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ARTICLE

Government size and the effectiveness of fiscal policy: the bigger the better?*

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Abstract
This study investigates the effect of government size, as measured by the tax revenue to gross domestic product (tax-GDP) ratio, on output responses to increases in government purchases. First, we show that in a standard static neoclassical model, the stimulus effect of fiscal expansion on output increases with the tax-GDP ratio. This finding is quantitatively confirmed using a dynamic neoclassical model with standard functional forms and parameter values. To empirically test the theoretical findings, we analyze the responses of macroeconomic variables to an unanticipated increase in government purchases for 12 Organisation for Economic Cooperation and Development (OECD) countries during 1985–2019 using a state-dependent local projection method. The estimation results reveal that while output responses to an unanticipated fiscal expansion are significantly positive when the tax-GDP ratio is high, they are statistically indistinguishable from zero when the ratio is low. Overall, our findings suggest that fiscal expansion can stimulate output more effectively at high tax rates, unlike the well-known predictions of the traditional Keynesian model.

Keywords: Fiscal multipliers; government size; fiscal policy; output responses

1. Introduction

Fiscal expansion through increased government spending is a key policy instrument for stimulating the economy. For instance, during the 2008 global financial crisis and recent COVID-19 pandemic, many countries implemented large-scale fiscal stimulus packages to fight severe recessions. Given the significance of the fiscal policy, it is necessary to understand the circumstances under which fiscal expansion is more effective in boosting the economy. Hence, numerous studies have investigated the potential factors that could affect fiscal multipliers, such as business cycles (Auerbach and Gorodnichenko (2012), Ramey and Zubairy (2018)), wealth inequality (Brinca et al. (2016)), government debt levels (Ilzetzki et al. (2013), Huidrom et al. (2020)), degree of economic development (Sheremirov and Spirovska (2022)), zero lower bound (Klein and Winkler (2021)), and demographic structure (Honda and Miyamoto (2021), Miyamoto and Yoshino (2022), Cho and Rhee (2024)).[1]

In addition to these potential factors, tax systems may be among the most substantial determinants of fiscal multipliers. Taxes significantly affect both resource allocation and responses to changes in government spending. Hence, fiscal policies may lead to considerably distinct

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economic outcomes between large-government countries with relatively high tax rates and those with relatively low tax rates. However, tax systems have received little attention in the literature as determinants of fiscal multipliers. Motivated by this, we provide a theoretical and empirical analysis of the effects of overall tax systems on the responses of key macroeconomic variables, such as output, employment, and consumption to changes in government purchases. To the best of our knowledge, this is the first study to investigate how the macroeconomic effects of fiscal policies interact with the overall tax systems.

First, we consider a static neoclassical model with variable labor for the theoretical analysis, following Baxter and King (1993) and Woodford (2011). In this framework, we derive an analytical result regarding the effect of the income tax rate on the government spending multiplier (i.e., the change in output caused by an unanticipated increase in government purchases). Then, we generalize the theoretical analysis to a dynamic neoclassical model with labor and capital. After calibrating the model, we quantify two types of fiscal multipliers: (i) the responses of steady-state output to a permanent increase in government purchases and (ii) the impulse responses of output to a temporary hike in government purchases. This analysis enables us to quantitatively explore the effects of the income tax rate on both the long- and short-run output responses.

Next, in an empirical analysis, we estimate the state-dependent impulse responses of output and other key macroeconomic variables to an unanticipated shock to government purchases in 12 Organisation for Economic Cooperation and Development (OECD) countries from 1985 to 2019. Specifically, we employ a state-dependent local projection method in which the estimated impulse responses depend on the tax revenue to gross domestic product (tax-GDP) ratio, that is, the ratio of total tax revenue to GDP. This measure is a useful indicator of government size or overall tax systems, and corresponds to the income tax rate in our theoretical models. Prior to estimating the state-dependent (or nonlinear) local projections, we identify government spending shocks based on the differences between the realized values of government purchases and their forecasts obtained from the OECD. Thus, the shocks identified in our empirical analysis represent unanticipated changes in government purchases in the theoretical analysis.

The main findings of this study are as follows. First, in the static neoclassical model, we show that the government spending multiplier increases in the income tax rate with standard forms of the utility and production functions.[2] Interestingly, this finding differs considerably from the traditional Keynesian model's prediction that a multiplier should decrease in the income tax rate. The two models yield contrasting results because they are based on different channels of fiscal expansion effects on output. In the traditional Keynesian model, a hike in government purchases increases output through positive consumption responses. However, in the static neoclassical model, such a fiscal expansion generates a negative wealth effect on households by reducing the goods available for consumption. Consequently, households consume less but work more in response to the fiscal expansion. As a result, output rises, driven by an increase in labor supply, but the stimulus effect is comparably weakened as consumption falls.

A possible explanation can also be provided for why the government spending multiplier increases with the income tax rate. With the standard forms of utility and production functions, labor supply becomes more elastic, and consumption becomes less elastic as household income decreases. Thus, when initial output is small, an increase in government purchases leads to a large increase in labor supply but a small decrease in consumption. In this case, fiscal expansion can increase output more significantly. Thus, high income tax rates can reinforce the stimulus effect of fiscal expansion on output because they reduce initial output through distortions in resource allocation. Thus, the government spending multiplier increases with the income tax rate.

The positive effect of the income tax rate on the government spending multiplier was also quantitatively confirmed in a dynamic neoclassical model calibrated with standard functional forms and parameter values.[3] We find that a permanent increase in government purchases has a stronger positive effect on steady-state output as the income tax rate increases. In addition, an unanticipated one-time hike in government purchases tends to generate more significant positive impulse responses of output when the income tax rate is high. These quantitative results are consistent with the analytical findings of the static neoclassical model. Taken together, our theoretical results suggest that fiscal expansion can be more effective in stimulating output in large governments with high income tax rates.[4]

Furthermore, our results from the empirical framework are consistent with the theoretical results. Specifically, the estimation results reveal that while the state-dependent impulse responses of output to an unanticipated government spending shock tend to be significantly positive when the tax-GDP ratio is high, they are statistically indistinguishable from zero when the ratio is low. Our empirical findings confirm the theoretical result that fiscal expansion can stimulate output more effectively in large governments with relatively high tax rates.

Our estimation results are inconsistent with the predictions of traditional Keynesian models, which imply that the government spending multiplier should decrease in the income tax rate. In addition, we find that the impulse responses of output are qualitatively similar to those of employment, but different from those of consumption. Specifically, the estimated impulse responses of employment to a positive government spending shock tend to be significantly positive when the tax-GDP ratio is high, but insignificant when the ratio is low. However, the estimated impulse responses of consumption are insignificant, regardless of the tax-GDP ratio. It should be emphasized that these results are not supported by the traditional Keynesian model. According to the model, the responses of output and consumption to fiscal expansion should exhibit a positive correlation because the multiplier effect on output is primarily driven by positive responses of consumption.

This study is related to several strands of the literature. First, our theoretical analysis builds on Baxter and King (1993) and Woodford (2011) as static and dynamic neoclassical models are drawn from them. However, we extend their analyses by examining how the income tax rate affects government spending multipliers in these models. As discussed, the government spending multiplier tends to increase with the income tax rate, which contradicts the well-known predictions of the traditional Keynesian model. As such, our theoretical analysis contributes to the literature by providing novel insights into the role of the income tax rate in the multiplier effect of government spending.

Our theoretical analysis is also related to the literature on the flypaper effect, that is, a well-documented empirical fact that local government spending responds more significantly to unconditional grants from the national government than to local income. Theoretically, this phenomenon is puzzling because unconditional grants and local tax revenue are perfect substitutes as a source of local government spending.[5] However, several studies (e.g., Hamilton (1986), Dahlby (2011), and Vegh and Vuletin (2016)) find that the flypaper effect can be explained if local tax is distortionary rather than lump-sum. Our theoretical analysis is related to these studies in that the economic models are similar and the interaction between government spending and distortionary taxes plays a key role.

However, our theoretical models are distinguishable from theirs in several aspects. In our analysis, government spending is exogenous whereas output is endogenous because the government spending multiplier represents the endogenous response of output to an exogenous change in government spending. For this reason, we consider a government that exogenously determines government spending. In contrast, in the aforementioned studies, income (or output) is exogenous whereas government spending is endogenous because the flypaper effect is concerned with the endogenous response of local government spending to an exogenous change in local income or unconditional inter-governmental grants. For this reason, they consider a Ramsey local government that optimizes local government spending (and tax rates). As such, our theoretical analysis is clearly distinct from the aforementioned studies in the government behavior and the focus of the analysis.

Our empirical analysis is based on a growing body of literature that measures the macroeconomic effects of changes in government spending or tax rates. Most studies in the related literature estimate the dynamic responses of output to an exogenous change in government spending or tax rates. The existing literature focuses on the first derivatives of output with respect to government spending and tax rates. In contrast, our study contributes to the literature by conducting a comprehensive analysis of the second-order cross-derivative of output with respect to government spending and tax revenue. As discussed earlier, in our empirical analysis, the dynamic responses of output to government spending shocks are determined by the tax-GDP ratio, which represents government size. Thus, our analysis sheds light on the interactions between government spending and tax policy or government size in the government's stabilization policy.

Our empirical analysis employs a state-dependent (or nonlinear) local projection method, with the state of the economy determined by the tax-GDP ratio. State-dependent local projection methods have been used to explore the characteristics of the economy that may influence the multiplier effects of government spending or tax rates. Ramey and Zubairy (2018) adopt a state-dependent local projection method to compare government spending multipliers for the U.S. during economic booms and slumps, the zero lower bound (ZLB) period and normal states. Klein and Winkler (2021) and Miyamoto et al. (2018) use similar approaches to examine the role of the ZLB in government spending multipliers for 13 OECD countries and Japan, respectively. Similarly, Miyamoto and Yoshino (2022) adopt a state-dependent local projection method to investigate the effect of population aging on the effectiveness of fiscal expansion.

Since the pioneering work of Blanchard and Perotti (2002), structural vector autoregressive (SVAR) models have been widely used to quantify the macroeconomic effects of changes in government spending or tax rates. For instance, Ben Zeev and Pappa (2017) and Mountford and Uhlig (2009) quantify the macroeconomic effects of government spending shocks in the U.S. using SVAR models. Ilzetzki et al. (2013) apply the SVAR approach to a panel of 44 countries to obtain government spending multipliers and examine several country-specific characteristics that could influence the multipliers.[6]

A key issue in the literature is the identification of government spending shocks representing unanticipated exogenous changes in government spending. In any period, part of government expenditure may be anticipated by people or motivated by changes in output or other important macroeconomic events. Hence, these components should be removed to identify government spending shocks relevant to fiscal multipliers. There have been alternative approaches to identifying exogenous shocks to government spending and tax rates. First, Blanchard and Perotti (2002) argue that for high-frequency data, government expenditures in a period are likely to be exogenous because they tend to be predetermined in the past through lengthy legislative and political processes. Several studies have exploited this identification scheme (Ilzetzki et al. (2013), Ramey and Zubairy (2018), Klein and Winkler (2021)). However, this may not be valid for our empirical analysis with annual data because government purchases in a year may be influenced by output in the same year.

