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ORIGINAL PAPER

Fiscal policy and economic growth: some evidence from China

Jungsuk Kim[1] · Mengxi Wang[1] · Donghyun Park[1] · Cynthia Castillejos Petalcorin[1]

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Abstract
China has experienced profound economic and social changes in recent decades. During this period, China's fiscal policy framework has been substantially reformed. The objective of this paper is to better understand the key features of the Chinese fiscal system and their impact on China's economic growth. The study performs empirical analysis to identify the relationship between fiscal policy variables and economic growth. Its evidence suggests that local expenditures growth has a larger impact on output growth than central expenditures growth. The results also reveal that the response of output growth to anticipated changes in taxation was impeded by liquidity constraints. During the initial stages of market-oriented reform, growth of public investment in manufacturing sector contributed the most to output growth. During more recent periods, public investment in R&D made a substantial contribution. In addition, evidence indicates that long-term debt has a significant influence on China's fiscal system, especially on government revenues.

Keywords Fiscal revenue · Fiscal expenditure · Fiscal policy · Economic growth · China · Structural vector autoregression

JEL Classification E60 · E62

1 Introduction

The strategic challenge facing Chinese policymakers is to ensure a gradual and smooth transition toward a more sustainable growth paradigm while maintaining healthy growth rates. The COVID-19 pandemic further strengthens the case for sustainable growth which protects the environment and benefits the poor. While Chinese policymakers have a number of policy tools at their disposal, fiscal policy—i.e.

✉ Jungsuk Kim
js_kim@sejong.ac.kr

1 Sejong University, Seoul, Republic of Korea

taxation and government expenditure is likely to be at the front and center of any policy package which can help China build back better after the pandemic. For example, fiscal spending on social safety nets may reduce risk and uncertainty facing households and thus encourage them to save less and spend more, thus strengthening domestic demand and economic recovery. Likewise, fiscal spending on COVID-19 vaccines can restore the health of the workforce and reduce social distancing restrictions which limit mobility, thus paving the way for the normalization of economic activity. Furthermore, an effective taxation system is needed to secure the fiscal resources for fiscal spending that promotes sustainable growth.

More generally, fiscal policy can influence economic growth through both macroeconomic and microeconomic channels (IMF, 2015a). At the macroeconomic level, fiscal sustainability is the cornerstone of macroeconomic stability, which, in turn, is indispensable for economic growth. When the government spends more than its income—i.e. tax and non-tax revenues it collects on a sustained basis, the inevitable outcome is macroeconomic instability, which creates uncertainty among companies and deters private investment. At the microeconomic level, both taxes and spending can influence the behavior of firms in ways that can promote growth. For example, well-targeted tax incentives can promote greater investment by companies and foster higher productivity through research and development (R&D). Another example is public spending on education and health care, which contribute to human capital formation, a core ingredient of economic growth.

The central objective of our paper is to empirically examine the relationship between fiscal policy and economic growth in China. The effectiveness of China's countercyclical fiscal response to the global financial crisis highlighted the sizable impact of fiscal policy on short-term growth. However, in this paper, we are interested in the effect of fiscal policy on China's growth beyond the short term.

Our paper contributes to the existing empirical literature on the nexus between fiscal policy and economic growth in China in a number of ways. Above all, we look at the growth impact of not only central government's fiscal policy but also the impact of local governments' fiscal policy. In light of the substantial role of local governments in China's fiscal policy, examining the impact both central and local governments on China's economic growth gives us a more accurate understanding of the effect of fiscal policy on China's growth. In addition, our empirical analysis is enriched and extended in several significant directions. In particular, we incorporate both investment and external debt into our empirical analysis of the link between fiscal policy and economic growth in China. Furthermore, we divide the sample period into three different sub-sample periods of China's economic development. In addition, our analysis distinguishes between automatic fiscal policy and discretionary fiscal policy.

Our econometric analysis yields a number of interesting findings. Our evidence suggests that local government expenditures have a larger impact on output growth than central government expenditures or net taxes. In addition, both government expenditure and net tax multipliers seem to change during the course of a business cycle. However, net tax growth becomes relatively but progressively more influential in the long run. The rest of this paper is organized as follows. Section 2 briefly reviews the relevant literature, Sect. 3 describes the data and methodology, Sect. 4 reports and discusses the empirical results, and Sect. 5 concludes the paper.

2 Literature review

There is a growing literature on the relationship between fiscal policy and economic growth. Through government expenditure and taxation, fiscal policy can have lasting effects on medium- and long-term economic growth through several major channels. However, the mix of appropriate policies will depend on the idiosyncratic conditions, capacities, and preferences of each country (IMF, 2015b). The country-specific nature of policy mix ensures that the policy track is sustainable in the short- and long run and also enhances the credibility of authorities (Kumhof et al., 2010).

Fiscal policy can promote economic growth through both macroeconomic and microeconomic channels. At the macroeconomic level, sound and responsible fiscal policy can affect aggregate demand and stabilize the economic cycle, thus boosting business confidence, investment, and long-term growth. At the microeconomic level, fiscal policy can impact private sector behavior via encouraging employment, investment, and productivity. (IMF, 2015b; Gerson, 1999). For example, efficient public investment in infrastructure can boost the productivity of all firms and industries, and reforming capital income taxes can encourage private investment. It is also important to understand the feedback between microeconomic effects and aggregate effects (Ramey, 2009).

The distinctive features of new Keynesian conditions include imperfect competition, forward looking expectations by individuals and firms, and some form of rigidity in prices or wages. New Keynesian model arguably remains the dominant framework in most policy modeling (Gali, 2018). Since policy interest rates fell to their near-zero levels in the aftermath of the 2009 global financial crisis (GFC), there is a renewed enthusiasm in new Keynesian models to examine fiscal policy effectiveness at the zero lower bound of nominal interest (e.g. Christiano et al., 2011; Eggertson, 2009).

Policymakers around the world turned to fiscal stimulus packages to support economic growth during GFC (Ramey, 2009). US and European countries adopted countercyclical fiscal policies, including tax cuts and government purchases, mainly to boost short-run and medium-run growth (Ramey, 2009). Many economies in developing Asia too implemented countercyclical fiscal policy to support domestic demand during the global crisis (Jha et al., 2014). In comparing the magnitude of government spending multipliers in US, Cogan et al., (2010) found out that the GDP and employment impacts estimated by using new Keynesian model are much smaller than the estimates from old Keynesian models.

A growing number of studies on advanced economies based on various modelling refinements provide a mixed picture of size of the fiscal multiplier. For fiscal policy to be effective, the government multiplier should be large to make a difference in the direction of the economy. However, multipliers are largely dependent on varying country-specific circumstances (Ramey & Zubairy, 2014).

Distinguishing between recessions and expansions, Riera-Crichton et al. (2014) found out that the response of the economy to changes in government spending is asymmetric. The long-run multiplier for bad times is 2.3 compared to 1.3 for good times, and up to 3.1 for extreme recessions. On the other hand, using US quarterly data covering wars and recessions, Ramey and Zubairy (2014) found that the estimated multipliers are below 1 irrespective of the amount of slack in the economy. But the results are more mixed for the lower zero bound state, with some specifications producing multipliers as high as 1.5. An extensive literature review by Hemming et al. (2002) concluded that fiscal multipliers are overwhelmingly positive but small. In a study of 10 developing Asian economies in 1985–1999, Jha et al. (2014) computed the tax-cut multipliers to be 2.0 at its maximum over a two-year horizon while government expenditure multipliers are around 1.0.

