A Second Thought on Estimating Expansionary Fiscal Policy Effects in the U.S.

JIA, BIJIE

College of Wooster

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Bijie Jia*
The College of Wooster

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Abstract

This paper revisits mixed findings of the expansionary fiscal spending effect in the U.S. An array of standard Vector-Autoregressive (VAR) models have been implemented to capture inconsistent effects of the fiscal expansion across studies. Findings in this paper consistently reveal that, first, government expenditures often generates less positive influence than government purchases; second, leaving aside the state and local government spending, federal government purchases alone have very limited influence on economy; third, 2007 recession significantly weakened the effectiveness of fiscal expansionary policy thereafter. Following these findings, this paper questions the validity of using government purchases alone to conclude the comprehensive effect of fiscal expansion.

Keywords: Fiscal Expansion; Government Spending; the Great Recession; Vector-Autoregressive Model; Cholesky Decomposition; Impulse Response Function

JEL Classification: E21; E32; E62; H30; H50.

*Department of Economics, 213 Morgan, The College of Wooster, Wooster, OH 33691. Tel: 330-287-1948. Email: bjia@wooster.edu

1 Introduction

The magnitude of expansionary fiscal effects on the economy has long been a heated debate in macroeconomics. After the implementation of the American Recovery and Reinvestment Act (ARRA) in 2009, extensive literature have grappled with this debate. For those studies which are mainly the echoes of the new Keynesian approach, the gist of their arguments are primarily about the positive stimulating effect of the fiscal expansion, such as the work of Rotemberg and Woodford (1992), Devereux, Head, and Laphan (1996), Fatás and Mihov (2001), Blanchard and Perotti (2002), Perotti (2005), Galí, López-Salido, and Vallés (2007). On the contrary, other studies tend to find either limited or negative influences of expansionary fiscal policy, for example, Aiyagari, Chirstiano, and Eichenbaum (1992), Hall (1986), Ramey and Shapiro (1998), Edelberg, Eichenbaum, and Fisher (1999), Burnside, Eichenbaum, and Fisher (2004), Cavallo (2005), Mountford and Uhlig (2009), Ramey (2012), Owyang, Ramey, and Zubairy (2013), and Kim and Jia (2018). In general, estimates of expansionary fiscal effects are quite varied across studies, and a definitive consensus has not been reached thus far.

Regardless of those inconclusive arguments about fiscal expansion effects, this paper questions the validity of using government purchases alone to conclude the comprehensive effect of fiscal expansion. For example, I am wondering if the expanded government purchase alone is an ideal proxy of a stimulating fiscal policy? Then, how does federal purchases and state and local spending affect the economy differently? Also, does the intervention of 2007 recession change the effectiveness of expansionary fiscal policy thereafter?

It's well-known that many papers estimate the fiscal effect by primarily focusing on government purchases—the sum of the government consumption and the gross investment, usually end up with conclusions that the expansionary fiscal policy has positive influence on economic activities, such as output, consumption and real wages (Baxter and King (1993), Fatás and Mihov (2001), Blanchard and Perotti (2002), McGrattan and Ohanian (2008), Hall (2009), Pappa (2009), Monacelli, Perotti and Trigari (2010), Auerbach and Gorodnichenko (2012), Leeper, Traum and Walker (2015), and Fishback and Kachanovskaya (2015)). However, such conclusion suffers two major cursorinesses: first, it omits the influence of expanded transfer payment, which is often an important component of the fiscal stimulus package. For example, Giambattista and Pennings (2017) uncovered that 75 % of the increase in the U.S. government spending during the Great Recession (2007-2009) consisted of transfers; Oh and Reis (2012) find the median share of transfer payments in the increased government spending could be as high as 64% in their sample of countries, including the U.S. Cogan and Taylor (2012) even question how much of government purchase is actually multiplied by expansionary fiscal packages? The second cursoriness is the fact that most government purchases used in previous literatures were including the state and local government purchase, which is not directly injected as the stimulating spending in the national fiscal stimulus package. So even if the expanded state and local government spending often positively affects economic activities, it does not fully guarantee a positive stimulation from the federal purchases.

In this paper, alternative identifications of the fiscal expansion shock have been identified based on a reduced-form VAR model. Following the recursive Cholesky decomposition, I derive impulse responses to different government spending shocks. Simultaneously, I generate

such responses within two different sample periods to observe the influence of 2007 recession.

The major contributions of this paper are threefold. First, even if government purchases have more positive influence on economic activities, the completed stimulus package often generates much less positive effect due to the intervention of expanded transfer payments. Second, over 50% of expanded government purchases is made by the state and local government, the federal purchase itself has very limited stimulating effect. Third, with the intervention of the 2007 recession, fiscal expansion effects get significantly weaker in contrast to the pre-crisis period. All findings reinforce the risk of overstating the effect of the expansionary fiscal policy by only focus on the work of government purchases.

The remainder of this paper is organized as follows. Detailed information of the empirical model is provided in Section 2. Data description and the primary findings are discussed in Section 3. In order to comparatively study findings in this paper with those in previous literature, an extensive discussion is developed in Section 4. Finally, Section 5 provides the concluding remark.