Alternatively, other studies use government military spending because it is mainly motivated by international conflicts or geopolitical risks and is unlikely to respond to the state of the economy. Based on this idea, Ramey and Zubairy (2018) use military spending as an instrument for government spending to estimate government spending multipliers.[7] However, military spending is less useful for this study because it does not exhibit sufficiently large variations for the European economies in our sample. The third approach to identifying exogenous fiscal policy shocks is narrative-based method. In this approach, government spending shocks are constructed based on historical government documents. Starting with the Romer and Romer's (2010) seminal work, several studies have used this approach to quantify the macroeconomic effects of exogenous tax rate changes (e.g., Mertens and Ravn (2013, 2014), Cloyne (2013), Guajardo et al. (2014), Riera-Crichton et al. (2016)). However, this type of a shock is not available for some countries in our sample. Thus, following Auerbach and Gorodnichenko (2012, 2013), we identify government spending shocks from government purchase forecast errors. As discussed, this notion of shocks is consistent with unexpected exogenous changes in government spending in our theoretical analysis.

The remainder of this paper is organized as follows. The next section presents a theoretical analysis using both standard static and dynamic neoclassical models. Section 3 describes the data used and presents state-dependent local projections. Section 4 presents the estimation results for the output effects and shows the state-dependent impulse responses of key macroeconomic variables such as employment and consumption to government spending shocks. Finally, Section 5 provides the concluding remarks.

2. Theoretical analysis

In this section, we analyze the effects of an unanticipated rise in government purchases on the economy and the role of the income tax rate in standard neoclassical models (Baxter and King (1993), Woodford (2011)). First, using a static neoclassical model with variable labor, we derive a formula suggesting that the government spending multiplier can increase with the income tax rate. Then, using a general dynamic neoclassical model with reasonable parameter values, we show that the government spending multiplier tends to increase in the income tax rate. Finally, we discuss whether such theoretical results can be extended to the standard New Keynesian models.

2.1 Static neoclassical model with variable labor

Before analyzing the neoclassical model, we briefly review the main predictions of the traditional Keynesian model regarding the macroeconomic effects of changes in government purchases. In the traditional Keynesian model, a one-unit increase in government purchases G can raise output Y by more than one unit because of positive consumption responses. This mechanism has several implications. First, fiscal expansions that raise G are expected to stimulate output significantly. Second, the government spending multiplier, $\partial Y/\partial G$, falls as the income tax rate rises because income tax payments weaken consumption responses by reducing disposable income. Thus, consumption and output are expected to move in the same direction in response to changes in government purchases because output is primarily driven by changes in consumption. As discussed, neoclassical models provide different predictions of the effects of fiscal expansion. Hence, in Sections 3 and 4, we evaluate the predictions of the two types of models in our empirical analysis.

Our theoretical analysis is based on static neoclassical models developed by Baxter and King (1993) and Woodford (2011). In this model, homogeneous households choose consumption C and labor supply L to maximize utility $u(C) - v(L)$, that satisfies $u' > 0 > u''$ and $v' > 0$, $v'' > 0$, subject to the budget constraint:

$$C = (1-\tau)(wL + \Pi) + TR,$$

where $\tau \in (0, 1)$, w, Π, and TR denote the income tax rate, wages, dividends from firm profits, and lump-sum transfers from the government, respectively. Then, labor supply is determined by the following condition:

$$(1-\tau)\, w = \frac{v'(L)}{u'(C)}$$

On the supply side, identical firms produce output using labor. Their problem is to maximize profits by optimally choosing labor.

$$\Pi = \max_L \left[f(L) - wL \right],$$

where $Y = f(L)$ is a production function satisfying $f' > 0 > f''$. Note that profit Π is distributed among households as dividends. The firms' labor demand is determined by

$$w = f'(L).$$

The government receives income tax from households, makes purchases G, and provides lump-sum transfers TR to households. Thus, the government budget constraint is given as

$$G + TR = \tau\,(wL + \Pi)\,.$$

In this model, we assume that the government chooses G exogenously but maintains τ at a given value. Then, the budget surplus, $TR = \tau\,(wL + \Pi) - G$, is rebated to households as lump-sum transfers. This type of government behavior is suitable for our analysis because the government spending multiplier represents the endogenous response of output Y to an exogenous change in G.

Alternatively, the current model could be combined with a Ramsey government that optimizes the policy instruments (τ, G, TR) . Such a model can be useful to analyze how G responds to various shocks. For example, Vegh and Vuletin (2016) consider a Ramsey local government problem in a model analogous to the current one to account for the flypaper effect, which refers to the phenomenon that local government spending responds more significantly to unconditional grants from the national government than to local income. They show that the flypaper effect arises in their model only under distortionary taxation.[8] Indeed, if we assumed a Ramsey government in the current model, we could replicate their results: there is a flypaper effect with $TR = 0$ but no flypaper effect with $\tau = 0$. However, since our main focus is on the government spending multiplier in this analysis, we assume that the government changes G exogenously, rather than optimizing it, in what follows.

In equilibrium, the resource constraint $Y = C + G$ and the conditions for labor supply and demand should be satisfied. Combining these results yields the following equation:

$$(1-\tau)\,u'\,(Y-G) = \frac{v'\,(L)}{f'\,(L)} \equiv \tilde{v}'\,(Y)\,, \tag{1}$$

where $\tilde{v}\,(Y) \equiv v\left(f^{-1}\,(Y)\right)$ represents the (utility) cost of producing output Y. It is trivial to verify $\tilde{v}'\,(Y) > 0$ and $\tilde{v}''\,(Y) < 0$ using the properties of $v\,(L)$ and $f\,(L)$. Equation (1) has only one endogenous variable Y with policy variables τ and G. Thus, we can use the equation to characterize the effects of τ and G on Y. First, total differentials of equation (1) with respect to τ and Y yields

$$\frac{\partial Y}{\partial \tau} = -\frac{u'}{\tilde{v}'' - (1-\tau)\,u''} < 0. \tag{2}$$

This equation implies that the income tax rate τ has a negative impact on equilibrium output Y. This appears to be intuitive because a large τ discourages labor supply, thereby reducing output. We can also derive the government spending multiplier, m, from the total differentials of equation (1) with respect to G and Y.

$$m \equiv \frac{\partial Y}{\partial G} = \frac{-\,(1-\tau)\,u''}{\tilde{v}'' - (1-\tau)\,u''}$$

Moreover, because $1 - \tau = \tilde{v}'/u'$ from equation (1), we can rewrite the above equation as

$$m = \frac{\eta_u}{\eta_v + \eta_u} = \frac{1}{\eta_v/\eta_u + 1}, \tag{3}$$

where $\eta_u \equiv -Yu''/u' > 0$ and $\eta_v \equiv Y\tilde{v}''/\tilde{v}' > 0$ denote the elasticities of marginal utility u' and marginal cost $\tilde{v}'$ with respect to Y.

Equation (3) implies that the government spending multiplier is positive but less than one. Hence, the static neoclassical model predicts a smaller multiplier effect than the traditional Keynesian model. This difference arises because government purchases influence output through different channels in the neoclassical model. Specifically, an increase in G has a negative wealth effect on households because, given $C = Y - G$, such fiscal expansion effectively removes resources from households. Hence, they reduce consumption but raise labor supply in response to fiscal expansion. In other words, $dG > 0$ leads to $dY > 0$ (because $dL > 0$) but $dY < dG$ because $dC = dY - dG < 0$. These results imply $0 < m < 1$, as suggested by equation (3). Interestingly, while consumption decreases under the static neoclassical model, it increases under the traditional Keynesian model.

We also examine the impact of the income tax rate on the government spending multiplier using $\partial m/\partial \tau$. Therefore, we decompose the derivative as follows.

$$\frac{\partial m}{\partial \tau} = \frac{\partial Y}{\partial \tau} \times \frac{\partial \left(\eta_v/\eta_u\right)}{\partial Y} \times \frac{dm}{d\left(\eta_v/\eta_u\right)}$$

In this equation, $\partial Y/\partial \tau < 0$ from equation (2) and $dm/d\left(\eta_v/\eta_u\right) < 0$ from equation (3). Thus, $\partial m/\partial \tau$ should have the same sign as $\partial \left(\eta_v/\eta_u\right)/\partial Y$ in the model. Intuitively, the sign of $\partial \left(\eta_v/\eta_u\right)/\partial Y$ determines the magnitude of labor supply and consumption responses to changes in government purchases. To observe this, we suppose that η_v/η_u is small. In other words, the marginal cost $\tilde{v}'$ is relatively inelastic whereas the marginal utility u' is relatively elastic. In this case, when government purchases rise, output increases significantly because the marginal cost $\tilde{v}'$ increases relatively slowly, whereas consumption does not decrease significantly because the marginal utility u' increases relatively rapidly. Consequently, the government spending multiplier is high when η_v/η_u is low. Then, we can conclude that $\partial m/\partial \tau > 0$ is associated with $\partial \left(\eta_v/\eta_u\right)/\partial Y > 0$ because η_v/η_u decreases as τ increases through a decrease in Y by equation (2). By contrast, $\partial m/\partial \tau < 0$ if $\partial \left(\eta_v/\eta_u\right)/\partial Y < 0$ because a large value of τ results in a large value of η_v/η_u.

The sign of $\partial m/\partial \tau$ is generally ambiguous because $\partial \left(\eta_v/\eta_u\right)/\partial Y$ can take any sign, depending on the form of the utility and production functions. However, $\partial m/\partial \tau > 0$ may arise realistically in the static neoclassical model, even though it is the opposite of the prediction of the traditional Keynesian model. To demonstrate this, we present the following group of widely used functional forms of u, v, and f that give rise to $\partial m/\partial \tau > 0$.

$$\begin{aligned}
&u\left(C\right) = \tfrac{C^{1-\sigma}-1}{1-\sigma},\ \ \sigma > 0\\
&v_1\left(L\right) = -\tfrac{\xi}{1-\phi}\left(1-L\right)^{1-\phi},\ \ \phi > 0,\ \xi > 0,\ L \in [0, 1]\\
&v_2\left(L\right) = \tfrac{\xi}{1+\phi}L^{1+\phi},\ \ \phi > 0,\ \xi > 0,\ L \geq 0\\
&f\left(L\right) = L^{\theta},\ \ 0 < \theta < 1
\end{aligned} \tag{4}$$

Each of these functions has been widely used in economics as a standard form of the utility and production functions. The consumption utility function $u\left(C\right)$ and one of the labor disutility functions, $v_1\left(L\right)$, exhibit constant relative risk aversion. The other labor disutility function $v_2\left(L\right)$ is characterized by the constant Frisch elasticity of labor supply. The production function is a standard concave power function.