A number of empirical studies support a positive relationship between fiscal policy and medium- and long-term economic growth. In advanced economies, the growth effect can be as high as 0.75 percentage points and even higher in developing countries. For example, IMF (2015c) finds that automatic fiscal stabilizers help prevent public debt accumulation and foster growth. Tax reform can lift long-term growth by as much as 0.5 percentage points while shifting the composition of government spending toward infrastructure can add 0.25 percentage points. Baldacci et al. (2010) concluded that fiscal deficit reductions based on broadening the tax base while maintaining public investment can support medium-term growth in both advanced and developing countries. Finally, macroeconomic instability associated with large fiscal deficits distorts price signals and thus causes volatility of returns on investment and misallocation of resources, see Fatás and Mihov (2013) and Fisher (1993).

The existing literature encompasses various empirical methodologies for assess the effect of fiscal policy shocks. The Cholesky identification approach assumes that fiscal policy variables and output variables do not have any structural effects on each other (e.g. Fatás & Mihov, 2001; Favero, 2002). The sign restriction approach, popularized by Uhlig (1997), identifies fiscal policy shocks using sign restrictions on impulse responses. The approach is traditionally used to assess the impact of monetary policy shocks (Mountford & Uhlig, 2002). Another is the strand of empirical studies which includes Romer (1994); Ramey and Shapiro (1999); Edelberg et al. (1998) and Blanchard and Perroti (1999, 2002). These studies distinguish between automatic policy and discretionary policy, and estimate the elasticity of tax on output using external information. Sims and Zha (1999) presented several issues related to the calculation of error bands using Monte Carlo integration, bootstrapping, and impulse response functions (IRFs) for structural vector autoregression (VAR). The methodology was further developed and refined by Perotti (2002). In contrast to monetary policy, decision and implementation lags in fiscal policy imply that there is limited scope for discretionary fiscal policy in response to unexpected movements in economic activity within a quarter.

Fiscal policy is making a substantial contribution to China's economic growth. For instance, a massive countercyclical fiscal stimulus during the GFC prevented a recession in China and contributed to the recovery of other emerging and developing economies (Fardoust et al., 2012). China's forceful fiscal response was made possible by the fact that China had ample fiscal space when the GFC hit. Kong and Feng (2019) find that China's fiscal policy is generally countercyclical and achieves its desired economic effects. Interestingly, a tax cut is found to have a positive impact on output in China (Jha et al. 2014; Kong & Feng, 2019). This can be attributed to taxation's function in promoting a more efficient resource allocation. For instance, Lam and Wingender (2015) find that improving the progressivity of personal income taxes, introducing property taxes, and setting up a comprehensive value-added tax can promote China's growth and boost fiscal revenues as well as reduce fiscal deficit.

Some studies have estimated China's fiscal multipliers. Using the IMF's GIMF model, Kumhof et al. (2010) find fiscal multipliers for China are broadly in line with United States. Chen et al. (2017) estimated that China's fiscal multiplier increased from 0.75 in 2001–2008 to 1.4 in 2010–2015, with the biggest impact on the manufacturing sector. Using annual data for 1,800 Chinese counties, Guo et al. (2016) obtained local government fiscal multipliers of approximately 0.6, which is much lower than the estimates of most previous studies. The effects of local public spending were most pronounced in non-tradable industries. Cove et al. (2010) calibrated New Keynesian model to China and finds that public expenditures which are managed by the local authority and can be financed by raising taxes on local households and issuing local government debt can have New Keynesian effects on output growth. Some province-level studies imply that that fiscal decentralization contributed to higher economic growth (Lin & Liu, 2000 and Jin et al. 2005).

3 Empirical framework

In this section, we describe the data and empirical framework used in our analysis. For developing countries such as China, monthly data are difficult to find even in statistical yearbook, so we use statistical way to transfer the yearly data into monthly data. For the Dickey-Fuller test and Phillips-Perron test, we converted all variables to first differences of natural logarithms to address the unit root problem in level data. Table 1 below lists the sources of our data and Table 2 below summarizes the mean values of data in three sub-periods—1985–1997, 1998─2007, and 2008─2015. The period from 1985 to 1997 marks the pre-Asian financial crisis (AFC) period, 1998–2007 is the period between AFC and global financial crisis (GFC), and 2008–2015 is the post-GFC period. To compare the effect of fiscal policy in the three sub-periods, we also denoted the three sub-periods from economic structure reform perspective. The 3 sub-periods are domestic demand-oriented model, three-wheel-oriented (investment, consumption, and trade) model, and export-oriented model, and they track the evolution of China's economic structure. For the identification of the fiscal policy shocks, the variables in the first structural model—government expenditure model are central government expenditure, local government expenditure, net tax, fixed asset investment, and gross domestic product per capital (GDP per capital).

In the Cholesky decomposition approach, there are several methods for estimating the precision matrix. For example, the order can be selected thorough

Table 1 Data sources. *Source*: Authors' calculations

Model	Variable list and sources
Government expenditure model (Model 1)	Central government expenditure, Local government expenditure, Net tax, Consumption, Trade balance and Gross domestic product per capital [Finance Yearbook of China (2016)]
Investment model (Model 2)	Investment in infrastructure, Investment in manufacturing, Investment in R&D [Statistical Yearbook of China (2003)]; Net tax and Gross national income [Finance Yearbook of China (2016)]
External debt model (Model 3)	Short-term debt and Long-term debt [Development Research Center of the State Council (DRCNet) Statistical Database System]; Government expenditure and Government revenue [Finance Yearbook of China (2016)]

Investment in infrastructure is calculated by adding investment in management of water, conservancy, environment and public facilities; transport, storage and post; production and supply of electricity, heat, water and gas; services to households, repair and other services; and education; culture, sports and entertainment and public management, social security and social organizations, between 1991 and 2014

All variables were deflated by the consumer price index (2015 = 100 and transformed to natural log form. All data are converted into monthly data series through Eviews

Table 2 Mean value of data classified by economic structure reform (Billion RMB). *Source*: Authors' calculations

Variable	GDP	Net Tax	Central government expenditure	Local government expenditure	Consumption	Trade balance
Domestic demand-oriented	3302.00	392.80	132.50	301.60	1538.50	49.40
Three-wheel-oriented	14,847.30	2188.50	708.60	1872.40	6122.50	714.60
Export-oriented	50,397.30	9149.20	1855.70	9792.40	18,089.20	1692.00

Variable	Gross National Income	Net Tax	Investment in infrastructure	Investment in manufacturing	Investment in R&D
Domestic demand-oriented	42,629.70	392.80	1749.40	557.80	257.30
Three-wheel-oriented	147,573.00	2188.50	10,994.00	7712.10	1410.60
Export-oriented	749,666.30	9149.20	34,508.10	39,962.60	8263.20

Variable	Short-term debt	Long-term debt	Government expenditure	Government revenue
Domestic demand-oriented	9408.10	4168.10	5843.30	6457.70
Three-wheel-oriented	16,877.80	6512.70	22,190.90	23,739.40
Export-oriented	38,190.30	13,285.90	42,266.50	43,521.80

Table 3 Summary statistics for the main variables used in analysis. *Source*: Authors' calculations

Variables	Observations	Mean	Standard deviation
Government expenditure model			
GDP	372	191,799	37,338
Net Tax	372	5,151	2,027
Central Government	372	7,630	1,334
Local Government	372	32,575	7,829
Consumption	372	72,884	13,219
Trade Balance	372	6,878	1,462
Investment model			
Gross National Income	372	2,762	201
Net Tax	372	5,151	2,027
Investment in infrastructure	372	473	47
Investment in manufacturing	372	482	59
Investment in R&D	372	99	13
External Debt model			
Short-term debt	372	115,367.0	15,427.8
Long-term debt	372	70,771.4	8,153.2
Government expenditure	372	197,912.2	27,843.8
Government revenue	372	208,665.3	28,579.5

comparison of the cross-correlation coefficients from the data, Granger causality verification, impact response function, or decomposition of expected error term (Chang & Tsay, 2010; Chen & Leng, 2015; Park, 2020; Wagaman & Levina, 2009). But in many applications, the variables often do not have a natural order. That is, the justifiable variable order is not available or the pre-determination of the variable order is not possible before the analysis (Xiaoning & Xinwei, 2020). When using structural VAR, one may order the variables with an economic rationale and in this case, the order would be specified by the author's own matrix (Ludvigson et al., 2020).