2 Empirical Model

In order to capture the fiscal expansion shock, a standard Vector Auto-Regressive (VAR) model has been implied. The basic setting of this model is:

$$\mathbf{x}_t = \mathbf{A}(\mathbf{L})\mathbf{x}_{t-1} + \mathbf{e}_t, \tag{1}$$

where $\mathbf{x}_t$ is an *(n·1)* vector containing n variables in the system; $\mathbf{A}(\mathbf{L})$ is the vector of lag operator polynomials, see equation 2, which includes up to p lags. $\mathbf{e}_t$ is the vector of reduced form error terms. The coefficient matrix of this VAR is identified by $\mathbf{A}$. The right-hand side of equation 1 includes all predetermined variables, and the error terms are assumed to be serially uncorrelated.

$$\mathbf{A}(\mathbf{L}) = \sum_{\mathbf{i=1}}^{\mathbf{p}} \mathbf{A_i L^i} \tag{2}$$

This paper is particularly interested in variables as it's listed below [1]:

$$\mathbf{x}_t = [g_t \; y_t | \; snt_t \; taxr_t \; ints_t \; mony_t]' \tag{3}$$

g_t alternatively denotes different types of government spending: government expenditures[2], government purchases[3], transfer payments, and state and local government spending. In which,

$$Government\ Expenditures = Government\ Purchases + Transfer\ Payments$$

[1] The order of variables is subject to the change of government spending type.

[2] The sum of "government purchases" and "transfer payments", or the sum of "federal government expenditures" and "state & local government expenditures".

[3] According to the NIPA Guide of the United States, it stands for government consumption expenditures and gross investment, "*the measure of government sector final demand, consists of two major components: Current consumption expenditures by general government and gross investment by both general government and government enterprises*".

and,

$$Government\ Purchases = Government\ Consumption\ Expenditures + Government\ Gorss\ Investment$$

y_t is a scalar (or vector) of interested variables, such as total GDP ($rgdp_t$), consumption (con_t) and investment (ivt_t). The sign "|" denotes the possible ordering shuffle between g_t and y_t. I am trying to incorporate the influence of business cycle into the calibration of the fiscal expansion effect, so g_t is only ordered first when it does not include the automatic stabilizer[4], otherwise, it will be ordered after the business cycle variable y_t. Besides, I have snt_t denotes a scalar of consumer sentiment index; $taxr_t$ is the federal government current tax receipts as a share of nominal GDP; $ints_t$ is the secondary market 3-month treasury bill yield, and $mony_t$ is the M2 money stock. For the purpose of stationarity, all the data is demeaned and detrended prior to the estimation[5].

In order to compare the fiscal expansion effect, two VAR(p) identification schemes have been employed in this paper. The first identification scheme (***TGDP*** *model*) is employed when the y_t is defined as total GDP. This setting of model is motivated by Fatás and Mihov (2001), Blanchard and Perotti (2002), Bachmann and Sims (2012), and Corsetti, Meier and Müller (2012a). The second identification scheme (***CI*** *model*) focuses on the private sector, similar with Galí, López-Salido and Vallés (2007), Fishback and Kachanovskaya (2010), Ramey (2011, 2012), and Perotti (2014), private consumption (con_t) and private investment (ivt_t) are treated as y_t in equation 3. For details, please see the equation group below.

$$\begin{aligned} TGDP &: \mathbf{x}_t = [g_t\ rgdp_t|\ snt_t\ taxr_t\ ints_t\ mony_t]' \\ CI &: \mathbf{x}_t = [g_t\ con_t\ ivt_t|\ snt_t\ taxr_t\ ints_t\ mony_t]' \end{aligned} \tag{4}$$

The calibration of equations 4 could capture the contemporaneous influence from the change of business cycle on automatic stabilizers and further generate more realistic impulse responses to the government spending shock. This framework is also applied by previous literatures, such as Kim and Roubini (2008), and Kim and Jia (2018). To clarify the logic, I rewrite the benchmark equation 1 into the format of equation 5. See details below:

$$\begin{bmatrix} g_t \\ y_t \\ Z_t \end{bmatrix} = \begin{bmatrix} \bar{g}_t \\ \bar{y}_t \\ \bar{Z}_t \end{bmatrix} + \sum_{i=0}^{P} \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ \Gamma_{31} & \Gamma_{32} & \Gamma_{33} \end{bmatrix}^i \begin{bmatrix} e_{g_{t-i}} \\ e_{y_{t-i}} \\ E_{Z_{t-i}} \end{bmatrix} \tag{5}$$

Where Z_t stands for the vector of control variables,

$$Z_t = [snt_t\ taxr_t\ ints_t\ mony_t]' \tag{6}$$

[4]In this paper, the primary proxy of automatic stabilizer is the transfer payment, tax is one of the control variables

[5]According to Sims and Watson (1990), data in VAR system does not need to be detrended since it might remove important information of the comovements among endogenous variables. However, following the majority view, Enders (2004) points out that the data in VAR should mimic the true data generating, especially if the major purpose is to estimate a structure VAR model.

and Γ is a (4×4) coefficient matrix for each control variable. The intercept vector $[\bar{g}_t\ \bar{y}_t\ \bar{Z}_t]'$ can be dropped due to the primarily demeaned and de-trended data set.