Using algebra, we can calculate η_v/η_u as implied by the functions in equation (4) as follows.

$$\frac{\eta_v}{\eta_u} = \begin{cases} \frac{1}{\sigma}\left(\frac{\phi}{\alpha}\frac{Y^{1/\theta}}{1-Y^{1/\theta}} + \frac{1}{\theta} - 1\right)\left(1 - \frac{G}{Y}\right) & \text{if } v\left(L\right) = v_1\left(L\right)\\ \left(\frac{1-\theta+\phi}{\theta\sigma}\right)\left(1 - \frac{G}{Y}\right) & \text{if } v\left(L\right) = v_2\left(L\right) \end{cases}$$

In both cases, η_v/η_u increases with Y. Consequently, $\partial m/\partial \tau > 0$ with functions in equation (4). In other words, the government spending multiplier increases with the income tax rate if the economy is well represented by these functions. Admittedly, this result does not prove that the income tax rate has a positive impact on the multiplier effect. However, it may suggest that the positive impact of the income tax rate on the government spending multiplier can be a realistic possibility because it is based on the standard utility and production functions that can account for numerous macroeconomic phenomena. Indeed, in our empirical analysis, we find that an unanticipated increase in government purchases tends to have more significant and positive effects on output when the tax-GDP ratio is high. This finding may corroborate our theoretical result in the static neoclassical model with the functions in equation (4).

2.2 Dynamic neoclassical model with labor and capital

In this subsection, we consider a dynamic neoclassical model with capital and labor following Baxter and King (1993). This is more general than the static neoclassical model because it has more channels through which government purchases can influence output. Even in this general dynamic model, we quantitatively show that the income tax rate tends to have a positive impact on output responses to a rise in government purchases.

2.2.1 Model setup

The economy is composed of households, firms, and a government. First, homogeneous households choose consumption C_t, labor $L_t \in [0, 1]$, and capital K_{t+1} in period t to maximize the following sum of utilities:

$$\mathbb{E}\left[\sum_{t=0}^{\infty} \beta^t \left[\ln C_t + \xi \ln\left(1 - L_t\right)\right]\right], \quad \beta \in (0, 1), \ \xi > 0,$$

where $\ln C_t$ and $\ln(1 - L_t)$ represent the utilities from consumption C_t and leisure $(1 - L_t)$, respectively. Notice that both functions have the form given in equation (4) for $dm/d\tau > 0$ in a static neoclassical model. Household choices $\{C_t, L_t, K_{t+1}\}$ should satisfy the following budget constraint.

$$C_t + K_{t+1} = (1 - \tau)\left(W_t L_t + R_t^k K_t\right) + (1 - \delta) K_t + TR_t,$$

where W_t and R_t^k denote the wage and rental price of capital in period t. As before, $\tau \in (0, 1)$ and TR_t are the income tax rate and lump-sum government transfers in period t. Finally, $\delta \in [0, 1]$ is the depreciation rate of capital.

On the supply side, homogeneous firms choose L_t and K_t to solve the following problem:

$$\max_{\{K_t, L_t\}} \left[K_t^{\alpha} L_t^{1-\alpha} - W_t L_t - R_t^k K_t\right], \quad \alpha \in (0, 1),$$

where $Y_t = K_t^{\alpha} L_t^{1-\alpha}$ denotes the production function. Finally, the government collects income tax, purchases goods G_t, and provides lump-sum transfers TR_t to households in period t. Hence, the government budget constraint can be written as

$$G_t + TR_t = \tau\left(W_t L_t + R_t^k K_t\right).$$

Note that TR_t can be interpreted as the government budget surplus.

The competitive equilibrium of this economy is characterized by the following equations.

$$\xi \frac{C_t}{1 - L_t} = (1 - \tau)(1 - \alpha) K_t^{\alpha} L_t^{-\alpha} \tag{5}$$

$$\frac{1}{C_t} = \beta \mathbb{E}_t\left[\frac{1}{C_{t+1}}\left\{1 - \delta + (1 - \tau)\alpha K_{t+1}^{\alpha-1} L_{t+1}^{1-\alpha}\right\}\right] \tag{6}$$

$$C_t + G_t + K_{t+1} = K_t^{\alpha} L_t^{1-\alpha} + (1 - \delta) K_t \tag{7}$$

We derive equation (5) by combining the first-order conditions for labor supply and demand. Similarly, we obtain equation (6) from the households' intertemporal Euler equation and condition for capital demand. In addition, equation (7) is the resource constraint or goods-market-clearing condition that should hold in competitive equilibrium. In the next subsections, we characterize the economy using equilibrium conditions (5)–(7) given government policy $\{\tau, G_t\}$.

2.2.2 The effects of a permanent fiscal expansion in the steady state

We begin by analyzing the effects of a permanent rise in government purchases on output and other steady-state variables. This exercise could be interpreted as a generalization of the static neoclassical model, as the dynamic model incorporates both the intratemporal and intertemporal responses of economic agents. In the steady state, equilibrium conditions (5)–(7) are simplified as follows:

$$\xi \frac{C^*}{1-L^*} = (1-\tau)(1-\alpha)\left(K^*\right)^{\alpha}\left(L^*\right)^{-\alpha}, \tag{8}$$

$$1 = \beta\left[1-\delta+\alpha(1-\tau)\left(K^*\right)^{\alpha-1}\left(L^*\right)^{1-\alpha}\right], \tag{9}$$

$$C^* + G^* + \delta K^* = \left(K^*\right)^{\alpha}\left(L^*\right)^{1-\alpha},$$

where X^* denotes the steady-state value of a variable X_t. For any policy mix (τ, G^*), we find (C^*, K^*, L^*, Y^*) from those conditions and the production function $Y^* = (K^*)^{\alpha}(L^*)^{1-\alpha}$.

We can also obtain the derivatives of (C^*, K^*, L^*, Y^*) with respect to G^* from the total differentials of steady-state equilibrium conditions. Our primary interest is in $\partial Y^*/\partial G^*$, denoted by m^*. This can be interpreted as a long-run government spending multiplier, because it represents the long-run effect of a permanent rise in government purchases on steady-state output. Appendix A shows, m^* is expressed in terms of the income tax rate τ and other model parameters as follows:

$$m^* = \frac{1}{1+\psi(1-\tau)}, \text{ with } \psi \equiv \frac{1-\alpha}{\xi} - \frac{\delta\alpha}{\beta^{-1}-1+\delta}. \tag{10}$$

The properties of m^* depend crucially on ψ, that is, the coefficient on $(1-\tau)$. If $\psi > 0$, then $\partial m^*/\partial\tau > 0$ and $0 < m^* < 1$. In this case, m^* exhibits qualitative properties similar to those of m in equation (3) into a static neoclassical model.[9] By contrast, if $\psi < 0$, then $\partial m^*/\partial\tau < 0$ and $m^* > 1$. In this case, m^* has properties similar to those of the government spending multiplier in the traditional Keynesian model.

In equation (10), the sign of ψ is primarily determined by ξ because there are standard values of α (capital share in GDP), β (discount factor), and δ (depreciation rate of capital) in the literature. Specifically, let us define $\bar{\xi}$ as the value of ξ corresponding to $\psi = 0$, given the values of (α, β, δ). From equation (10), we obtain $\bar{\xi}$ as follows:

$$\bar{\xi} \equiv \frac{(1-\alpha)\left(\beta^{-1}-1+\delta\right)}{\alpha\delta}. \tag{11}$$

Then, $\xi < \bar{\xi}$ is required for $\psi > 0$ because ψ decreases in ξ. This condition is likely to be satisfied by realistic parameter values. It should be noted that the equilibrium labor L^* tends to decrease with ξ because the parameter represents the importance of leisure in the utility function. However, if $\xi \geq \bar{\xi}$ with standard values of (α, β, δ), L^* tends to be unrealistically low. Thus, the value of ξ is likely to be smaller than $\bar{\xi}$ to generate an empirically plausible L^*. In other words, the condition $\psi > 0$ tends to be satisfied in the steady state.

To illustrate these results, we simulate the model using realistic parameter values. To this end, we choose $\alpha = 0.33$, $\beta = 0.96$, and $\delta = 0.1$ because we interpret one model period as one year. These parameter values are widely used in the literature. We set ξ depending on fiscal policy

(τ, G^*) so that $L^* = 0.33$ may be attained in the steady state under any given combination of τ and G^*. Then, we compare ξ with the threshold $\bar{\xi} = 2.876$, which can be calculated from equation (11). We also examine the behavior of the long-run multiplier m^* and related variables from the simulated model.

To assess the plausibility of $\xi < \bar{\xi}$ through this simulation, we need to consider a wide range of fiscal policy (e.g., from a small government to a big one). Therefore, we choose 20%, 40%, and 60%, as values of τ. These values can represent government size observed in the real world. For each value of τ, we choose G^* ranging from 95% of total tax revenue τY^* to 120%. As a result, the government deficit to GDP ratio falls on the interval [−5%, 20%] in the simulation. As such, the combinations of τ and G^* can capture the various types of fiscal policy observed in the real world.

The simulation results are shown in Fig. 1. In Panel (a), we display ξ that can yield $L^* = 0.33$ for each combination of τ and G^*. The figures in all other panels are drawn for the various values of τ and G^* and corresponding values of ξ. In Panel (a), we can clearly see that $\xi < \bar{\xi}$, which is the condition for $\psi > 0$, is satisfied for most values of τ and G^*. We observe $\xi > \bar{\xi}$ only when both τ and G^* are unrealistically large. By equation (10), the result implies $\psi > 0$, $0 < m^* < 1$, and $\partial m^*/\partial \tau > 0$ in cases where $\xi < \bar{\xi}$, as shown in Panels (b)–(d) of Fig. 1. These results are consistent with the properties of the multiplier m in equation (3) in the static neoclassical model. They suggest that m^* tends to be smaller than one, but increases in τ in the steady states under the realistic types of fiscal policy. Moreover, we observe a negative wealth effect of an increase in government purchases in the steady states of the dynamic neoclassical model. As discussed previously, such fiscal expansion reduces consumption, but raises labor supply in the static neoclassical model through the negative wealth effect. Indeed, Fig. 1 shows that $\partial L^*/\partial G^* > 0$ in Panel (e) and $\partial C^*/\partial G^* < 0$ in Panel (f) regardless of τ and G^* in the steady states of the dynamic model.[10]

Overall, the simulation results from the steady state of the dynamic neoclassical model tend to confirm the analytical results from the static neoclassical model. In addition, the main simulation results, such as $m^* \in (0, 1)$ and $\partial m^*/\partial \tau > 0$ are quite robust, because they are shown in Fig. 1 for almost all values of τ and G^*. These results suggest that a relatively small multiplier effect and the positive effect of the income tax rate on the multiplier can be realistic outcomes of an increase in government purchases and not just theoretical possibilities.

2.2.3 Impulse responses to a one-time fiscal expansion

In the second exercise using the dynamic neoclassical model, we quantify the effects of an unanticipated one-time increase in government purchases. To this end, we characterize the impulse responses of macroeconomic variables to one-time fiscal expansion. In particular, we focus on the magnitude of the impulse responses of output and the impact of the income tax rate on these impulse responses. The results in this subsection can be compared with the empirical results for the government spending multipliers in Section 3.