According to de Castro Fernández & Hernández de Cos (2006), in the ordering between variables such as taxes and expenditure, it could be quite difficult to fully justify which one should come first. Nevertheless, this choice does not seem to substantially affect the main results, mainly due to the low and non-significant correlation between expenditure and net-tax shocks. In this regard, we decided to re-estimate under the alternative assumption that taxes or consumption come first. Since the residuals of reduced-form in the expenditure and net-tax equations showed low and non-significant correlation, the differences with the baseline VAR results, if any, were minimal. As a matter of fact, none of the variables under analysis showed different response profiles and the output multipliers were almost identical.

Barro (1990) assumed that government expenditure is financed contemporaneously by a flat-rate income tax which is 0.25 for the Cobb–Douglas case. In our study, we removed the substitution effect between government expenditure and tax through applying 75% of tax as the original tax before regression. Then we follow

Perotti (2002) to build up a model including net tax but without division of the government sector into central versus local government. Table 3 below shows the summary statistics of the main variables.

The structural vector autoregression (SVAR) model can be formed as below:

$$y_t = A_1 y_{t-1} + A_2 y_{t-2} + \dots A_p y_{t-k} + Dx_t + e_t \quad (1)$$

$$\Delta y_t = \prod y_{t-1} + \sum_{i-1}^{p-1} \Gamma_t \Delta y_{t-1} + Dx_t + u_t \quad (2)$$

$$\Pi = \sum_{i=1}^{p} A_i - I,\ \Gamma_i = -\sum_{j=i+1}^{p} A_j$$

$$y_t = A1 + A_1 L + A_2 L^2 + \dots + A_p L^p = A \in_t = Be_t \quad (3)$$

Perotti (2002) divides fiscal policy into discretionary measures and automatic stabilizers. The effectiveness of discretionary measures is quantified by the size of the multipliers while the effectiveness of the automatic stabilizer is measured by the magnitude of an exogenous shock that fiscal policy can smoothen out. The formula to calculate net tax is:

$$NetTax = Revenues - Transfers$$

where

$$Revenues = Tax\ revenues + Nontax\ revenues$$

$$\begin{aligned} Transfers =& Social\ security\ transfers\ to\ households + Other\ transfers\ to\ households \\ &+ Subsidies\ to\ firms + Transfers\ abroad \end{aligned}$$

The orthogonalization matrix $P_s = A^{-1}B$ is then related to the error covariance matrix by $\Sigma = P_s P_s'$ in the short-run SVAR model.

The variables in the second structural model—the investment model—are investment in infrastructure, investment in manufacturing, investment in R&D, net tax, and GNI. We choose these three investment variables in light of the aggregate nature of the production functions. The exact contribution of infrastructure to productivity remains limited in the sense that the production function approach does not cover all welfare aspects of infrastructure investment. For example, the impact of infrastructure investments on consumers is not taken into account. Furthermore, the production function approach cannot give an ex-ante evaluation of specific investment projects. Industrial development plays an important role in the economic growth of developing countries such as China. Furthermore, manufacturing investment influences the productivity performance of these countries. Romer (1986) developed the endogenous growth model, in which technological innovation is created in a R&D sector that combines human capital and knowledge.

The second structural model also share the Cobb–Douglas production function which is in line with Gramlich (1994) and Voss et al (2003). In this model, public capital is disaggregated into various components. This exercise is similar in spirit to Easterly and Rebelo (1993) which also examines whether particular sectors of public investment are important for economic growth. In China's case, investment in infrastructure is calculated by adding investment in management of water, conservancy, environment and public facilities; transport, storage and post; production and supply of electricity, heat, water and gas, services to households, repair and other services; and education; culture, sports and entertainment and public management, and social security and social organizations. Data are collected for 1985–2015 from various editions of the Statistical Yearbook of China from 2003 through 2016.

In the third structural model, external debt is divided into short-term and long-term debt. Other variables are government expenditure and government revenue. Favero and Giavazzi (2007) emphasized the importance of including the debt feedback effect when estimating the effects of fiscal policy shocks. The identified system is:

$$Y_t = \sum_{i=1}^{n} A_i Y_{t-i} + \sum_{i=1}^{n} B_i (d_{t-i} - d^*) + u_t \tag{4}$$

$$d_{l,t} + d_{s,t} = \frac{1 + i_t}{\left(1 + \Delta\pi_t\right)\left(1 + \Delta y_t\right)} \left[(d_{l,t-1} - d_l^*\right) + (d_{s,t-1} - d_s^*)] + \frac{g_t - t_t}{y_t} \tag{5}$$

where $Y_t = \left(g_e g_r\right)$, which denote government expenditure and government revenue, $d_{l,t}$ is long-term debt to GDP ratio, $d_{s,t}$ is short-term debt to GDP ratio, and d_l^* and d_s^* are unconditional mean values.

Generally speaking, in terms of impulse-response functions, fiscal multipliers reflect the impact of fiscal variables on GDP or GNI, or $\frac{\Delta Y_t}{\Delta X_t}$, where X is government expenditure or tax. However, Davig et al. (2010) point out that current fiscal policy will affect future fiscal policy, which means that ordinary impulse response cannot accurately capture the impact of fiscal policy on the economy. Therefore, Perotti (2004) applies the SVAR model to calculate cumulative impulse response and cumulative multipliers as $\frac{\sum_{i=0}^{k} \Delta Y_{t+k}}{\sum_{i=0}^{k} \Delta X_{t+k}}$, which can be interpreted as the ratio of the cumulative value of GDP or GNI to the cumulative value of government expenditure or tax. In addition, Mountford and Uhlig (2009) develop a new method assuming the discount rate as $\frac{\sum_{i=0}^{k} \prod_{i=0}^{i} (1+\gamma_{t+i})^{-i} \Delta Y_{t+k}}{\sum_{i=0}^{k} \prod_{i=0}^{i} (1+\gamma_{t+i})^{-i} \Delta X_{t+k}}$. In our paper, we calculate the multipliers based on three models: $\frac{\Delta Y_t}{\Delta X_t} \times \frac{Y}{X}$; $\frac{\sum_{i=0}^{k} \Delta Y_{t+k}}{\sum_{i=0}^{k} \Delta X_{t+k}} \times \frac{Y}{X}$; and $\frac{\sum_{i=0}^{k} \prod_{i=0}^{i} (1+r_{t+i})^{-i} \Delta Y_{t+k}}{\sum_{i=0}^{k} \prod_{i=0}^{i} (1+r_{t+i})^{-i} \Delta X_{t+k}} \times \frac{Y}{X}$; which represent the multiplier, cumulative multiplier, and discounted cumulative multiplier.