In order to understand the initial ordering shuffle between g_t and y_t, I will only focus on those two variables start from equation 7. The error terms $[e_{g_{t-i}}\ e_{y_{t-i}}]'$ could be composited by primitive shocks $[\varepsilon_{g_{t-i}}\ \varepsilon_{y_{t-i}}]'$. Knowing that γ_{12} captures the contemporaneous effect of y_t on g_t, and γ_{21} captures the current effect of g_t on y_t.

$$\begin{bmatrix} e_{g_t} \\ e_{y_t} \end{bmatrix} = \frac{1}{1-\gamma_{12}\gamma_{21}} \begin{bmatrix} 1 & -\gamma_{12} \\ -\gamma_{21} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{g_t} \\ \varepsilon_{y_t} \end{bmatrix} \tag{7}$$

For only g_t and y_t, after integrated with 7, equation 5 could be rewritten as:

$$\begin{bmatrix} g_t \\ y_t \end{bmatrix} = \begin{bmatrix} \bar{g}_t \\ \bar{y}_t \end{bmatrix} + \frac{1}{1-\gamma_{12}\gamma_{21}} \sum_{i=0}^{P} \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}^i \begin{bmatrix} 1 & -\gamma_{12} \\ -\gamma_{21} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{g_t} \\ \varepsilon_{y_t} \end{bmatrix} \tag{8}$$

Eventually, I could derive the impulse response element η_i as:

$$\eta_i = \frac{B^i}{1-\gamma_{12}\gamma_{21}} \begin{bmatrix} 1 & -\gamma_{12} \\ -\gamma_{21} & 1 \end{bmatrix} \tag{9}$$

where,

$$B^i = \sum_{i=0}^{P} \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}^i \begin{bmatrix} \varepsilon_{g_t} \\ \varepsilon_{y_t} \end{bmatrix} \tag{10}$$

According to the derivation of equations above, in order to address the underlying "under-identification" issue of the impulse response function, I implement the recursive Choleski Decomposition and add a restriction as $\gamma_{12} = 0$. This is turning off the contemporaneous influence from y_t to g_t , which makes practical sense if g_t denotes the government purchase and ranks the first. The reasons are, first, government purchases do not include transfer payments, which would often be influenced by the current economic fluctuation; second, wheels of fiscal policy often spin slowly and deliberately due to the implementation lag [6], government purchases usually can not quickly respond to the change of economic activities within one quarter.

However, if g_t stands for other types of government spending that include the automatic stabilizer, in order to incorporate the instantaneous impact from the business cycle variable y_t, I put y_t in front of g_t when I am testing the impact of fiscal expansion. One limitation of this identification is that the initial response of economic activities to the shock of fiscal expansion would be recorded as zero, due to the coefficient constraint.

[6] The time lag between when government decides to implement a new fiscal policy and when it's actually enacted through the market.

3 Empirical Findings

3.1 Data Description

All the data used in this paper is on a quarterly basis, and most data is collected from the Federal Reserve Economic Data[7] with one exception: the consumer sentiment index ($sent_t$). The quarterly consumer sentiment index is collected from the Survey of Consumers[8], which is constructed by the University of Michigan. For data transformation, a natural logarithm has been applied to this index.

The full sample period in this paper is stretching from 1960Q1 to 2017Q3, which includes the Great Recession period that started in 2007. All public and private spending variables such as the multiple types of government spending, total GDP ($tgdp_t$), private consumption (con_t), and private investment (ivt_t) are in the format of real value per capita. Additionally, they are all in logarithmic format.

Under the VAR model, multiple types of government spending variables have been plugged in alternatively. This includes not only the total government expenditures, but also the disaggregated spendings, for example, government purchases, transfer payment, and state and local government spending. For more detailed description about the government spending variables, please refer to Table 1; for other interested economic variables, please see Table 2.

Table 1 and Table 2 around here

3.2 Primary Results

3.2.1 Fiscal Expansion and Total GDP

In order to study fiscal policy effects on the total output, Figure 1 displays impulse responses of total GDP to various government spending shocks. The solid line traces down the impulse responses in the full sample, which considers the Great Recession of 2007 as an intervention. The dash-dot line is the response of total GDP in the sub-sample ("pre-crisis") , which depicts how the fiscal shock works before the Great Recession period.

Figure 1 around here

[7] Federal Reserve Economics Data: https://fred.stlouisfed.org/

[8] University of Michigan: Consumer Sentiment, retrieved from https://data.sca.isr.umich.edu/data-archive/mine.php.

Given a quick glance of results in Figure 1, government purchases are positively stimulating the total GDP. Transfer payments, on the other hand, constantly generate negative impact on the total GDP. According to this, total expenditures normally do not exhibit as much positive influence as the government purchases do. Since government expenditures are the sum of government purchases and transfer payments, and expanded transfer payments often take a considerable weight in total expenditures (see Figure 3). So it makes sense that the effect of expansionary expenditures would be more influenced by transfer payments and running less stimulating effect than the purchases.

As to the timing issue, in Figure 1, the total GDP almost always has a more positive response to fiscal expansion shocks during the sub-sample ("pre-crisis") period, regardless of which specific government spending variable is utilized. This result reveals that the 2007 recession has substantially muted the positive effect of the expansionary fiscal policy thereafter.

3.2.2 Fiscal Expansion and Consumption

As long as I am interested in the stimulating effect of fiscal policy, the private sector should not be overlooked. Except for total GDP, private consumption is another important target to be stimulated. Similarly, the gross government expenditures have much less positive effect on consumption, and this again is due to the negative influence of transfer payments and how big a proportion has been shared by transfer payments in the government total expenditures. See Figure 2 for details.

Figure 2 around here

If I shift the focus on time-variant estimates in Figure 2, again, consumption is more responsive before the great recession of 2007, which indicates a weaker expansionary fiscal effect due to the intervention of the Great Recession.