We log-linearize the equilibrium conditions (5)–(7) and production function $Y_t = K_t^{\alpha} L_t^{1-\alpha}$ around the steady state:

$$\begin{aligned} c_t &= \alpha k_t - \left(\alpha + \frac{L^*}{1-L^*}\right) l_t, \\ c_t &= \mathbb{E}_t\left[c_{t+1} + \{1 - \beta(1-\delta)\}(1-\alpha)\left(k_{t+1} - l_{t+1}\right)\right], \\ s_K k_{t+1} &= [\alpha + (1-\delta) s_K] k_t + (1-\alpha) l_t - s_C c_t - s_G g_t, \\ y_t &= \alpha k_t + (1-\alpha) l_t, \end{aligned}$$

where $x_t \equiv \ln X_t - \ln X^*$ and $s_X \equiv X^*/Y^*$ for each variable X_t with steady-state output Y^*. Government purchases are assumed to evolve as an AR(1) process as follows:

$$g_t = \rho g_{t-1} + \nu_t, \quad \rho \in (0, 1), \tag{12}$$

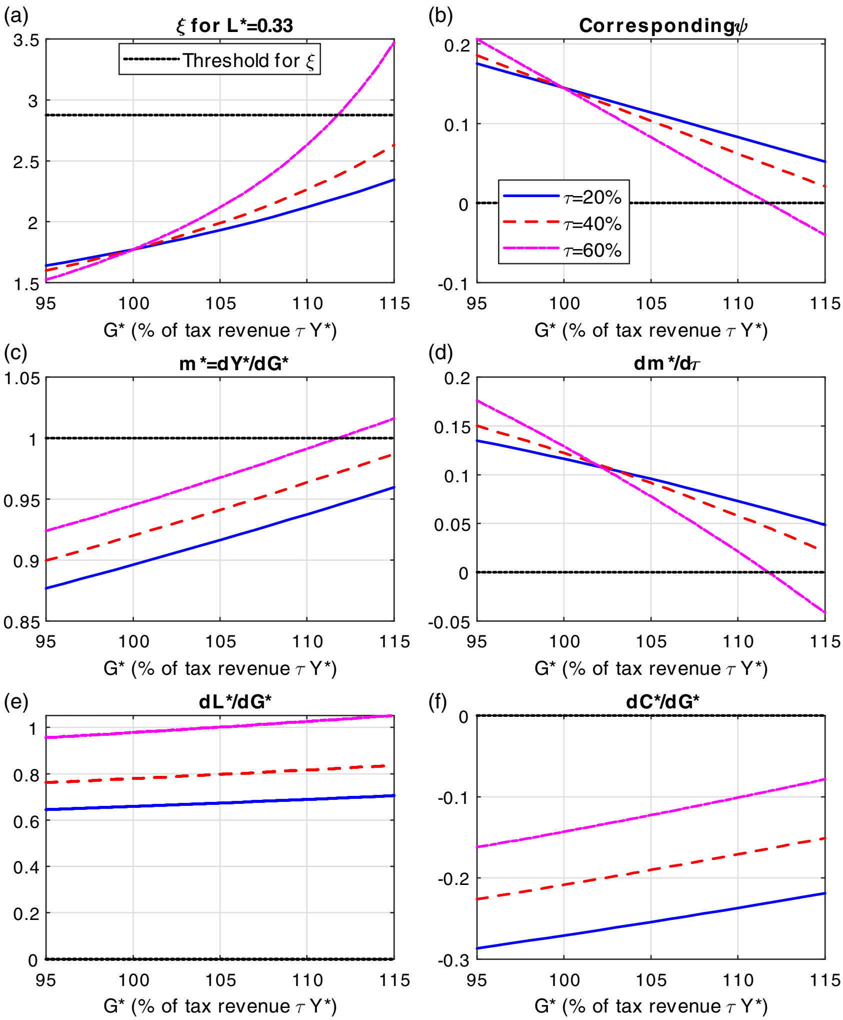

Figure 1. Long-run effects of a permanent rise in government purchases. This figure displays the steady-state outcomes of the simulated dynamic neoclassical model with labor and capital as discussed in Subsection 2.2. In all panels, the horizontal axis represents government purchases G^* as a percentage of total tax revenue τY^*. Also, in all panels, for each combination of τ and G^*, we choose a different ξ so that $L^* = 0.33$ may be attained. Such ξ is displayed for all combinations of τ and G^* in panel (a). In other panels, we display ψ, defined in equation (10), in panel (b); $m^* = \partial Y^*/\partial G^*$, also defined in equation (10), in panel (c); $\partial m^*/\partial \tau$ in panel (d); $\partial L^*/\partial G^*$ in panel (e); and $\partial C^*/\partial G^*$ in panel (f). The black dashed line in panel (a) represents a threshold value $\bar{\xi}$ defined in equation (11). If $\xi < \bar{\xi}$, $\psi > 0$ in panel (b), $m^* < 1$ in panel (c), and $\partial m^*/\partial \tau > 0$ in panel (d). See the equations and related discussion in Subsection 2.2.2 for details.

where $g_t \equiv \ln(G_t/G^*)$ and ν_t is an *i.i.d.* shock. For the quantitative analysis, we assume $\rho = 0.7$. In addition, we choose $\alpha = 0.33$, $\beta = 0.96$, and $\delta = 0.1$ as in the steady-state analysis. For fiscal policy, we consider the two values of τ, 0.2 and 0.4, to examine the role of the income tax rate. For each τ, we choose G^* such that the government budget is balanced in the steady state (i.e., $G^* = \tau Y^*$ or $TR^* = 0$). Subsequently, we set ξ such that $L^* = 0.33$ can be obtained in the steady state for each combination of τ and G^*.

To obtain impulse responses, we assume that each economy has been in a balanced-budget steady state up to period −1. However, a one-time positive shock occurs to government purchases in period 0, such that $\nu_t = 1$ for $t = 0$ and $\nu_t = 0$ for $t \geq 1$ in equation (12). In other

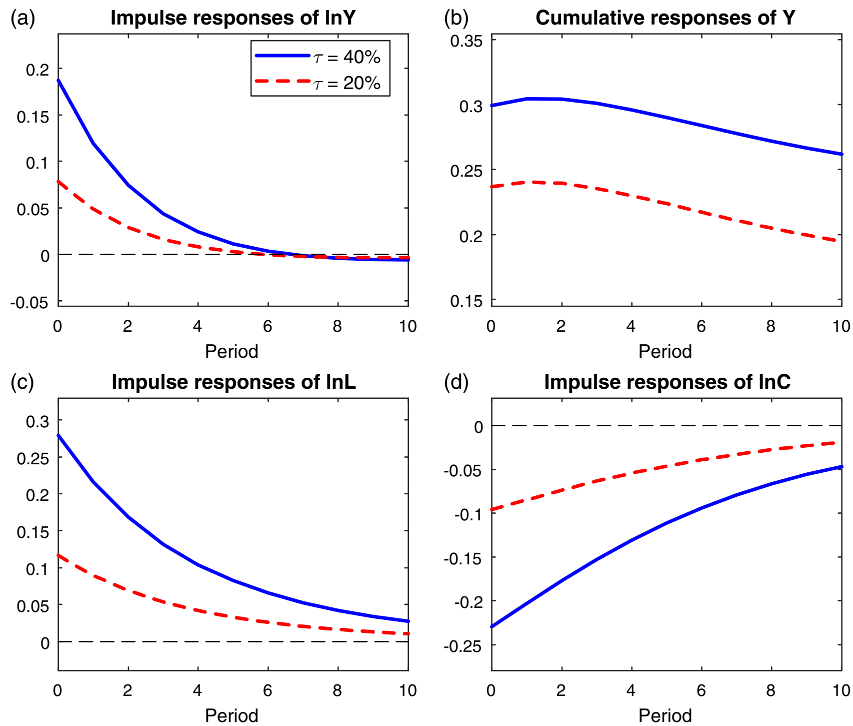

Figure 2. Simulated impulse responses to a one-time fiscal expansion. Panels (a), (c), and (d) display the impulse responses of log of output, labor, and consumption to an unexpected one-time 1% rise in government purchases in period 0. Panel (b) shows the cumulative responses of output. All panels are based on the calibrated dynamic neoclassical model. Refer to discussion in Subsection 2.2 for details regarding the model specification and calibration.

words, government purchases increase unexpectedly by 1% in period 0 and change in subsequent periods according to equation (12). Given the process for g_t and parameter values, we can calculate the impulse responses (c_t, l_t, k_t, y_t) using log-linearized equilibrium conditions. However, the impulse responses of output are not government spending multipliers because both g_t and y_t are logarithmic. Hence, we calculate the cumulative output responses as follows:

$$M^h \equiv \frac{\sum_{t=0}^{h} (Y_t - Y^*)}{\sum_{t=0}^{h} (G_t - G^*)}$$

Intuitively, M^h represents the total change in output over h periods, due to the total change in government purchases. In this sense, the cumulative responses can be interpreted as cumulative government spending multipliers.

Figure 2 presents the simulated output, labor, and consumption responses. In Panels (a) and (b), the characteristics of the impulse and cumulative responses of output are consistent with the main theoretical results. First, a positive shock to government purchases can stimulate output. However, all impulse responses are smaller than 0.2 in Panel (a), and the cumulative responses are far below one in Panel (b). These results indicate that government spending multipliers are smaller than one. Another interesting finding is that the negative wealth effect of fiscal expansion is also observed in impulse responses. In Panels (c) and (d) of Fig. 2, labor supply increases, whereas consumption decreases in response to a positive shock to government purchases. As previously discussed, these are characteristics of the negative wealth effect of fiscal expansion.

Regarding the role of the income tax rate, a positive shock to government purchases has a more significant stimulating impact on output when τ is higher. In Panel (a) of Fig. 2, output exhibits stronger impulse responses when $\tau = 0.4$ for up to six periods after the shock. Similarly, the cumulative responses of output are larger for $\tau = 0.4$ than for $\tau = 0.2$ in Panel (b). Such differences in impulse and cumulative responses indicate that the higher the income tax rate, the stronger the multiplier effect of a rise in government purchases. Obviously, this relationship is not generalizable. However, this has been proven analytically in the static neoclassical model with standard forms of the utility and production functions. It is also verified quantitatively using a dynamic neoclassical model calibrated with standard functional forms and parameter values. With a high income tax rate, a permanent increase in government purchases raises the steady-state output more significantly, and a temporary increase in government purchases leads to stronger positive output responses. Overall, the positive impact of the income tax rate on the government spending multiplier is quite robust in our theoretical analysis using both static and dynamic neoclassical models.

2.3 Economies with monopolistic competition

So far, we have analyzed both static and dynamic neoclassical models. In these models, we showed that high tax rates can amplify the multiplier effect of increased government purchases with realistic functional forms and parameter values. However, this result might hold less relevance for other types of models if they have a quite different structure from the neoclassical models. In particular, the New Keynesian models feature monopolistic competition and various types of frictions such as nominal rigidities. Hence, our theoretical results from the neoclassical models may not necessarily apply to the New Keynesian models. Given the importance of New Keynesian models in macroeconomics, we discuss in this subsection how our theoretical findings can be extended to the New Keynesian models.