Table 4 Johansen cointegration test results of Model 1. *Source*: Authors' calculations

Maximum rank	LL*	Eigenvalue	Trace statistic	1% critical value
0	547.07		233.62	103.18
1	590.44	0.96	146.87	76.07
2	626.58	0.93	50.15	54.46
3	644.56	0.73	29.64	35.65
4	657.09	0.60	13.58	20.04
5	661.63	0.29	4.49	6.65

VAR Specification includes unrestricted constant and three lags

*Log likelihood values

4 Empirical results

In this section, we discuss and report the main findings of our empirical analysis, for both the full sample period of 1985–2015 as well as the three sub-periods. We use monthly data because approving and implementing new measures in response to innovations in the macroeconomic variables typically takes at least one month. Therefore, the use of monthly variables allows for setting the discretionary contemporaneous response of government expenditure or net taxes to GNI to zero. Pre-regression analysis shows the presence of co-integrating relations and hence a possible specification of a vector error correction model but the number of long-term equations shows no feasibilities. Blanchard and Perotti (2002) find no significant differences between estimated results obtained with and without taking the co-integrating relation into account. With regard to the choice of the interest rate, most existing studies use the short-term interest rate. For example, Chan et al. (1992) uses the one-month US treasury bond yield, while Nowman (1997) uses the one-month LIBOR.[1] This study selects 7-day interbank interest rate as the discount rate. It should be pointed out that our sample period 1985 to 2015 coincides with a significant expansion of China's external debt in tandem with sustained rapid economic growth.

4.1 Test of Johansen cointegration

We use Johansen cointegration test to obtain preliminary evidence of cointegration relationships. The result provides evidence in favor of two cointegration relationship in Model 1. The lag length was chosen by final prediction error (FPE) to be 2.[2] Tables 4 and 5 show the results for Model 1 and Model 2, respectively.

[1] London Inter-bank Offer Rate.

[2] In determining the lag lengths of the Johansen's procedure, we have to select the smallest criteria which are statistically significant. The final prediction error (FPE) meets this condition and is superior to the other criteria. In addition to FPE, for choosing the lag lengths of the Johansen's procedure, we need to see if trace statistics is 5% higher than 1% critical value then we reject the null hypothesis that there is no cointegration among variables. We can accept the null hypothesis at rank 2 for model 1, and rank 3 for model 2 by assuring that there are no cointegrations among variables.

Table 5 Johansen cointegration test results of Model 2. *Source:* Authors' calculations

Maximum rank	LL*	Eigenvalue	Trace statistic	1% critical value
0	749.28		216.63	76.07
1	819.76	0.76	75.66	54.46
2	836.79	0.29	41.61	35.65
3	848.15	0.21	18.88	20.04
4	856.68	0.16	1.83	6.65

VAR Specification includes unrestricted constant and one lag

*Log likelihood values

In a similar way, the result of Johansen cointegration test for Model 2 shows evidence in favor of three cointegration relationship. The lag length was chosen by SBIC to be 1.[3]

4.2 Test for unit roots

The structural vector autoregressive (SVAR) methodology requires that all variables be stationary. Therefore, a formal analysis of the stochastic properties of the series is needed. We make alternative assumptions about the deterministic components of the model. More specifically, before our econometric analysis, we (a) remove the different sample means from the series, and (b) remove the different fitted-trend lines from the raw series. The second issue concerns the presence of unit roots in the series, which is tested by the standard Dickey-Fuller and Phillips–Perron tests. The results are reported in Table 6 below. Both tests reject the null of unit root for the first differences of the log of the series. The t-statistic for the null hypothesis of a unit root is tested with 4 lags at 5% significance critical values. Since the t-statistic values are smaller than the critical values, we reject the null of unit root at conventional significance levels.

4.3 Test for variables order

Considering the importance of variable order on VAR/SVAR results, we carried out Granger causality Wald tests for different VAR/SVAR results in order to find the most robust variable order. In model 1, the Granger causality Wald tests results with the best variable order are shown in Table 7. The same tests of Model 2 and Model 3 prove our model fits the best as well. The Granger causality tests show that there is a significant bidirectional causality from net taxes, central government expenditures, local government expenditures, consumption, and trade balance to GDP in China.

[3] In determining lag lengths for the Johansen's procedure, we need to choose the smallest criteria with statistically significant and here Schwarz's Bayesian (SBIC) information criterion processes is the smallest by showing most efficient and consistent than the other criteria.

Table 6 Augmented Dickey Fuller and Phillips-Perron test for unit roots. *Source* Authors' calculations

Government expenditure model							
Tests	Δy	Δnt	Δnc	Δnl	Δna	Δnb	
ADF	Critical value at 5%*	− 2.73 (− 1.95)	− 2.47 (− 1.95)	− 3.37 (− 1.95)	− 2.02 (− 1.95)	− 2.25 (− 1.95)	− 3.97 (− 1.95)
PP		− 3.03 (− 2.98)	− 3.41 (− 2.98)	− 3.58 (− 2.98)	− 4.01 (− 2.98)	− 3.00 (− 1.95)	− 7.10 (− 2.98)
Investment model							
Tests	Δy	Δt	Δi	Δm	Δr		
ADF	Critical value at 5%	− 2.73 (− 1.95)	− 2.98 (− 1.95)	− 2.25 (− 1.95)	− 3.56 (− 2.98)	− 2.31 (− 1.95)	
PP		− 3.03(− 2.98)	− 3.84 (− 1.95)	− 4.12 (− 1.95)	− 3.77 (− 2.98)	2.80 (− 1.95)	
External debt model							
Tests	Δds	Δdl	Δgr	Δge			
ADF	Critical value at 5%	− 2.15 (− 1.95)	− 3.19 (− 1.95)	− 2.43 (− 1.95)	− 3.61 (− 2.98)		
PP		− 2.89 (− 1.95)	− 3.32 (− 1.95)	− 2.95 (− 1.95)	− 6.18 (− 2.98)		

*Values in parenthesis are test statistics

Table 7 Granger causality Wald test for Model 1. Source: Authors' calculations

Equation	Excluded	Chi^2	DF*	*P*-value
Gross domestic product	Net tax	2058.9	4	0.000
	Central government expenditure	3777.4	4	0.000
	Local government expenditure	318.72	4	0.000
	Consumption	2586.3	4	0.000
	Trade balance	413.56	4	0.000
Net tax	GDP	460.5	4	0.000
	Central government expenditure	980.22	4	0.000
	Local government expenditure	675.85	4	0.000
	Consumption	747.72	4	0.000
	Trade balance	61.702	4	0.000
Central government expenditure	GDP	93.016	4	0.000
	Net Tax	157.14	4	0.000
	Local government expenditure	92.632	4	0.000
	Consumption	118.18	4	0.000
	Trade balance	43.925	4	0.000
Local government expenditure	GDP	1199	4	0.000
	Net Tax	1076.6	4	0.000
	Central government expenditure	2334.1	4	0.000
	Consumption	666.76	4	0.000
	Trade balance	216.3	4	0.000
Consumption	GDP	689	4	0.000
	Net Tax	729.8	4	0.000
	Central government expenditure	1341.4	4	0.000
	Local government expenditure	166.08	4	0.000
	Trade balance	351.51	4	0.000
Trade balance	GDP	518.28	4	0.000
	Net Tax	592.37	4	0.000
	Central government expenditure	754.26	4	0.000
	Local government expenditure	1059.2	4	0.000
	Consumption	1024.8	4	0.000

*Degree of freedom

This means that the maximum of the five variables Granger-causes the other variables and GDP, and GDP Granger-cause each of the five variables. This suggests that each of the five variables contributed to the progress of the Chinese economy.

4.4 Government expenditure model

In terms of fiscal policy, China's government expenditure is determined primarily by the central government. The central government's fiscal decisions substantially affect the local government's fiscal decisions. We identified fiscal policy shocks using vector error correction model (VECM) model with 6 variables. We set the variable sequence as GDP per capita (y), net tax (t), central government expenditure (c), local government expenditure (l), consumption (a) and trade balance (b) during calculation. According to Barro (1990), under the assumption of constant returns to scale, government expenditure can change the steady growth rate. Fiscal decentralization leads to greater autonomy of local government. Zhang and Zou (1998) used the ratio of provincial government expenditure to central government expenditure as the measure of fiscal decentralization and found that decentralization affects provincial economic growth. The results of the government expenditure model are shown in Table 8.