4 Extensive Discussion

4.1 Is Expanded Government Purchases A Good Proxy?

Across previous studies, papers that often find very positive effect of expansionary fiscal policy usually treat government purchases as the primary proxy of expanded fiscal spending. For example, with government purchases, Baxter and King (1993) states that the fiscal multiplier could be greater than 1 in the long run; this strong positive influence is also possible to be observed in the short run, as long as labor supply is highly elastic. Following this, Auerbach and Gorodnichenko (2012) estimates the government purchases multiplier could be as large as 1.5. Later, Fazzari, Morley and Panovaska (2015) also estimated a high purchases multiplier around 1.6 for the "low-capacity" regime.

However, government fiscal stimulus is not only about expanding purchases, but also about increasing transfer payments (Oh and Reis (2012), Mehrotra(2018), Giambattista and Pennings (2017)), let alone transfer payments often take a greater proportion than government purchases (see Figure 3) in total expanded spending. Especially during the "in-crisis" period, in Figure 4, transfers increase more than 65% , while purchases are only expanded by about 20%. Unlike government purchases, transfer payments constantly generate negative impacts on economic activities (Churchill and Yew (2017)), see Figure 1 and Figure 2. Apparently, while purchases have positive stimulating effect on the market, the expanded transfer payments would attenuate this positive effect simultaneously. So using government purchases alone would very likely generate a result that is overvaluing the comprehensive fiscal expansionary effect.

Figure 3 and Figure 4 around here

4.2 Intervention of State and Local Government Spending

As long as people study effects of expanded government purchases on the economy, they should be careful about which purchase variable has been used. Many previous literatures often use total government purchase instead of federal purchase alone to measure the expansionary fiscal effect (Baxter and King (1993), Fatás and Mihov (2001), Blanchard and Perotti (2002), Galí, López-Salido, and Vallés (2007), McGrattan and Ohanian (2008), Hall (2009), Mountford and Uhlig (2009)), in which state and local government spending is also included. However, according to Hubbard and O'brien (2015), spending policies implemented by state and local governments are not directly affecting the national economy, whereby the *fiscal policy* only refers to actions of the federal government.

Recall what has been presented in Figure 5, state and local purchases often takes up a larger proportion of total government purchases than the federal purchase does. In order to have a more precise estimate for the effect of expansionary fiscal policy, it's important to isolate federal purchases from state and local spending, then observe how would output respond to federal purchase and state and local spending differently. Results are presented in Figure 6.

Figure 5 and Figure 6 around here

Apparently, state and local government spending accounts for most of the positive stimulation, because total output has more positive response to the expansion of state and local spending. The federal government purchases, on the other hand, have very limited stimulating effect. This reinforces that using total government purchases to measure the effectiveness of expansionary fiscal policy would end up overstating the stimulating effect.

5 Conclusion

Facing various arguments about the fiscal expansion effect among previous literatures, this paper questions the validity of using government total purchases alone to conclude the comprehensive effect of fiscal expansion. I start this argument with asking a few questions such as if the expanded government purchase alone is an ideal proxy of a stimulating fiscal package? How does federal purchases and state and local spending affect the economy differently? Does the great recession in 2007 change the effectiveness pattern of expansionary fiscal policy overall?

In order to address the first question, this paper distinguishes "*government purchases*" from "*government expenditures*". It turns out that government purchases alone generate very dissimilar stimulating effect on the economy in contrast to government expenditures. The main driver of such divergence is the *transfer payment*. According to empirical results in this paper, expanded transfer payments almost always have negative impact on economic activities, and this negative impact is quite robust across different identification schemes. This provides the clue that why the expansion of government expenditures often generates less positive influence than the expanded purchases, because the negative impact of transfer payments erode the positive stimulating effect from government purchases. This finding reveals that by using government purchases alone would easily generate an overstated stimulating effect of fiscal expansions.

Another noteworthy finding is that state and local government spending often has a stronger stimulating effect than the federal purchases. Due to the fact that spending policies implemented by state and local governments do not directly affect the national economy, using total government purchases to evaluate the effectiveness of fiscal expansion could result in an upward bias.

As to the timing issue, the Great Recession of 2007 plays an important role to intervene the fiscal stimulus effect. Empirical results in this paper present a fact that with the intervention of the Great Recession, the effectiveness of fiscal stimulus would be prominently weakened.

Following all the empirical findings in this paper, I don't deny the fact that government purchases often exhibit a positive influence on total output and consumption in the U.S. However, by only using government purchases to measure the effectiveness of fiscal stimulating package is not quite precise. Base on all the concerns discussed in this paper, when policymakers plan to adjust the fiscal policy in oder to stimulate the economy, it's important that transfer payments will not be overlooked and the state and local government spending will not be mixed in.

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Table 1: **Government Spending Data**

Fred. Data ID	**Description**
W068RCQ027SBEA	Government Total Expenditures
A955RC1Q027SBEA	Government Consumption Expenditures
A782RC1Q027SBEA	Gross Government Investment
GCE	Government Consumption Expenditures and Gross Investment
A084RC1Q027SBEA	Government Current Transfer Payments
W019RCQ027SBEA	Federal Government Total Expenditures
A957RC1Q027SBEA	Federal Government Consumption Expenditures
A787RC1Q027SBEA	Gross Government Investment: Federal
FGCE	Federal Consumption Expenditures and Gross Investment
W014RC1Q027SBEA	Federal Government Current Transfer Payments
W079RCQ027SBEA	State and Local Government Total Expenditures
A991RC1Q027SBEA	Government Consumption Expenditures: State and Local
SLINV	State and Local Government Gross Investment
SLCE	State and Local Consumption Expenditures & Gross Investment

Note: US. Bureau of Economic Analysis, retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series. Time span is 1960Q1- 2017Q3.