First, we show that our theoretical results still hold even if monopolistic competition is introduced to the model. For this purpose, we consider the Dixit–Stiglitz model of monopolistic competition. In the economy, there is a continuum of differentiated goods on the interval $[0, 1]$. Each good is produced by a producer with some degree of market power. Households consume differentiated goods and supply labor for the production of those goods. Let $c(i)$ and $l(i)$ denote consumption and labor supply for good i. The utility function for households is assumed as follows:

$$u(C) - \int_0^1 v\left(l(i)\right) di,$$

where C is composite consumption defined as

$$C \equiv \left[\int_0^1 c(i)^{\frac{\theta-1}{\theta}} di\right]^{\frac{\theta}{\theta-1}}, \;\; \theta > 1.$$

As in the neoclassical models, we assume $u' > 0 > u''$ and $v' > 0,\;\; v'' > 0$. With differentiated goods, the households' budget constraint is modified as follows:

$$\int_0^1 p(i)\, c(i)\, di = (1-\tau)\left[w\int_0^1 l(i)\, di + \Pi\right] + TR,$$

where $p(i)$ is the price of good i. As defined earlier, $w,\;\tau,\;\Pi$, and TR denote the wage, income tax rate, dividends from firms and lump-sum transfers from the government, respectively.

Each household maximizes its utility subject to the budget constraint. The first-order conditions of the households' problem imply that $l(i)$ is the same for all i. Hence, we denote common labor supply by L. Then, labor disutility can be simplified to $v(L)$, which coincides with labor disutility in the static neoclassical model. Also, the demand for good i is obtained as

$$c\left(i\right)=\left(\frac{p\left(i\right)}{P}\right)^{-\theta}C \text{ for all } i\in\left[0,1\right],$$

where P is the price index defined as

$$P=\left[\int_{0}^{1}p\left(i\right)^{1-\theta}di\right]^{\frac{1}{1-\theta}}.$$

Finally, labor supply and consumption should satisfy the following condition:

$$v'\left(L\right)=\left(1-\tau\right)\frac{w}{P}u'\left(C\right)$$

On the production side, firm i produces output $y\left(i\right)$ using labor $l\left(i\right)$ according to a production function $y\left(i\right)=f\left(l\left(i\right)\right)$. The production function f is assumed to be identical across firms. Also, it satisfies the standard assumption, $f'>0>f''$. As firms have market power, firm i chooses $p\left(i\right)$ to maximize its profit $p\left(i\right)c\left(i\right)-wf^{-1}\left(c\left(i\right)\right)$. Solving the firm's problem provides the following condition for labor demand.

$$p\left(i\right)=\mu\frac{w}{f'\left(l\left(i\right)\right)},$$

where $\mu\equiv\frac{\theta}{\theta-1}$ represents the degree of the markup. From the household's problem, $l\left(i\right)=L$ for all i. Then, the labor demand condition implies $p\left(i\right)=P$ for all i.

In equilibrium, both labor supply and demand conditions are satisfied. Also, $Y=C+G$ for goods market clearing. Combining all those conditions, we obtain the following equation:

$$\left(1-\tau\right)u'\left(Y-G\right)=\mu\tilde{v}'\left(Y\right), \tag{13}$$

where $\tilde{v}\left(Y\right)=v\left(f^{-1}\left(Y\right)\right)$ is defined in the static neoclassical model. This equation is almost identical to equation (1), except for the markup μ. Moreover, all results in the static neoclassical model still hold in the current model with monopolistic competition. More specifically, (i) the income tax rate has a negative impact on the equilibrium output (i.e., $\partial Y/\partial\tau<0$); (ii) the government spending multiplier m takes exactly the same form as in equation (3); and (iii) $\partial m/\partial\tau$ will be positive for the functions in equation (4). As such, the main theoretical results in the static neoclassical model can be generalized to the economies with monopolistic competition. In addition, the negative wealth effect channel is still relevant even if the economy is characterized with monopolistic competition.

Our interest lies in whether it is feasible to derive analogous theoretical outcomes in New Keynesian dynamic models. Although New Keynesian models are more complicated than the simple model of monopolistic competition. However, even in the New Keynesian models, an equilibrium condition analogous to equation (13) should be satisfied for the labor market. In addition, households' labor supply and firms' labor demand in the New Keynesian models are based on those in the simple model of monopolistic competition. Given these similarities, it is reasonable to anticipate that in the New Keynesian models, an increase in government purchases may still induce a negative wealth effect, reducing consumption but raising labor supply. Moreover, the New Keynesian models are often calibrated with the functions presented in equation (4). Consequently, the negative wealth effect of fiscal expansion can also generate a positive impact of the income tax rate on the government spending multiplier in the New Keynesian models.

On the other hand, there are many other channels through which the income tax rate affects the government spending multiplier. Consequently, the overall effect of the income tax rate on the government spending multiplier may often be negative in the New Keynesian models. However, the negative wealth effect is expected to exist and interact with the income tax rate in these models. Therefore, if the New Keynesian models are calibrated with the functions specified in equation (4), the income tax rate can positively affect the government spending multiplier through the negative wealth effect. Taken together, the assertion that an increase in government purchases stimulates output more effectively when the income tax rate is high is not generally applicable in the New Keynesian models. Nevertheless, the positive effect of the income tax rate on the government spending multiplier is likely to coexist with other channels in the New Keynesian models.

3. Empirical analysis

The theoretical analysis indicates that the government spending multiplier tends to be less than one but increases with the income tax rate. Motivated by these theoretical results, we estimate the dynamic effects of a shock to government purchases on output and other macroeconomic variables. This section describes the dataset and explains the econometric methods used in the empirical analysis. In the next section, we discuss the estimation results and implement robustness checks.

3.1 Data and the identification of shocks to government purchases

For our empirical analysis, we construct a dataset of both macroeconomic and fiscal variables for 12 OECD countries over the period 1985–2019. All variables in our dataset are obtained from the OECD Economic Outlook and OECD Statistics and Projections databases. Our dataset includes Belgium, Denmark, France, Germany, Italy, the Netherlands, Spain, Sweden, Portugal, Switzerland, the United Kingdom, and the United States.[11] However, our dataset is an unbalanced panel, due to differences in data availability across the sample countries.

In our empirical analysis, we estimate the macroeconomic effects of unanticipated changes in government purchases using the state-dependent local projection method (Jordà (2005)). To implement this method, the shocks to government purchases must be identified. Following Auerbach and Gorodnichenko (2012, 2013), we use forecast errors of government purchases as "government spending shocks" because they represent the component of government purchases unexpected by economic agents. Specifically, let G_{it} and G_{it}^e denote actual and forecasted government purchases, respectively, for country i in year t.[12] The forecast G_{it}^e is predetermined in year $t-1$. We define the government spending shock ε_{it} for country i in year t as follows:

$$\varepsilon_{it} \equiv \frac{G_{it} - G_{it}^e}{Y_{i,t-1}}, \tag{14}$$

where $Y_{i,t-1}$ is GDP of country i in year $t-1$. In other words, the government spending shock in a year is the forecast error of government purchases scaled by GDP in the previous year.[13,14] Note that ε_{it} is analogous to the shock ν_t in equation (12) for the calibrated dynamic neoclassical model in Section 2 because both can be interpreted as forecast errors of government purchases.

Ideally, G_{it}^e should be determined at the end of year $t-1$. In this case, ε_{it} could be a pure shock to G_{it} because it would only include the component of G_{it} that was totally unanticipated until the end of the previous year. Moreover, a regression of $Y_{i,t+h}$ on ε_{it} yields an unbiased estimate of the output response in period $t+h$ to an unexpected change in G_{it} in period t. In other words, we can avoid the well-known issues of fiscal foresight (Leeper et al. (2013)) and potential feedback from the state of the economy to fiscal policy. In contrast, if G_{it}^e is determined relatively early in year $t-1$, ε_{it} may include the component of G_{it} that is fully expected in year $t-1$ based on the newly available information after G_{it}^e is determined. In this case, a regression of Y_{it} on ε_{it} may also include part of output that is not caused by shocks to government purchases in period t.

Considering the importance of the forecasting timing, we draw G_{it}^e from forecasts of government purchases published in the fall issue of the previous year in the OECD Economic Outlook and Statistics and Projections databases. Hence, there is only a two- or three-month gap between the publication of forecast G_{it}^{e} and the beginning of year t. Consequently, ε_{it} can identify the shock component of G_{it} reasonably well as significant events or policy changes are not as frequent after the publication of OECD forecasts of government purchases. If this is the case, then the regression of the macroeconomic variables on ε_{it} can properly capture their responses to unanticipated changes in government purchases. Based on these advantages, we interpret ε_{it} as a government spending shock, which is the main explanatory variable in our empirical analysis.

3.2 Estimation equations

To evaluate the dynamic responses of the macroeconomic variables to unexpected changes in government purchases, we employ a state-dependent local projection method. We estimate the following equation for each $h = 0, 1, \cdots, 4$:

$$\ln Z_{i,t+h} - \ln Z_{i,t-1} = \alpha_i^h + \theta_t^h + \left[\beta_{LT}^h H\left(T_{i,t-1}\right) + \beta_{HT}^h \left\{1 - H\left(T_{i,t-1}\right)\right\}\right] \varepsilon_{it} + \omega^h X_{it} + u_{i,t+h}^h, \tag{15}$$

with the transition function $H(\cdot)$ defined as

$$H\left(T_{i,t-1}\right) = \frac{1}{1 + \exp\left(\gamma T_{i,t-1}\right)}, \quad \gamma > 0. \tag{16}$$

In the estimation equation, Z is a variable of interest, and i and t are the indices for the country and year, respectively. α_i^h and θ_t^h are the country and year dummies, respectively, and X_{it} is a vector of the control variables.[15] ε_{it} denotes the government spending shock defined in equation (14). Note that the coefficient on ε_{it} consists of two parameters, β_{LT}^h and β_{HT}^h, which correspond to the "low-tax (LT)" and "high-tax (HT)" states, as explained below. The error term $u_{i,t+h}^h$ may not be spherical. Hence, we calculate the Driscoll–Kraay (1998) standard errors, as they are robust to heteroskedasticity, autocorrelation, and cross-sectional dependence. We estimate equation (15) for various Z, such as output, employment, and consumption, over the horizon $h = 0, 1, \cdots, 4$, so that we can characterize their dynamic responses over four years after a government spending shock occurs.

In the transition function H in equation (16), we use the lagged tax-GDP ratio, denoted by $T_{i,t-1}$, as a transition variable. The tax-GDP ratio is a useful indicator of the overall tax burden or government size. Also, it is directly related to the income tax rate τ in the theoretical analysis in Section 2 because it coincides with the tax-GDP ratio in equilibrium. The parameter γ in equation (16) determines the speed of transition. We assume $\gamma = 1.5$ following Auerbach and Gorodnichenko (2013) and Honda and Miyamoto (2021). However, the main results are robust to changes in γ. We also normalize T_{it} in equation (16) so that $\mathbb{E}\left(T_{it}\right) = 0$ and $var\left(T_{it}\right) = 1$.