The impulse response results are reported in Tables 9, 10, and 11 along with Appendix Fig. 1. A number of interesting patterns emerge. First, the overall trend for the full sample period indicates that the growth of both central government expenditure and local government expenditure, as discretionary fiscal policy tools, had positive effect on output growth except during the first quarter of central government expenditure. The response of output to net tax increase also appeared to be positive. Comparing the multipliers of other two impulse shocks, local government expenditure increase was more effective than central government expenditure in both short term and long term. In the first month, net tax increase had a bigger impact than local government expenditure increase.

Second, before the Asian Financial Crisis, central government expenditure increase had the biggest short-term impact on output growth, but the three fiscal variables all became permanently positive in terms long-term effects. Nevertheless, the cumulative multiplier of local government expenditure growth was larger than the cumulative multiplier of the other two fiscal variables.

Third, after the Asian Financial Crisis, the multiplier of central government expenditure was still bigger than the multiplier of local government expenditure. The multiplier of net tax growth tends to be negative after 20 quarters.

Fourth, during 2008–2015, local government expenditure increase had a significant impact on output growth, with a much larger multiplier than central government expenditure or net taxes. Its effect was positive and significant, implying that fiscal decentralization benefits economic growth.

The impulse response functions for the government expenditure model yields the following findings. For one, they provide strong evidence that fiscal policy multipliers may change over the business cycle—i.e. they tend to be larger during recessions than expansions (Woodford, 2010). Such evidence supports Keynesian arguments for using discretionary government expenditure during downturns to stimulate aggregate demand. Both Blanchard and Perotti (2002) and Mountfourd and Uhlig (2009) find that tax multipliers are smaller than spending multipliers in the short-term, which is plausible since theory predicts that part of the higher disposable income stemming from tax cuts is saved.

Our analysis shows that during 1998–2007, net tax multipliers show negative value, which implies that tax cuts stimulate output. During 1985–2015, central government and local government expenditure multipliers were 4.267 and 4.420, respectively, after one month. On the other hand, net tax growth multiplier was 0.508, which was smaller than central government expenditure multiplier, but it became bigger from 10th quarter onward. According to conventional wisdom, the

Table 8 The results of government expenditure VEC model. Source: Authors' calculations

Long-term variables

	Lny	Lnt	Lnc	Lnl	Lna	Lnb
Lny	1	0	1.1269* (−1.03)	1.9460** (1.91)	−2.8798*** (−7.36)	0.4969 (1.01)
Lnt	0	1	0.2592* (0.71)	−2.0854*** (−6.11)	0.7978*** (6.07)	0.4104*** (2.48)

Short-term variables

	Lags	D(Lny)	D(Lnt)	D(Lnc)	D(Lnl)	D(Lna)	D(Lnb)
Lny	L1	−0.0684 (−0.15)	0.6285* (1.11)	0.4217* (0.93)	0.5337* (0.88)	0.2848* (0.49)	0.6113*** (1.85)
	L2	−0.4165** (−0.44)	0.0252* (0.02)	1.3398* (1.36)	1.0941** (1.33)	−0.2006* (−0.34)	0.1619** (0.11)
	L3	1.12* (1.24)	0.7123 (0.73)	−0.4015* (−0.43)	0.5808** (0.74)	0.6031** (1.06)	3.1619* (0.42)
Lnt	L1	−0.0101*** (−0.03)	−0.2429* (−0.50)	0.0335** (0.09)	0.0537* (0.10)	−0.3059* (−0.61)	0.3064** (1.08)
	L2	−0.0324* (−0.03)	−1.0728* (−0.99)	−0.0959* (−0.09)	1.3655** (1.57)	0.1672 (0.27)	0.1806* (0.65)
	L3	0.8276* (0.88)	−0.0814 (−0.08)	−0.1467** (−0.15)	0.4553* (0.56)	1.2914* (2.20)	−0.3895* (−0.67)
Lnc	L1	−0.3470* (−0.59)	−0.6170* (−0.86)	−0.8724** (−1.51)	−0.5211* (−0.68)	−0.2435 (−0.33)	0.4432** (1.06)
	L2	−0.4681* (−1.22)	−0.0817* (−0.20)	−0.1097* (−0.28)	−0.1741 (−0.53)	−0.4212* (−1.77)	−0.3198* (−0.48)
	L3	0.6663** (2.69)	0.3391* (1.28)	−0.2417** (−0.95)	−0.5506* (−2.59)	0.6562* (4.25)	−0.8653* (−1.78)
Lnl	L1	0.1538* (0.26)	0.0060 (0.01)	0.1504 (0.26)	−0.2814 (−0.37)	0.0822 (0.11)	−1.2409*** (−2.96)
	L2	0.2466* (0.18)	0.0565 (0.04)	0.8673** (0.87)	3.1539* (2.70)	0.0977 (0.12)	−0.6728* (−0.57)
	L3	0.9247* (0.95)	0.4951* (0.48)	0.4125 (0.60)	1.2549* (1.50)	1.3257* (2.19)	−0.1629 (−0.43)
Lna	L1	−0.0519* (−0.65)	−0.0712* (−0.74)	−0.0626* (−0.81)	−0.0749* (−0.73)	−0.1496** (−1.50)	−0.0413** (−0.73)
	L2	0.0660*** (0.05)	0.6639 (0.43)	1.6324* (1.10)	−2.2827** (−1.84)	−0.2307 (−0.26)	0.9987* (0.76)
	L3	−2.5645* (−2.30)	−1.4424** (−1.21)	0.8242* (0.72)	−1.9303 (−2.02)	−2.6201* (−3.77)	0.0004* (0.58)
Lnb	L1	−0.2209** (−1.58)	−0.2577** (−1.53)	−0.2241 (−1.64)	−0.2845** (−1.57)	−0.1860** (−1.06)	0.0292 (0.30)
	L2	0.0287* (1.06)	−0.0208** (−0.71)	−0.0540 (−1.94)	0.0623* (2.67)	0.0096* (0.56)	−0.4184* (−0.53)
	L3	0.0115 (0.52)	0.0110*** (0.47)	−0.0121** (−0.54)	0.0152 (0.80)	0.0056 (0.41)	−0.1357* (−0.21)

Standard errors in parentheses, $*p<.05$; $**p<.01$; $***p<.001$

Table 9 Multiplier output growth response to central government expenditure shock. Source: Authors' calculations

Periods	Step*	Multiplier	Cumulative multiplier	Discounted cumulative multiplier
1985–1997	1	2.139	−9.597	−1.3529
	5	4.775	18.349	−0.8212
	10	4.365	8.422	−0.8061
	20	4.347	6.309	−0.7530
1998–2007	1	1.013	0.705	1.6455
	5	2.340	−8.377	−1.9900
	10	2.301	4.665	−2.0192
	20	2.301	3.137	−1.9608
2008–2015	1	−0.418	−0.122	−0.1392
	5	0.976	0.723	2.1821
	10	1.028	0.868	2.4976
	20	1.039	0.942	2.4725
1985–2015	1	4.267	0.425	−0.3573
	5	0.011	−0.280	0.0053
	10	0.173	−0.105	0.0905
	20	0.196	0.008	0.0999

*Month(s)

Table 10 Multiplier output growth response to local government expenditure shock. Source: Authors' calculations