Table 2: **Interested Macroeconomic Data**

Fred. Data ID	**Description**
GDP	Gross Domestic Product
PCE	Personal Consumption Expenditures
GPDI	Gross Private Domestic Investment
GDPDEF	Gross Domestic Product: Implicit Price Deflator
W006RC1Q027SBEA	Federal government current tax receipts
POP	Total Population: All Ages including Armed Forces Overseas
TB3MS	3-Month Treasury Bill: Secondary Market Rate
M2	M2 Money Stock
ConsSent	Consumer Sentiment Index: Servey of Consumer, conducted by University of Michigan

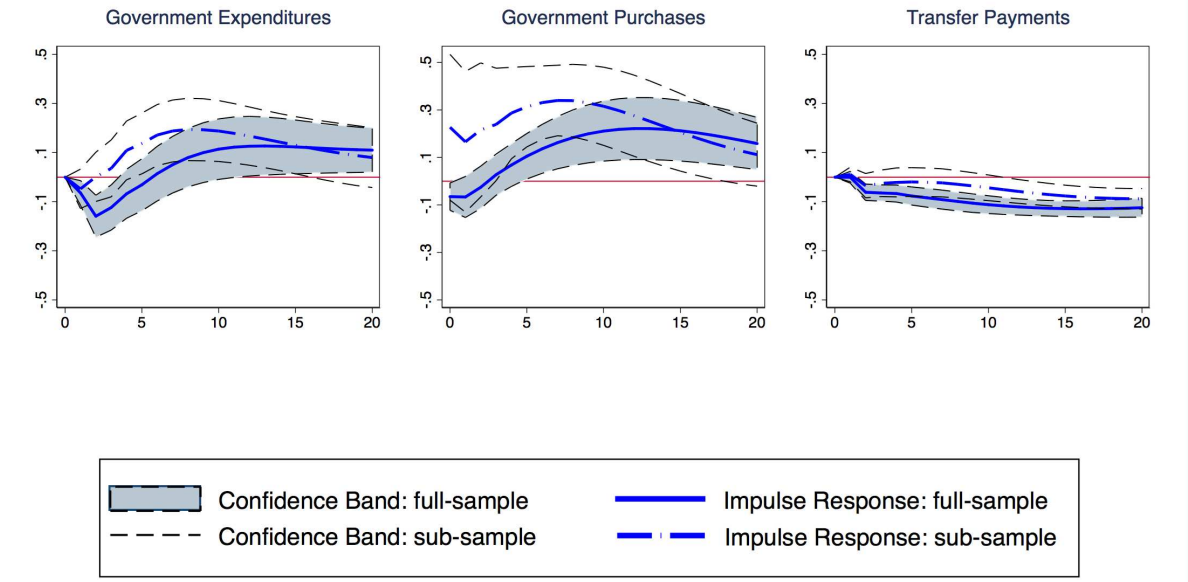
Note: US. Bureau of Economic Analysis, retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series. Time span is 1960Q1-2017Q3. Consumer Sentiment Index is collected from Survey of Consumers, UMC online database (http://www.sca.isr.umich.edu/), and the news variable is from Valerie Ann Rameys research database (http://econweb.ucsd.edu/ vramey/).

Table 3: **Share of Total Government Purchases by Governments**

Time Period	Proportion in Total Purchases		Difference
	State & Local	Federal	
Sub-sample ("pre-crisis")	53%	46%	7%
In-crisis	61%	39%	23%
Post-crisis	61%	39%	21%
Full-sample	55%	45%	9%

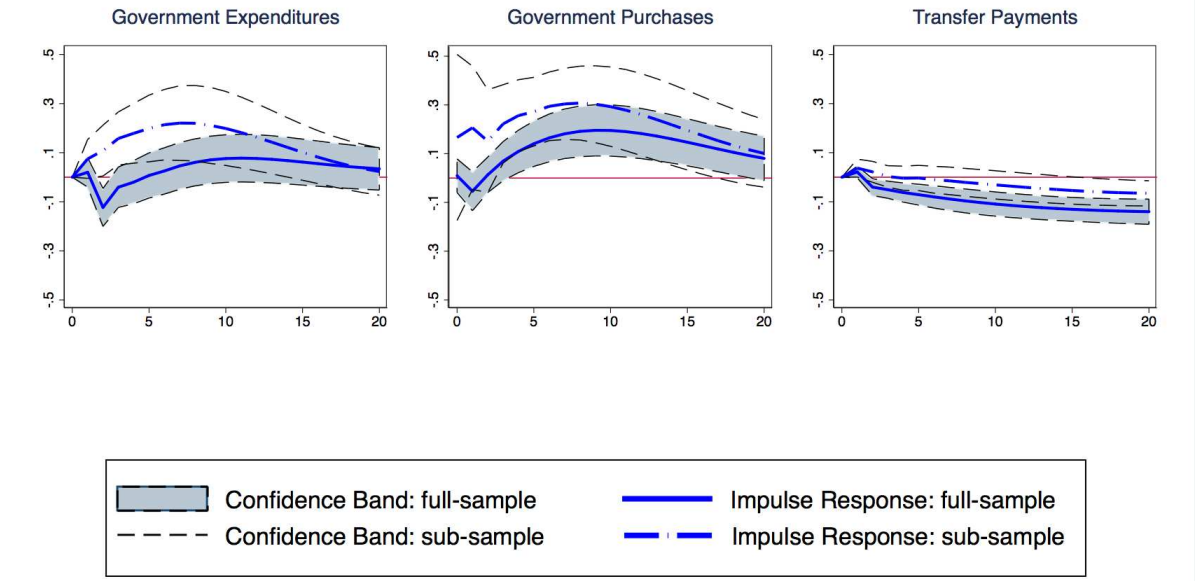
Note: "**pre-crisis**" is 1960Q1-2007Q3; "**in-crisis**" is the Great Recession of 2007Q4-2009Q2; "**post-crisis**" is 2009Q3-2017Q2; "difference" is measuring the gap between state and local purchases and federal government purchases. All the values are in the arithmetic average on a quarterly basis.