We use the lagged tax-GDP as the transition variable to avoid potential issues caused by contemporaneous effects of government purchases and the dependent variables on tax revenue. For example, there can be potential reverse causality from output to tax revenue. Also, if government purchases can influence tax revenue, a positive ε_{it}, or equivalently, an unanticipated increase in government purchases, may also affect tax revenue. In other words, the government spending shock may influence the transition variable. These issues can create some bias in our regression analysis. Therefore, we use the lagged tax-GDP ratio $T_{i,t-1}$ as the transition variable because it is unlikely to be affected by the government spending shock ε_{it} or output Y_{it} in period t.[16]

With the transition function discussed so far, we can interpret the regression equation (15). In particular, the coefficient on ε_{it} is expressed as a weighted average of β_{LT}^h and β_{HT}^h with the weights, H and $(1 - H)$. With this specification, the tax-GDP ratio controls the dynamic responses of the macroeconomic variables to government spending shocks because weights are fully determined by $T_{i,t-1}$. Specifically, as the lagged tax-GDP ratio increases, the weight on β_{HT}^h increases, but the weight on β_{LT}^h decreases in the coefficient on ε_{it} because H is a decreasing function of $T_{i,t-1}$.

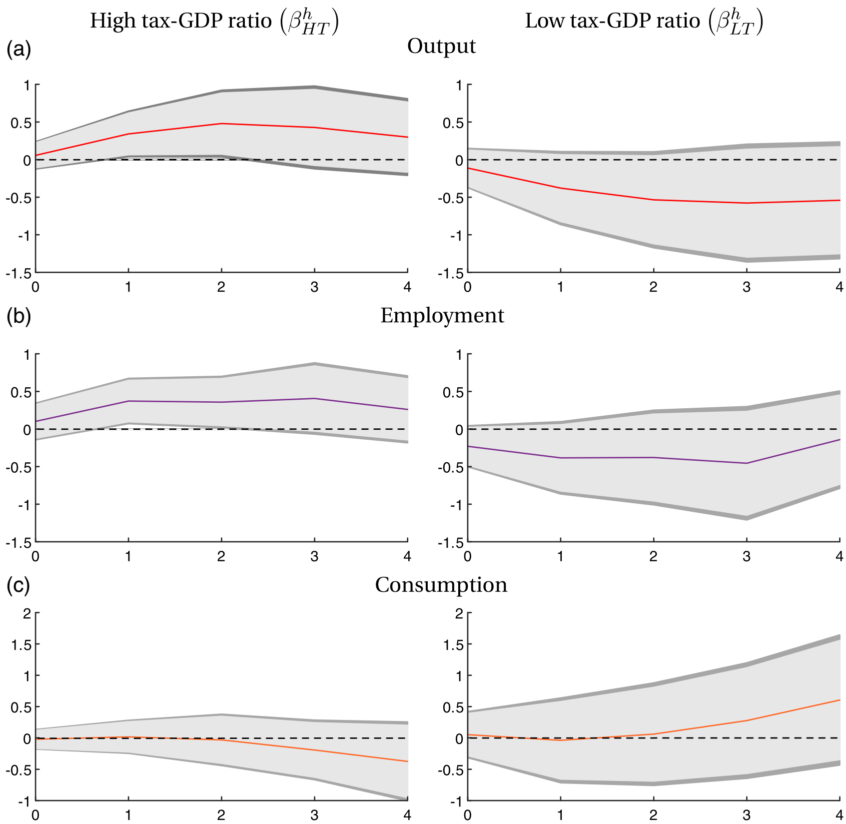

Figure 3. Estimated impulse responses of output, employment, and consumption to a positive shock to government purchases. This figure displays the responses of the log of those variables to an unexpected rise in government purchases by 1% of GDP. In each panel, the horizontal axis indicates the years from the shock. Left and right panels show β^h_{HT} and β^h_{LT}, which are relevant for high and low tax-GDP ratios, respectively. Shaded areas indicate 90% confidence bands and dark shaded areas denote 95% confidence bands. See equation (15) for details.

Thus, β^h_{HT} is more relevant for large governments with high tax rates, whereas β^h_{LT} is more relevant for small governments with low tax rates. We compare β^h_{LT} and β^h_{HT} to evaluate the quantitative effects of the tax-GDP ratio or government size on the dynamic responses of the macroeconomic variables to government spending shocks. Such an analysis is closely related to the theoretical analysis in Section 2 because the tax-GDP ratio is represented by the income tax rate τ in theoretical models. We focus on the comparison between β^h_{LT} and β^h_{HT} when interpreting the estimation results in the next section.

4. Estimation results

This section discusses the estimation results of equation (15) for output, employment, and consumption because they are key variables in the theoretical analysis in Section 2. The results are shown in Fig. 3. For each variable, the figure displays the estimates of β^h_{LT} and β^h_{HT} for $h = 0, 1, \cdots, 4$ with 90% and 95% confidence bands to highlight the role of the tax-GDP ratio or government size on the macroeconomic effects of a positive government spending shock, which represents an unanticipated increase in government purchases.

4.1 Responses of output

First, we discuss the estimated output responses to positive government spending shocks. Noticeably, the estimated output responses are almost opposite in the high- and low-tax economies shown in the top panels of Fig. 3. In the left panel, the estimated β^h_{HT} is positive for all $h = 0, 1, \cdots, 4$ and even statistically significant for $h = 1, 2$. By contrast, the estimated β^h_{LT} in the right panel is negative regardless of h, although all estimates are statistically insignificant. These contrasting results clearly suggest that a positive government spending shock can stimulate output only when the tax-GDP ratio is relatively high. In an economy with a relatively low tax-GDP ratio, such fiscal expansion may fail to increase output.

These empirical results are consistent with the corresponding theoretical results. In Section 2, using the standard neoclassical models, we find that the stimulus effect of an increase in government purchases can increase with the income tax rate. This result is proven analytically in a static neoclassical model with standard functional forms and confirmed quantitatively through steady-state and impulse-response analyses in dynamic neoclassical models calibrated with standard functional forms and parameter values. The theoretical result is similar to the empirical result $\beta^h_{HT} > \beta^h_{LT}$ for output because both indicate that increases in government purchases have stronger stimulating effects as tax rates rise or government size grows.

Despite these similarities, we also observe differences between the estimated impulse responses of output in Fig. 3 and the simulated impulse responses in Panel (a) of Fig. 2 from the dynamic neoclassical model. First, the estimated impulse responses in Fig. 3 are positive only with a high tax-GDP ratio, whereas the simulated impulse responses in Panel (a) of Fig. 2 are always positive for $h = 0, 1, \cdots, 4$ whether the income tax rate τ is high or low. In addition, the estimated responses are U-shaped or inverted U-shaped, whereas the simulated impulse responses are monotonically decreasing up to $h = 4$ regardless of the value of τ.

However, these differences appear plausible because the dynamic neoclassical model is intended to clearly highlight how the income tax rate influences the macroeconomic effects of a government spending shock. Thus, we set up a dynamic neoclassical model as simply as possible, abstracting from various factors and frictions that could help the model better match the macroeconomy of the countries in the sample. Due to its simplicity, the dynamic neoclassical model may not generate impulse responses that match their empirical counterparts, which could explain the differences between the theoretical and empirical impulse responses. From this perspective, our primary focus is on the qualitative properties of $\left(\beta^h_{HT} - \beta^h_{LT}\right)$ when we compare the theoretical results in Fig. 2 with the empirical results in Fig. 3.

4.2 Responses of employment

Next, we analyze the impulse responses of employment, as presented in the second row of Fig. 3. In the left panel, the estimates of β^h_{HT} are positive for all $h = 0, 1, \cdots, 4$, but statistically significant only for $h = 1, 2$. By contrast, in the right panel, the estimates of β^h_{LT} are negative and statistically insignificant, regardless of h. In other words, a positive government spending shock can boost employment when the tax-GDP ratio is high but it fails to do so when the tax-GDP ratio is low. These results are qualitatively identical to those of the output responses shown in the top panels of Fig. 3. Such similarities suggest that employment responses could be one of the key driving forces for output responses.

Neoclassical models appear to explain the important characteristics of employment impulse responses. As discussed in Section 2, an increase in government purchases can increase output because it induces people to work more through a negative wealth effect. In this sense, whether and how much such fiscal expansion stimulates output depends crucially on the magnitude of the positive labor response. Hence, output and labor are expected to exhibit qualitatively similar impulse responses, as theoretically confirmed in Fig. 2. Thus, the similarity in the estimated responses between output and labor in Fig. 3 is consistent with the theoretical prediction.

Moreover, the empirical result $\beta^h_{HT} > \beta^h_{LT}$ for employment can be explained using the neoclassical models with the standard functional forms considered in Section 2. In this case, the negative wealth effect of an unanticipated increase in government purchases tends to have a stronger positive impact on labor supply as the income tax rate τ rises. Therefore, output can be further stimulated by a high value of τ. For this reason, the theoretical impulse responses of both output and labor are more significant with a high value of τ, especially for $h = 0, 1, \cdots, 4$, as shown in Panels (a) and (c) of Fig. 2. As such, the income tax rate can influence the characteristics of the negative wealth effect, thereby affecting both output and labor responses. This effect could also contribute to the empirical result $\beta^h_{HT} > \beta^h_{LT}$ as shown in Fig. 3.

4.3 Responses of consumption

We characterize the estimated impulse responses of consumption to a positive government spending shock. In the third row of Fig. 3, all estimates of β^h_{HT} and β^h_{LT} are statistically insignificant for consumption. This result indicates that consumption does not respond strongly to changes in government purchases regardless of the tax-GDP ratio. Focusing on the point estimates, both β^h_{HT} and β^h_{LT} remain close to zero for $h \leq 2$, but diverge for $h = 3, 4$. Consequently, $\left(\beta^h_{HT} - \beta^h_{LT}\right)$ for consumption is essentially zero for $h \leq 2$ but becomes negative for $h = 3, 4$. This result could be related to the theoretical counterpart in Panel (d) of Fig. 2, in which the simulated impulse responses of consumption are larger for the low-income tax rate. However, we do not observe a significant drop in consumption in Fig. 3, unlike the impulse responses obtained from the dynamic neoclassical model through a negative wealth effect. As previously discussed, this inconsistency could be caused by factors that were not considered in our theoretical analysis.

Moreover, the estimated responses of output and consumption tend to support the predictions of the neoclassical models rather than those of the traditional Keynesian model. In response to a positive shock to government purchases, output rises but consumption drops, according to neoclassical models, through the negative wealth effect of fiscal expansion. If this prediction is correct, then the output and consumption responses should exhibit a negative correlation. In contrast, according to the traditional Keynesian model, both output and consumption rise in response to fiscal expansion because output is stimulated through the positive reaction of consumption. In this case, the output and consumption responses exhibit a positive correlation. However, the estimated output and consumption responses tend to be negatively correlated, as shown in Fig. 3, because $\left(\beta^h_{HT} - \beta^h_{LT}\right) > 0$ for output and $\left(\beta^h_{HT} - \beta^h_{LT}\right) < 0$ for consumption. Overall, these empirical results tend to be more consistent with neoclassical models than traditional Keynesian models.