Periods	Step*	Multiplier	Cumulative multiplier	Discounted cumulative multiplier
1985–1997	1	0.323	0.438	0.4412
	5	0.304	0.342	0.3441
	10	0.303	0.326	0.3275
	20	0.303	0.317	0.3185
1998–2007	1	1.311	0.953	0.9501
	5	0.653	−5.113	−8.2552
	10	0.655	0.386	0.3735
	20	0.655	0.544	0.5387
2008–2015	1	0.328	0.161	0.1600
	5	1.442	1.039	1.0310
	10	1.384	1.204	1.1978
	20	1.386	1.283	1.2778
1985–2015	1	4.420	−0.654	0.6438
	5	1.288	1.789	1.8237
	10	1.195	1.375	1.3857
	20	0.180	1.272	1.2783

*Month(s)

Table 11 Multiplier output growth response to net tax shock. Source: Authors' calculations

Periods	Step*	Multiplier	Cumulative multiplier	Discounted cumulative multiplier
1985–1997	1	1.248	7.705	8.7646
	5	0.783	0.979	0.9890
	10	0.786	0.885	0.8930
	20	0.786	0.844	0.8501
1998–2007	1	1.588	3.086	3.1146
	5	−5.792	7.971	8.0013
	10	−5.245	5.665	7.2786
	20	−5.273	−2.805	−9.7817
2008–2015	1	0.272	0.118	0.1176
	5	0.467	0.281	0.2791
	10	0.492	0.353	0.3503
	20	0.500	0.404	0.4003
1985–2015	1	0.508	0.279	0.2769
	5	0.740	0.5372	0.5336
	10	0.788	0.637	0.6327
	20	0.796	0.698	0.6932

*Month(s)

Table 12 VECM equation of Model 2. Source: Authors' calculations

	Manufacturing	R&D	Constant
GNI	−0.50 (0.03)	1.24 (0.49)	−0.06
Net tax	−2.79 (0.17)	9.50 (2.73)	−0.31
Infrastructure	−3.50 (0.21)	11.54 (3.36)	−0.38

multiplier should be larger during recessions. It is noteworthy that the effect of local government expenditure was significant, with a post-GFC discounted multiplier of 1.2778 after 20 months. Interestingly, the impact of central government expenditure on output did not change visibly after AFC.

Before 1997, the cumulative multiplier of both government expenditure and net tax declined steadily after 5 months, but the former is much larger than the latter. During 1998–2007, the cumulative multiplier of government expenditure increased from a negative value, whereas that of net tax decreased progressively. The value of government expenditure multiplier increased during 2008–2015. However, during the whole period of 1985–2015, the cumulative multiplier declined to 1.272 after 5 months. This amount is still larger than the cumulative net tax multiplier, which increased during the whole period.

Table 13 Multipliers output growth response to infrastructure investment shock. Source: Authors' calculations

Periods	Step	Multiplier	Cumulative multiplier	Discounted cumulative multiplier
1985—1997	1	0.1041	0.0142	0.0132
	3	0.0522	0.0084	0.0047
	5	0.0561	0.0256	0.0174
	8	0.0510	0.0050	0.0021
1998—2007	1	0.2149	0.0641	0.0625
	3	0.1807	0.0464	0.0462
	5	0.3148	0.0468	0.0363
	8	0.6375	0.0335	0.0304
2008—2015	1	0.3785	0.1894	0.1843
	3	0.1561	1.9012	1.8110
	5	0.6691	0.3508	0.3597
	8	1.0139	0.2307	0.2324
1985—2015	1	0.0471	0.0070	0.0067
	3	0.0759	0.0265	0.0222
	5	0.0299	0.0488	0.0405
	8	0.0680	0.0032	0.0067

* Month(s)

4.5 Investment model

Three cointegration equation could be constructed via Johansen cointegraion tests. The results suggest that R&D investment has long-term positive impact on GNI, net tax, and infrastructure while manufacturing investment shows the opposite impact. Table 12 shows the results.

However, this result does not provide any evidence regarding the temporal stability of the parameters of the relationship. The paper constructs a 5-variable SVAR model which estimates the responses of GNI to total investment (Model 2). For convenience, the variables' names are shortened as follows—GNI to y, net tax to t, investment in infrastructure to i, investment in manufacturing to m, and investment in R&D to r. The coefficients corresponding to the uncorrelated structural shocks ε_t^t, ε_t^i, ε_t^m, ε_t^r, ε_t^y can be obtained in Eq. (5) below.

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ -0.81^{***} & 1 & 0 & 0 & 0 \\ -0.60^{***} & -0.56^{***} & 1 & 0 & 0 \\ 0.27 & -1.33^{***} & 0.18 & 1 & 0 \\ -0.22^{***} & -0.39^{***} & -0.11^{***} & 0.03^{***} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_t^t \\ \varepsilon_t^i \\ \varepsilon_t^m \\ \varepsilon_t^r \\ \varepsilon_t^y \end{bmatrix} = \begin{bmatrix} 0.05^{***} & 0 & 0 & 0 & 0 \\ 0 & 0.06^{***} & 0 & 0 & 0 \\ 0 & 0 & 0.06^{***} & 0 & 0 \\ 0 & 0 & 0 & 0.13^{***} & 0 \\ 0 & 0 & 0 & 0 & 0.02^{***} \end{bmatrix} \begin{bmatrix} e_t^t \\ e_t^i \\ e_t^m \\ e_t^r \\ e_t^y \end{bmatrix} \tag{6}$$

Table 14 Multiplier output growth response to manufacturing investment shock. Source: Authors' calculations

Periods	Step*	Multiplier	Cumulative multiplier	Discounted cumulative multiplier
1985—1997	1	0.0684	0.0087	0.0081
	3	0.0147	0.0273	0.0240
	5	0.2683	0.0058	0.0091
	8	0.3377	0.0132	0.0124
1998—2007	1	0.3302	0.0405	0.0395
	3	0.0648	0.0931	0.0893
	5	0.2125	0.0550	0.0562
	8	0.1830	0.0503	0.0499
2008—2015	1	0.4843	0.2424	0.2358
	3	0.0928	0.1962	0.1875
	5	0.5297	0.1127	0.1167
	8	0.5846	0.1189	0.1190
1985—2015	1	0.0181	0.0019	0.0018
	3	0.0125	0.0036	0.0032
	5	0.0663	0.0076	0.0063
	8	0.0950	0.0012	0.0016

* Month(s)

Table 15 Multiplier output growth response to R&D investment hock. Source: Authors' calculations

Periods	Step*	Multiplier	Cumulative multiplier	Discounted cumulative multiplier
1985—1997	1	0.0153	0.0046	0.0043
	3	0.0147	0.0007	0.0006
	5	0.0231	0.0034	0.0016
	8	0.0553	0.0037	0.0029
1998—2007	1	1.1528	0.1921	0.1873
	3	0.2948	0.3741	0.3592
	5	0.2605	0.1309	0.1355
	8	1.5322	0.1555	0.1545
2008—2015	1	1.3619	0.2921	0.2842
	3	0.3477	1.4991	1.4276
	5	0.8714	0.6271	0.6240
	8	0.8983	0.4118	0.4153
1985—2015	1	0.0839	0.0071	0.0067
	3	0.0031	0.0159	0.0149
	5	0.2691	0.0015	0.0032
	8	0.3680	0.0085	0.0078

* Month(s)

Note: *** represents null hypothesis rejected at 1% level of significance. $e_t^t, e_t^i, e_t^m, e_t^r e_t^y$ are the orthonormal unobserved factors from structural innovations, $\epsilon_t = A^{-1}Be_t$.