Figure 1: **Government Spending Shocks on Total GDP**



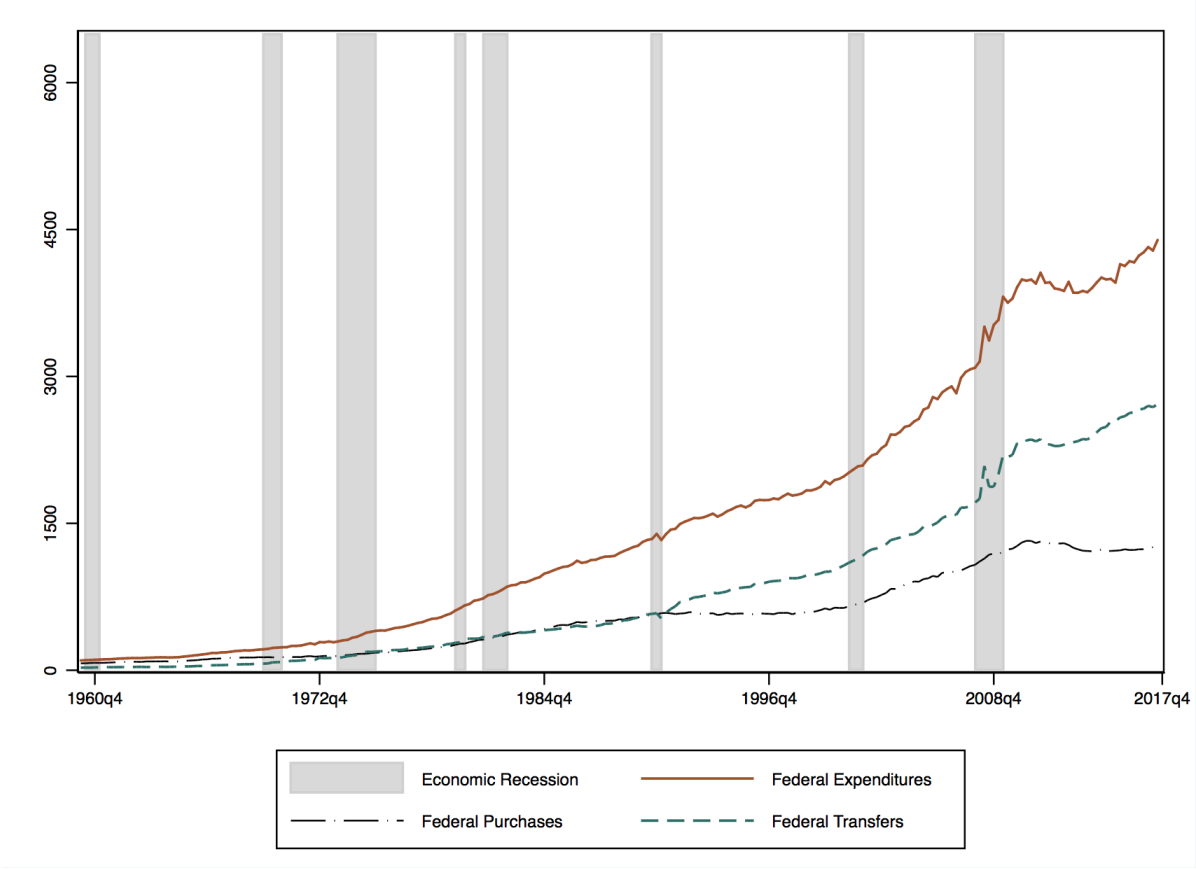
Note: Data source is US. Bureau of Economic Analysis, selected series are retrieved from FRED, Federal Reserve Bank of St. Louis. The result is based on the 1-standard deviation confidence band (68% CI) and 100 times non-parametric bootstrap simulation. Time span of full sample is 1960Q1-2017Q3, and 1960Q1-2007Q3 for sub-sample.