4.4 Discussion

Our empirical results can be summarized as follows. First, a positive shock to government purchases can significantly stimulate output only when the tax-GDP ratio is sufficiently high. This result is inconsistent with the predictions of the traditional Keynesian model. However, this can be better explained by static and dynamic neoclassical models, as discussed in Section 2. We find that government spending multipliers tend to increase in the income tax rate in neoclassical models with standard functional forms and parameter values. Taken together, these theoretical and empirical results suggest that fiscal expansion through rises in government purchases tends to be more effective in large governments with relatively high tax rates.

Second, we provide evidence of a negative wealth effect when governments make more purchases. In Fig. 3, output tends to exhibit a strong positive correlation with employment, but a weak negative correlation with consumption. Again, such differences in the signs of the correlations are better explained by the negative wealth effect in the neoclassical models than by the multiplier effect in the traditional Keynesian model. Thus, the empirical results corroborate the theoretical analysis.

4.5 Robustness checks

In this subsection, we confirm the robustness of our empirical results from state-dependent local projections. Specifically, we obtain state-dependent impulse responses of output to a government spending shock using various specifications as robustness checks in Fig. 4: (a) using an alternative government spending shock based on the forecast of government spending in the fall issue of the same year rather than that in the fall issue of the previous year as in the baseline case, (b) including control variables, such as current and lagged output growth shocks defined as the forecast error of GDP growth to deal with the endogeneity issue, which is caused by unexpected business cycle conditions, (c) including country-specific time trends, (d) excluding control variables such as government spending (over GDP), consumer price inflation, and short-term interest rate, and (e) controlling for tax response.

The estimated fiscal multipliers, using alternative specifications in Panels (a) through (e), remain similar to those from the baseline case as reported in Panel (a) of Fig. 3. That is, it suggests that a positive government spending shock can boost output when the tax-GDP ratio is relatively high. However, in an economy with a relatively low tax-GDP ratio, such fiscal expansion yields statistically insignificant responses of output. Overall, our main findings in Fig. 3 remain qualitatively unaltered across alternative specifications.

5. Conclusion

This study investigates the association between the effectiveness of fiscal policy and government size. To this end, we analyze the effects of the tax-GDP ratio on the responses of output and other macroeconomic variables to unanticipated changes in government purchases. Our main findings are summarized as follows. Theoretically, we show that the government spending multiplier can increase with the income tax rate in a static neoclassical model with standard forms of utility and production functions. Interestingly, this result contradicts the prediction of the traditional Keynesian model that the multiplier effect decreases in the income tax rate. The two models yield contrasting results because they are based on different channels of fiscal expansion effects on output.

In addition, the positive effect of the income tax rate on the government spending multiplier is quantitatively confirmed using a dynamic neoclassical model calibrated with standard functional forms and parameter values. We find that a permanent increase in government purchases has a stronger positive effect on steady-state output as the income tax rate rises. Regarding the effect of a one-time hike in government purchases, such a temporary fiscal expansion tends to generate more significant positive impulse responses of output when the income tax rate is high. Hence, these quantitative results validate the analytical findings of the static neoclassical model.

Furthermore, our empirical analysis using a state-dependent local projection method provides supporting evidence for our theoretical results. Specifically, the estimation results reveal that, while the state-dependent impulse responses of output to an unanticipated government spending shock tend to be significantly positive when the tax-GDP ratio is high, they are statistically insignificant when the tax-GDP ratio is low. In addition, the estimated impulse responses of output tend to be positively correlated with those of employment but negatively correlated with those of consumption. The signs of the correlation appear consistent with the predictions of the static and dynamic neoclassical models whereas they are at odds with the predictions of the traditional

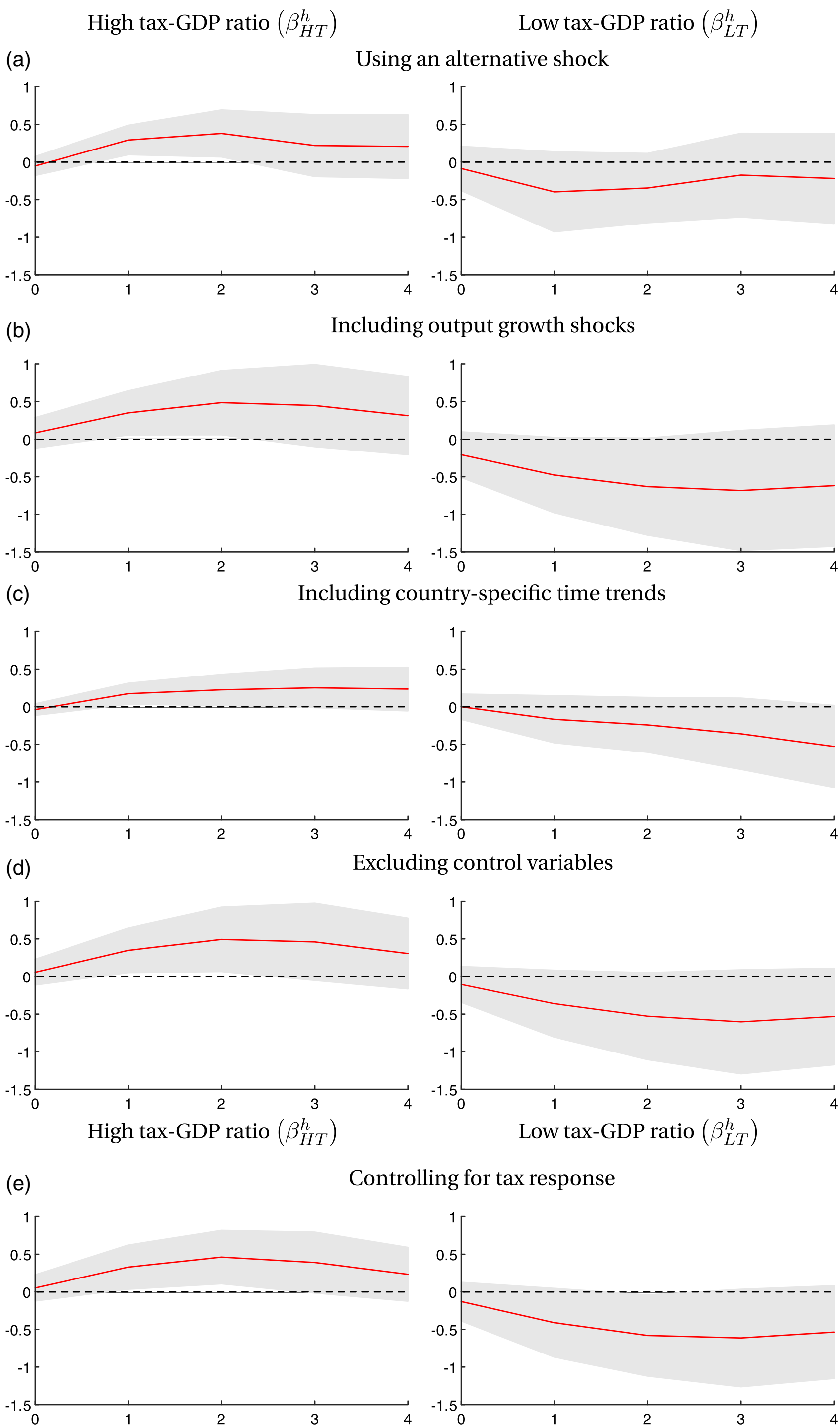

Figure 4. Robustness checks. Estimated impulse responses of output to a positive shock to government purchases using various specifications, with 90% confidence bands.

Keynesian model. Overall, our theoretical and empirical findings suggest that fiscal expansion has more significant positive effects on output in countries with large governments or relatively high tax rates.

This study contributes to the literature by providing a comprehensive analysis on the impact of tax policy or government size on government spending multipliers because no previous study considered overall tax rates or government size as a factor or determinant of the multipliers. In this sense, this study provides novel insights into the role of underlying tax rates in government stabilization policies through government spending. However, our analysis can be extended in several ways. First, we consider relatively simple neoclassical models to illustrate the role of the income tax rate in the government spending multiplier. In contrast, a similar analytical or quantitative analysis could be conducted using more sophisticated models that could better match real-world phenomena. Empirically, we use the tax-GDP ratio as an indicator of overall tax policy. Alternatively, one can use actual tax rates, such as income and value-added tax rates, as indicators of tax policy. In addition, one could estimate state-dependent tax multipliers that depend on the size of government spending using the narrative-based method à la Romer and Romer (2010). These approaches could shed light on the interactions between taxes and government spending on fiscal policy to stabilize the macroeconomy.

Notes

1 Refer to Ramey (2019) for an extensive review of the related literature. We will also discuss the literature briefly later in this section.

2 Refer to equation (4) in Subsection 2.1 for the exact functional forms.

3 See Subsection 2.2 for more details on the dynamic neoclassical model and calibration.

4 Admittedly, such theoretical results rely on the specific forms of utility and production functions. Nevertheless, the results are relevant for fiscal policy because the utility and production functions used in this study are quite standard and have been widely adopted in numerous previous studies. Also, similar results could be obtained in more general dynamic models because tax rates can influence the characteristics of the negative wealth effects in any economic model as long as households adjust consumption and labor supply depending on income.

5 See Hines and Thalter (1995) and Inman (2008) for an extensive review of the literature.

6 Despite the frequent use of the SVAR approach in the literature, we employ the local projection method because our dataset, which consists of annual data for 35 years, is relatively short for the SVAR model, and the local projection method tends to be less sensitive to misspecification and relies on fewer identifying restrictions than the SVAR model.

7 Also, see Barro and Redlick (2011) and Ben Zeev and Pappa (2017).

8 See Vegh and Vuletin (2016) for details. Hamilton (1986) and Dahlby (2011) also provide theories for the flypaper based on distortionary taxation. For a review of the literature on the flypaper effect, see Hines and Thalter (1995) and Inman (2008).

9 In this model, $u(C) = \ln C$ and $v(L) = -\xi \ln(1 - L)$ have the forms that would yield $\partial m/\partial \tau > 0$ in the static neoclassical model. Furthermore, the production function $Y = K^{\alpha} L^{1-\alpha}$ could be reinterpreted as $Y = L^{\theta}$, if K is fixed. Hence, the utility and production functions could generate $\partial m/\partial \tau > 0$ in the static neoclassical model.

10 The results also hold analytically. As shown in Appendix A, the steady-state equilibrium conditions imply $sign(\partial Y^*/\partial G^*) = sign(\partial L^*/\partial G^*) = -\, sign(\partial C^*/\partial G^*)$.

11 We select a smaller set of countries to ensure a more representative sample that captures a range of economic conditions along with policy responses. In addition, it may be more effective to focus on a smaller set of countries with similar economic characteristics.

12 In our empirical analysis, government purchases only include government consumption excluding government investment. However, we refer to government consumption as government purchases for simplicity.