Our results show that the coefficient signs from investment increases in infrastructure and manufacturing are negative, but they are statistically insignificant. Another interesting finding was that during the 1985–2015 time period, 1% increase of investment in manufacturing led to 0.11% decrease of GNI. On the other hand, 1% increase of R&D investment generated 0.03% increase in GNI, which is significant and positive compared to the other variables.

The results are reported in Tables 13, 14, and 15 along with Appendix Fig. 2. First, the response of GNI growth to manufacturing investment growth decreased in the first quarter and then recovered slightly from 2nd quarter onward. For investment growth in infrastructure and R&D, there was a positive initial impact. The responses were relatively large in the 1st quarter and peaks at 8th quarter. Until the 8th quarter, the response of GNI to R&D shock was the largest, with a discounted cumulative multiplier of 0.0078, followed by infrastructure at 0.0067. The manufacturing investment growth multiplier was only 0.0016. Second, before the AFC, GNI growth reacted negatively to increase in both infrastructure and R&D investment. During the same period, the output growth multiplier of manufacturing investment shock was positive and much higher than the other two sectors. Third, after the AFC, the discounted cumulative multiplier of manufacturing investment was much larger than that for infrastructure and R&D investment.

The impulse response functions generate a number of findings. The government was a main driver of manufacturing investment in the PRC. Due to the low efficiency of government investment and crowding out of private investment, a negative impact cannot be ruled out. Furthermore, some previous studies have shown that R&D investment can have a negative effect on economic growth. Technological progress may cause higher unemployment rate and in addition, strengthening of intellectual property rights protection may impede diffusion of new knowledge. Furthermore, infrastructure investment may promote economic growth in the long term by raising the productivity of all firms and industries. This explains why, upon the increase of infrastructure investment, the output growth multiplier increases from 0.0471 to 0.0680 during 8 quarters in 1985–2015 and from 0.2149 to 0.6375 after the AFC. The increase in the R&D multiplier after 1998 reflects China's gradual shift from an input-based economy to a knowledge- and innovation-based economy.

For infrastructure, the cumulative multiplier reached the highest value after 10 months during 1985–1997 and 2008–2015, and even in the whole time periods except for 1998–2007. For manufacturing factor, during 1998–2017, the highest cumulative multiplier appears after 3 months, but before 1997, the value decreases as the times goes on. At last, for R&D sector, the highest value usually appeared after 3 months except before 1997.

4.6 External debt model

In the third model, we consider the potential debt feedback following Bohn (1998), who developed a fiscal reaction function in which d^* is the unconditional mean of

Table 16 The effect of $\left(d_{t-i} - d^{*}\right)$ in the external debt model of China. Source: Authors' calculations

	Period	Government revenue	Government expenditure
$\left(d_{s,t-i} - d_{s}^{*}\right)$	1985–1997	−4.23** (2. 56)	−4.83** (1.91)
	1998–2007	2.05*** (0.42)	0.78 (0.91)
	2008–2015	0.57*** (0.15)	−0.03 (0.58)
	1985–2015	0.49*** (0.11)	0.51*** (0.13)
$\left(d_{l,t-i} - d_{l}^{*}\right)$	1985–1997	−0.39 (0.71)	−0.12 (0.66)
	1998–2007	2.72*** (0.50)	2.08* (1.08)
	2008–2015	5.99*** (0.90)	2.64 (3.47)
	1985–2015	1.01*** (0.30)	1.40*** (0.35)

Standard errors in parentheses, *$p<.05$; **$p<.01$; ***$p<.001$

the debt-to-GDP ratio as shown in formula (2). Following Favero and Giavazzi (2007), we build a 3-variable SVAR model which includes the government expenditure to GDP ratio and the government revenue to GDP ratio, and then examine the response of the two variables to the debt-to-GDP ratio.

In Table 16, we report the coefficients and the standard errors from the estimation for the full sample period and sub-sample periods.

The debt-to-GDP ratio has significant positive effect on both government revenue and expenditure ratios for the full period, but the effect differs across sub-periods. After the Asian financial crisis, the ratio of short-term debt to GDP has a significant effect on government revenues but an insignificant effect on government expenditure. Both government expenditure and revenue respond significantly to the ratio of long-term debt to GDP for the full sample period but there is no significant effect before the Asian financial crisis. Both long-term and short-term debt have a more significant effect on government revenues than government expenditures. This suggests that the debt level helps to stabilize government budget balance primarily through the response of government revenues to deviations of actual debt level from the target level. It is noticeable that after GFC, both of the long-term debt and short-term debt have no significant impact on government expenditure. During 2007–2008, external debt outflow, which sustained at around 16%, is much faster than inflow. Comparing to 4 trillion fiscal stimulus, paying external debt interests have little impact on government expenditure, simultaneously this means Chinese government expenditure had smaller degree of dependence on external debt.

5 Conclusion

Sustained rapid growth since the initiation of market-oriented reforms in 1978 transformed China into the world's second largest economy. However, China's growth has slowed down visibly since the global financial crisis, primarily due to long-term structural factors. Furthermore, the COVID-19 highlights the need for more sustainable growth which protects the environment and benefits the broader population, including the poor. China's positive experience with countercyclical fiscal policy during the global financial crisis highlights the potential of fiscal policy as an important tool for supporting the country's growth. A massive fiscal stimulus staved off recession and the economy weathered the global financial crisis remarkably well. In addition, fiscal policy can help China build back better after COVID-19—e.g. public investments in clean energy. China's experiences are generally consistent with a large literature that suggests that fiscal policy can have a significant and positive effect on economic growth.

In this paper, we empirically examine the relationship between fiscal policy and economic growth in China. To do so, we use empirical methods which distinguish automatic fiscal policy from discretionary fiscal policy (e.g. Perroti, 2002). Our econometric analysis yields a number of interesting findings. Our evidence suggests that local government expenditures have a larger impact on output growth than central government expenditures or net taxes. However, net taxes become progressively more influential in the long run. In addition, both government expenditure and net tax multipliers seem to change depending on the phase of the business cycle. During the initial stages of market liberalization in 1990s, manufacturing investment contributed the most to output growth but in recent periods, public investment in R&D made a substantial contribution. In addition, our evidence indicates that long-term debt has a significant influence on China's key fiscal variables, especially government revenues.

Overall, our analysis provides cautious grounds for optimism that fiscal policy can help Chinese policymakers engineer a gradual and smooth transition toward a more sustainable growth paradigm while maintaining healthy growth rates. Fiscal policy, especially government spending, seems to have a significant and positive effect on output in both short and long run. Since local government spending in particular seems to affect output, there is an urgent need to induce local governments to take sound and efficient fiscal decisions so that their expenditures can contribute to sustainable growth beyond the short term.

Samuelson emphasized the prominent position of consumption and technology in a market-oriented economy. In this connection, future research may consider adding total factor productivity as a proxy for technology shock to further enrich the model. In our analysis of China, we find that in recent years the effect of R&D investment on output exceeds the effect of infrastructure investment. It is consistent with the conventional wisdom that in order to sustain growth China has to shift from a growth strategy based on more capital and labor to one that is based on productivity and innovation. In fact, this shift has already been occurring for some time. Finally, the significant effect of long-term public debt on the fiscal balance, especially through fiscal revenues, suggests a need for China to monitor debt as an indicator of fiscal sustainability.

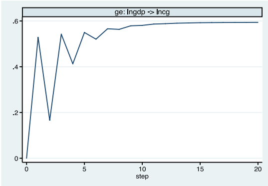
Appendix

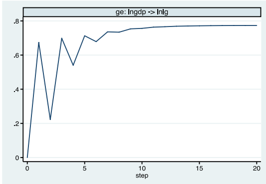
See Figs. 1 and 2.