Figure 2: **Government Spending Shocks on Consumption**



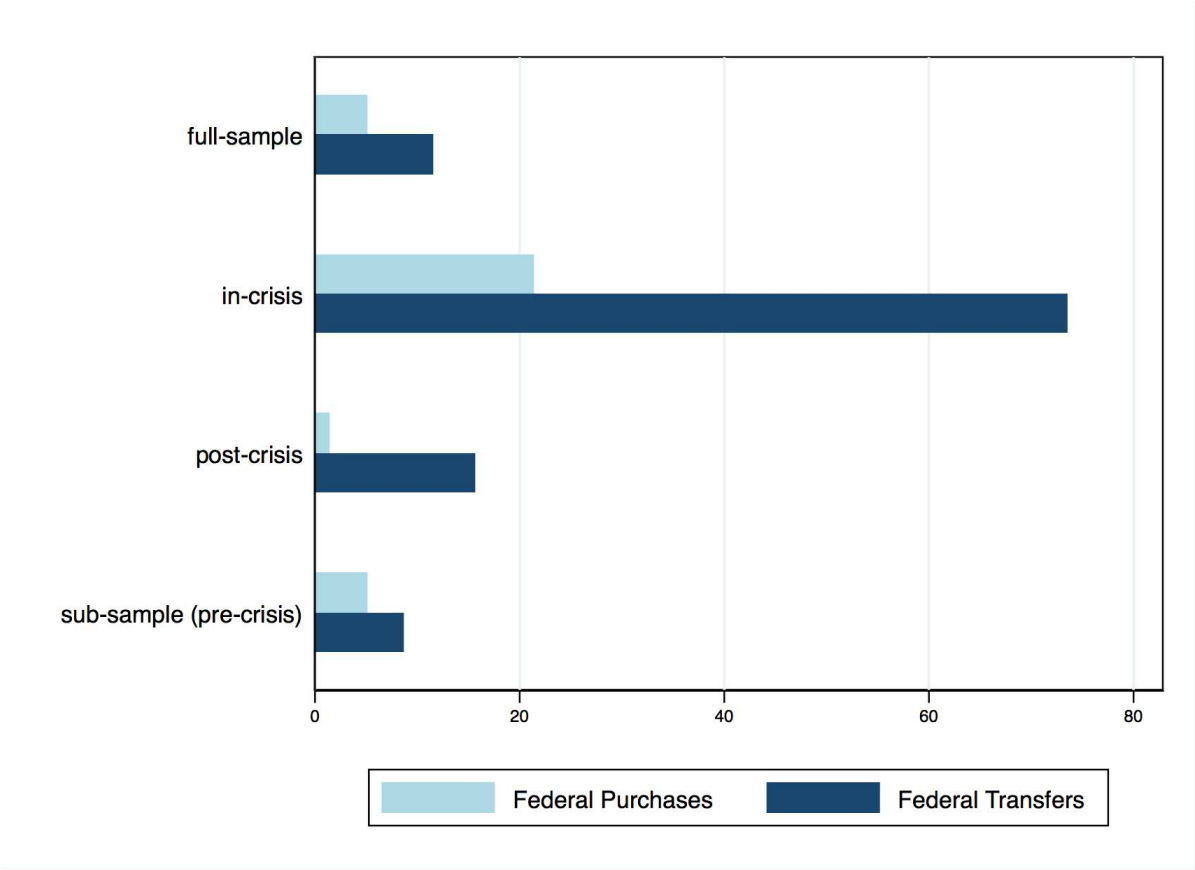
Note: The data source is US. Bureau of Economic Analysis, selected series are retrieved from FRED, Federal Reserve Bank of St. Louis. The result is based on the 1-standard deviation confidence band (68% CI) and 100 times non-parametric bootstrap simulation. Time span of the full sample is 1960Q1-2017Q3, and 1960Q1-2007Q3 for the "*pre-crisis*" period.

Figure 3: **Primary Components of Federal Government Spending**



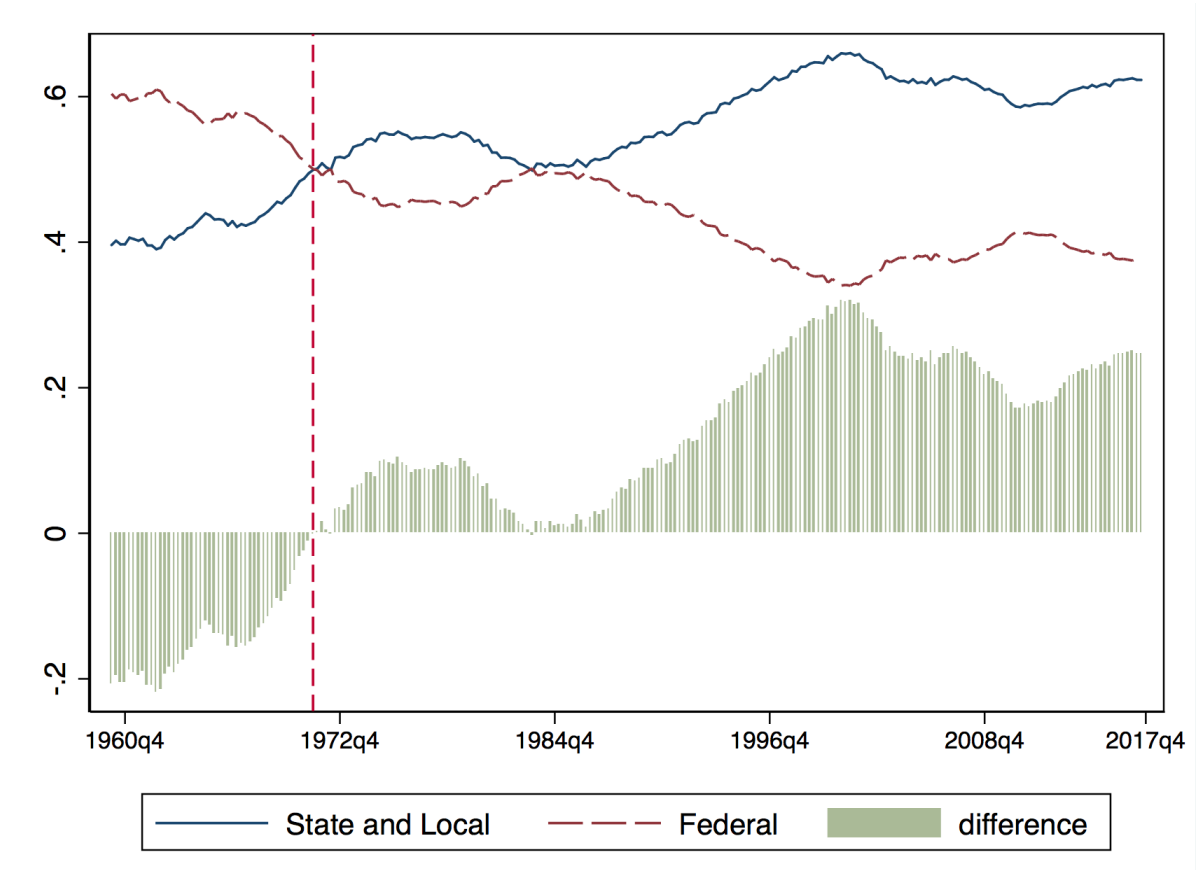
Note: The data source is originally from US. Bureau of Economic Analysis, selected series are retrieved from FRED, Federal Reserve Bank of St. Louis. The economic recession periods are defined by NBER US Business Cycle Expansions and Contractions. Time span is 1960Q1-2017Q3.