13 As in Honda and Miyamoto (2021), rather than employing logarithms of variables (e.g., real GDP and fiscal variables), we scale the variables by the previous year's GDP. This scaling yields estimated coefficients representing fiscal multipliers directly.

14 As pointed out by an anonymous reviewer, the identification strategy relies on the fact that ε_{it} is exogenous. However, it is weighted by $Y_{i,t-1}$, which is also on the right hand side of equation (15). To address this issue, we estimate state-dependent local projections using a government spending shock which is weighted by $Y_{i,t-5}$ instead of $Y_{i,t-1}$. In such a case, our main results remain qualitatively unaltered.

15 X_{it} includes three lags of government spending shocks, real GDP growth, the government spending to GDP ratio, consumer price inflation, and a short-term interest rate. The lag order is selected based on the Bayesian information criterion.

16 $T_{i,t-1}$ may be correlated with the expected government purchases G^e_{it} because tax revenue in a period can influence the government budget for the next period. However, ε_{it} represents the unexpected change in government purchases, $G_{it} - G^e_{it}$, as clear in equation (14). Hence, the correlation between $T_{i,t-1}$ and ε_{it} is likely to be weak.
17 We are grateful to an anonymous reviewer for suggesting this.
18 Ramey (2019) offers comprehensive overviews of the literature regarding the impulse response of output (i.e., fiscal multiplier).

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Appendix A. The steady state of the dynamic neoclassical model

In this appendix, we prove the two propositions discussed in Subsection 2.2. First, we show that $m^* = \partial Y^*/\partial G^*$ has the same sign as $\partial L^*/\partial G^*$ but has the opposite sign to $\partial C^*/\partial G^*$. Then, we derive equation (10). We can provide the equilibrium conditions in the steady state as follows:

$$\xi \frac{C^*}{1-L^*} = (1-\tau)(1-\alpha)\left(K^*\right)^{\alpha}\left(L^*\right)^{-\alpha}$$

$$1 = \beta\left[1-\delta+\alpha(1-\tau)\left(K^*\right)^{\alpha-1}\left(L^*\right)^{1-\alpha}\right]$$

$$C^* + G^* + \delta K^* = \left(K^*\right)^{\alpha}\left(L^*\right)^{1-\alpha}$$

$$Y^* = \left(K^*\right)^{\alpha}\left(L^*\right)^{1-\alpha}$$

We can find the values of (C^*, L^*, K^*, Y^*) from these equations.

Next, we take total differentials of the steady-state equilibrium conditions and divide them by dG^* as follows:

$$\frac{1}{C^*}\frac{\partial C^*}{\partial G^*} + \left(\frac{1}{1-L^*} + \frac{\alpha}{L^*}\right)\frac{\partial L^*}{\partial G^*} - \frac{\alpha}{K^*}\frac{\partial K^*}{\partial G^*} = 0 \tag{A1}$$

$$\frac{1}{L^*}\frac{\partial L^*}{\partial G^*} = \frac{1}{K^*}\frac{\partial K^*}{\partial G^*} \tag{A2}$$

$$-\frac{\partial C^*}{\partial G^*} + (1-\alpha)\frac{Y^*}{L^*}\frac{\partial L^*}{\partial G^*} + \left[\alpha\frac{Y^*}{K^*} - \delta\right]\frac{\partial K^*}{\partial G^*} = 1 \tag{A3}$$

$$\frac{\partial Y^*}{\partial G^*} = \alpha\frac{Y^*}{K^*}\frac{\partial K^*}{\partial G^*} + (1-\alpha)\frac{Y^*}{L^*}\frac{\partial L^*}{\partial G^*} \tag{A4}$$

Using these conditions, we prove the following proposition:

$$sign\left(\frac{\partial Y^*}{\partial G^*}\right) = sign\left(\frac{\partial L^*}{\partial G^*}\right) = -sign\left(\frac{\partial C^*}{\partial G^*}\right). \tag{A5}$$

Equation (A2) implies

$$\frac{\partial K^*}{\partial G^*} = \frac{K^*}{L^*}\frac{\partial L^*}{\partial G^*}.$$

Plugging this equation into equations (A1) and (A4), we obtain the following equations:

$$\frac{\partial C^*}{\partial G^*} = -\frac{C^*}{1-L^*}\frac{\partial L^*}{\partial G^*}$$

$$\frac{\partial Y^*}{\partial G^*} = \frac{Y^*}{L^*}\frac{\partial L^*}{\partial G^*}$$

Clearly, these equations imply equation (A5).

We turn to express $m^* = \partial Y^*/\partial G^*$ in terms of model parameters. Using the previous three equations, we can rewrite equation (A3) as

$$\frac{\partial L^*}{\partial G^*} = \left[\frac{C^*}{1-L^*} + \frac{Y^*}{L^*} - \delta\frac{K^*}{L^*}\right]^{-1}.$$

Then, $\partial Y^*/\partial G^*$ is obtained from equation (A4) as follows:

$$\frac{\partial Y^*}{\partial G^*} = \frac{Y^*}{L^*}\frac{\partial L^*}{\partial G^*} = \left[\frac{C^*}{1-L^*}\frac{L^*}{Y^*} + 1 - \delta\frac{K^*}{Y^*}\right]^{-1}.$$

The first and third terms in the square brackets are obtained from equations (8) and (9) as follows:

$$\frac{C^*}{1-L^*}\frac{L^*}{Y^*} = \frac{(1-\tau)(1-\alpha)}{\xi}$$

$$\delta\frac{K^*}{Y^*} = \delta\left(\frac{K^*}{L^*}\right)^{1-\alpha} = \frac{\delta\alpha(1-\tau)}{\beta^{-1}-1+\delta}$$

Therefore, m^* is rewritten as

$$m^* = \frac{\partial Y^*}{\partial G^*} = \left[\frac{(1-\tau)(1-\alpha)}{\xi} + 1 - \frac{\delta\alpha(1-\tau)}{\beta^{-1}-1+\delta}\right]^{-1}.$$

Rearranging terms yields the expression for m^* in equation (10).

Appendix B. Impulse responses of output during expansions and recessions depending on the size of governments

Recent studies, such as Auerbach and Gorodnichenko (2012) and Ramey and Zubairy (2018), indicate that fiscal multipliers are contingent on the phase of the business cycle.[17] It has been suggested that fiscal multipliers tend to be more substantial during periods of economic downturn. When estimating the effect of fiscal policy on economic variables, economic conditions, whether a boom or recession, can be considered. Thus, our study takes into consideration both the business cycle and the size of governments (i.e., tax revenue).

Specifically, we employ a dummy variable for the tax-GDP ratio. Then, we estimate state-dependent local projections using output growth in the previous period as a transition variable so that we can analyze the effect of fiscal policy during periods of expansion and recession. Fig. B1 illustrates the estimated impulse responses of output to a positive government purchases shock, contrasting economies with high tax-GDP ratios against those with low ratios. Interestingly, during recessions, countries with higher tax revenues exhibit a more significant and pronounced effect of fiscal policy compared to those with lower revenues, and this difference is statistically significant. However, for both groups, it appears that fiscal policy is ineffective during expansions. Taken together, this analysis suggests that countries with higher tax revenues may have more fiscal space, which allows them to pursue more expansive fiscal policies during recessions. This can include increasing government spending on infrastructure and social services to stimulate demand. In contrast, countries with lower tax revenues may have limited fiscal space, making it challenging to implement significant fiscal stimulus measures during recessions.

Appendix C. Impulse response of output estimated from a linear model

Figure C1 demonstrates the impulse response of output, estimated from a linear model. The linear model delivers a clear picture. Following an expansionary fiscal policy shock, the level of output

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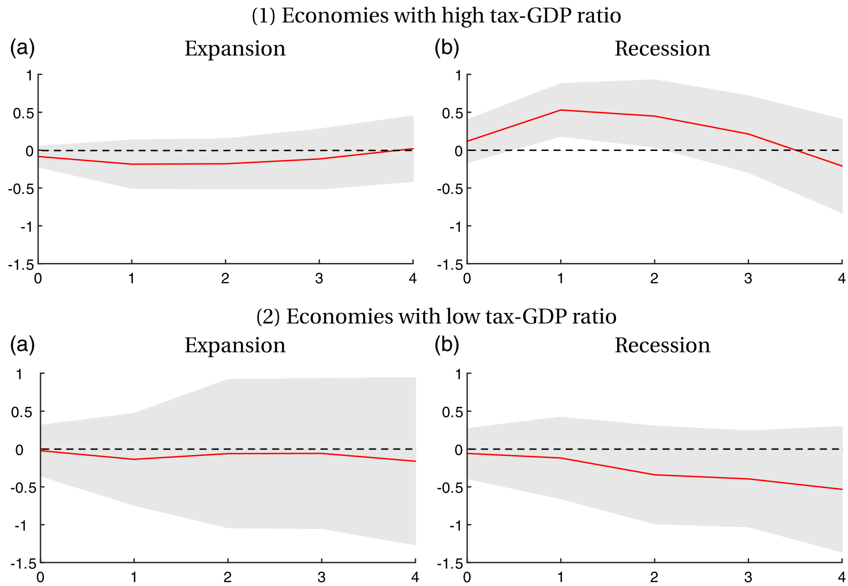

Figure B1. Estimated impulse responses of output to a positive shock to government purchases using lagged output growth as a transition variable for economies with high and low tax-GDP ratios, respectively, with 90% confidence bands.

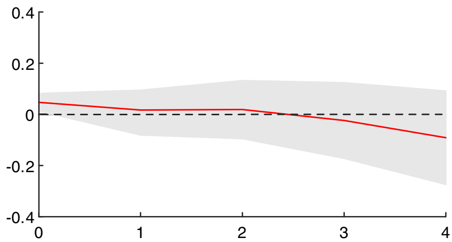

Figure C1. Impulse response of output to a positive shock to government purchases estimated from a linear model. Shaded areas indicate 90% confidence bands.

increases. Specifically, to a positive government spending shock, there is an immediate positive impact on output (i.e., at $h = 0$), which is statistically significant. This suggests that, in the absence of considering the state of tax revenue, an increase in government spending tends to stimulate output. Subsequently, at $h = 1$ and $h = 2$, the impulse response of output continues to exhibit positive values, indicating a prolonged but diminishing effect of the government spending shock on output. However, these effects are statistically insignificant. This suggests that while the positive impact on output persists beyond the immediate period, it becomes less discernible and lacks statistical significance as time progresses.

Overall, the estimation results imply that when tax revenue is not taken into account, a positive government spending shock tends to induce a short-term boost in output. This finding is in line with the literature.[18] That is, previous studies suggest that the effect of fiscal policy is positive, meaning that government purchases stimulate output. However, as aforementioned, when the state of tax revenue is considered, the dynamics of fiscal policy effects on output reveal a notable pattern. The state-dependent output responses tend to diverge between economies with high and low tax revenues. This divergent pattern indicates that an increase in government spending tends to boost output when the tax-GDP ratio is high. Conversely, in economies with a lower tax-GDP ratio, such an expansion in fiscal policy may lead to a statistically insignificant response of output.

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