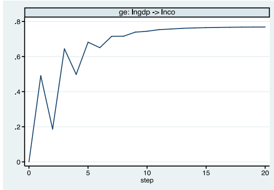
Fig. 1 Orthogonalized impulse-response results of government expenditure model (Model 1). *Notes*: IRFs depict the GDP per capital response to a 1% shock in local government expenditure, central government expenditure, consumption, GDP per capital, net tax, trade balance. *Source*: Authors' estimation ▸

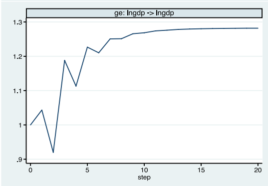
Response of gross national income to central government expenditure shock	Response of gross national income to local government expenditure shock	Response of gross national income to net tax shock

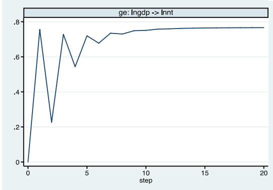
1985-2015 (full sample)

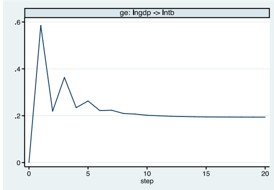




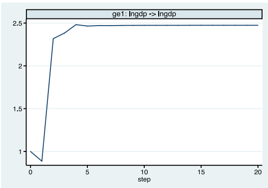


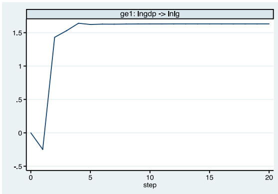


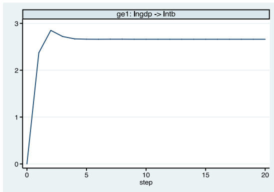


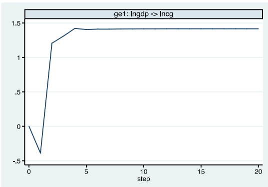


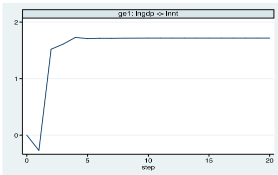
1985-1997

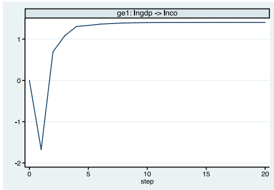




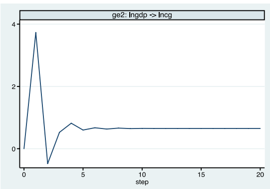


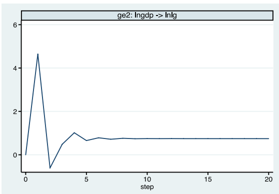


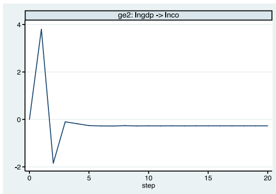


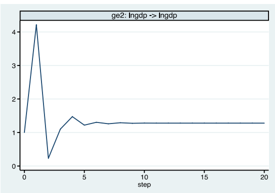


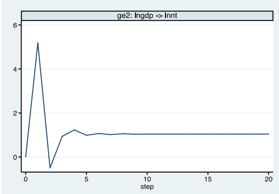
1998-2007

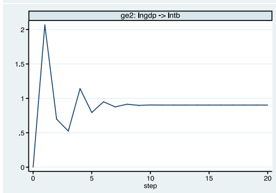












2008-2015

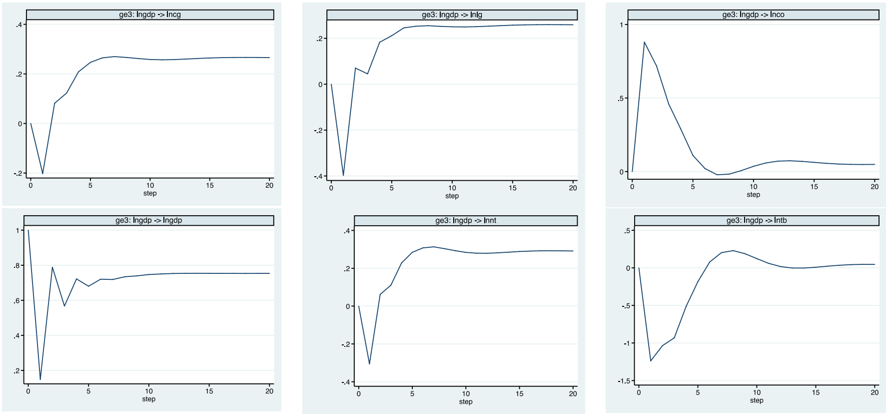


Fig. 1 (continued)

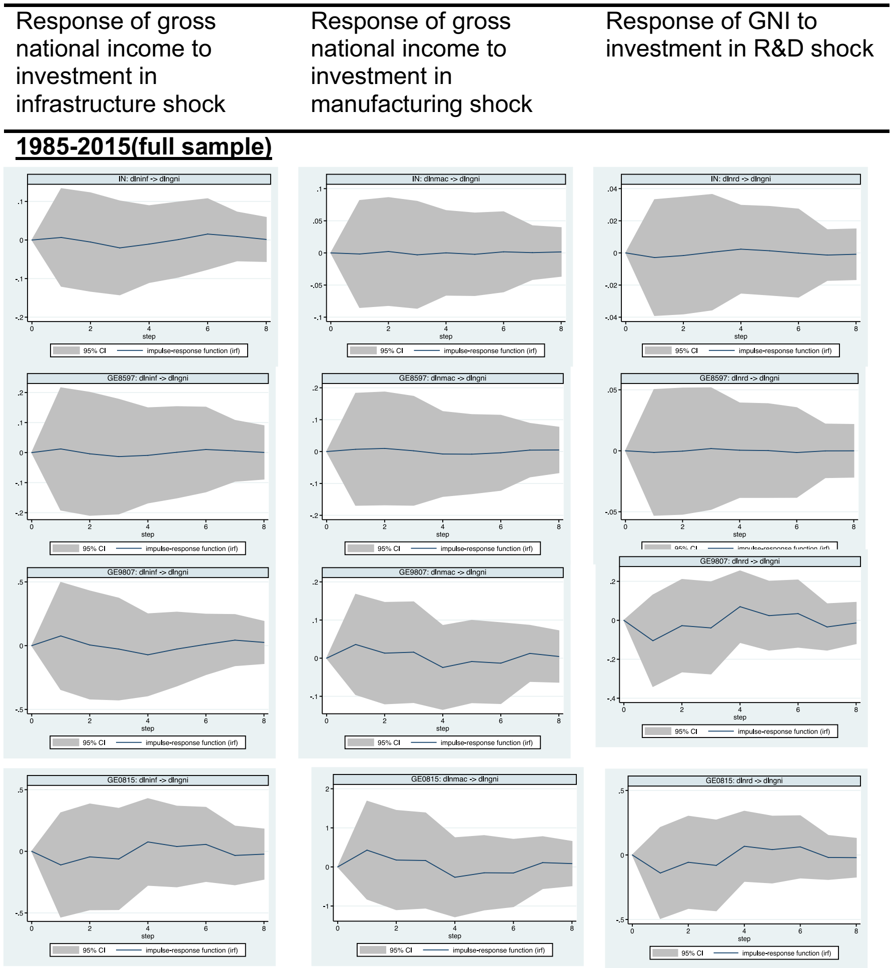


Fig. 2 Orthogonalized impulse-response results of investment model (Model 2). *Notes*: IRFs depict the GNI response to a 1% shock in investment in infrastructure, investment in manufacturing and investment in R&D. The grey shadow area in the SVAR panels show 95% upper and lower confidence bands. *Source*: Authors' estimation

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