Figure 4: **Growth of Federal Purchases v.s. Transfers: quarterly mean (%)**



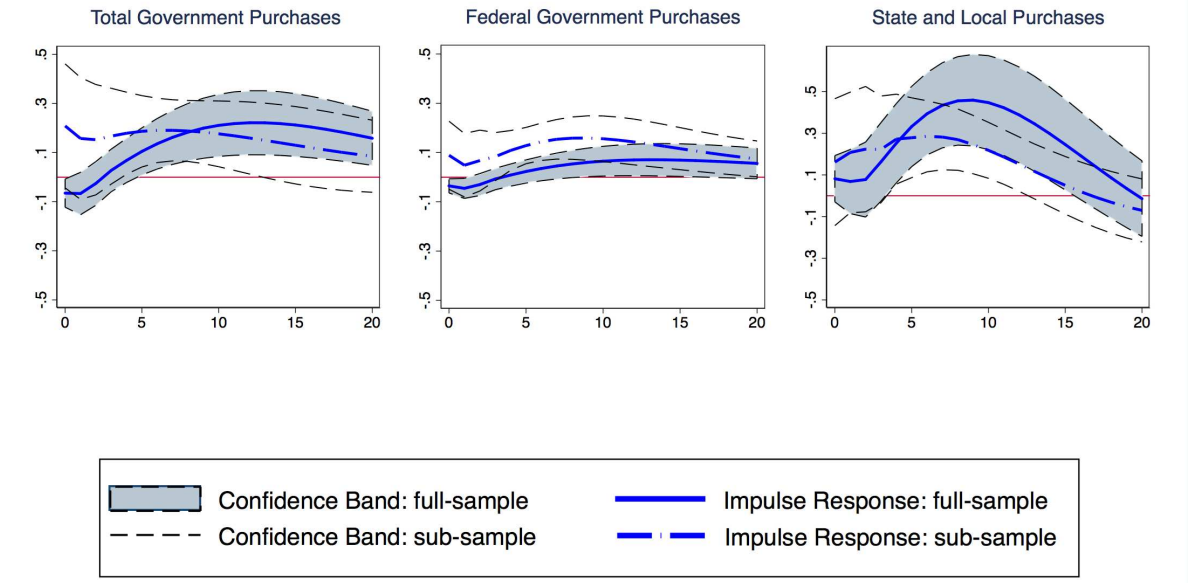
Note: The data source is originally from US. Bureau of Economic Analysis, selected series are retrieved from FRED, Federal Reserve Bank of St. Louis. The "in-crisis" period is particularly focus on the Great Economic Recession period: 2007Q4-2009Q2, which is defined by NBER US Business Cycle Expansions and Contractions; "**pre-crisis**" is 1960Q1-2007Q3; "**post-crisis**" is 2009Q3-2017Q2; "**full-sample**" is 1960Q1-2017Q3.

Figure 5: **The Share of Total Purchases by Governments: Federal v.s. State & Local**



Note: The ***solid line*** depicts the state & local government purchases share of total purchases. The ***long-dash line*** is the federal purchases share of total purchases. The *bar chart* shows the differences between federal and state and local shares. The *reference line in dash* is indicating the break-even point of the differences. Data source is US. Bureau of Economic Analysis, selected series are retrieved from FRED, Federal Reserve Bank of St. Louis. Time span is 1960Q1-2017Q3.

Figure 6: **Government Purchases Shocks on Total GDP**



Note: The data source is US. Bureau of Economic Analysis, selected series are retrieved from FRED, Federal Reserve Bank of St. Louis. The result is based on the 1-standard deviation confidence band (68% CI) and 100 times non-parametric bootstrap simulation. Time span of the full sample is 1960Q1-2017Q3, and 1960Q1-2007Q3 for the sub-sample.