

[14]Impulse response functions of all variables can be found in Appendix.

[15]Since there is a lack of theories or related literature about the setting and the ordering of variables when applying SVAR to estimate the impulse responses of the urban and rural income and the income ratio or Gini index for the robustness check, I only do SVAR for government spending, output, consumption, and investment. The reason to abandon export is to avoid high colinearity in this system.

[16]Impulse response functions of private investment are not significant while private consumption has large and significant positive responses during the 4 years.

6 Conclusion

This study investigates the macroeconomic effects of government spending, especially effects on output and income inequality. Using a constructed "forecasting" government spending shock series as an instrument, I adopt the LP-IV method to estimate the impulse response functions and multipliers or effects with the 1978-2019 annual data in China.

The analysis results prove that government spending in China can generate large multipliers and can reduce income inequality as well. I find that the output multiplier in China is 2.08 on impact, and it is still larger than 1.5 at the 4-year horizon; the government spending does not have significant crowd-out effects on private investment and export, while it has significant crowd-in effects on private consumption. Regarding income inequality, as the authorities spend additional RMB per capita on the market, the urban-rural per capita disposable income ratio will drop by 0.79 on impact and drop by 0.34 in the long run, meanwhile, Gini coefficient also decreases by 1.35 and 1.05 in short-run and long-run. All in all, the expansionary government spending will not bring about any undesirable consequences generally. By a stimulus program, as is discussed in the paper, the Chinese government expenditure can certainly boost its economy and improve the people's living standards, in the meantime, it helps to eliminate the income inequality in the Chinese society.

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