How Can the Government Spending Multiplier Be Small at the Zero Lower Bound? *

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Abstract

Some recent empirical evidence questions the typical large size of government spending multipliers when the nominal interest rate is stuck at zero, finding output multipliers around unity or even lower. In this paper, we use a recent estimate of the degree of substitutability between private and government consumption in an otherwise standard New Keynesian model to show that this channel significantly reduces the size of government spending multipliers obtained when the nominal interest rate is at zero. All else equal, the relationship of substitutability makes a government spending shock crowd out private consumption while being less inflationary, thus limiting the typical expansionary effect of the fall in the real interest rate. Conditional on the nominal interest rate constrained at zero, the model generates output multipliers ranging between 0.8 and 1, on impact.

JEL classification: E32, E62

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1 Introduction

Since the end of 2008, nominal interest rates have moved towards the zero lower bound (ZLB) across major developed economies. As of the beginning of 2015 the Bank of Japan, the Federal Reserve and the European Central Bank are not giving signs that the policy rate will soon be increased. On the contrary, over the last months, there has been constant reference to the “need of accommodative monetary policy for an extended period of time” (President Draghi, August 22 2014, Jackson Hole Meeting) or “The Committee is also fostering accommodative financial conditions through forward guidance [...]” (Chairman Yellen, 15 July 2014, Semiannual Monetary Policy Report to the Congress). In other words, the ZLB state is likely to persist over a quite long period of time.

The ZLB state is relevant because typical interest rate monetary stimulus is, by definition, constrained, while the effects of fiscal policy can deviate substantially from what obtains in normal times. Hence, the analysis of the effects of fiscal policy at the ZLB seems to deserve some attention, not only to validate normative statements (which we do not attempt to do) but also to try to discriminate among models (which is the preferred application of our results).

Christiano et al. (2011), henceforth CER (2011), have shown, within a calibrated New Keynesian (NK) model, that a fiscal stimulus on the spending side can be particularly effective in boosting output when the nominal interest rate is at the ZLB. To see why, suppose, as in Eggertsson and Woodford (2003), that due to some shock desired savings increase but, because of price stickiness and the ZLB, the fall in the real interest rate is not enough to re-establish the equilibrium. In this situation desired savings must decrease, which only occurs with a potentially sharp reduction in consumption and output. At this point, an increase in government spending produces, all else equal, an upward pressure on expected future inflation which translates into a lower real interest rate. This mitigates the fall in output needed to restore the equilibrium and adds to the standard upward shift of labor supply generated by the expansion in government spending. Thus, the output multipliers can be significantly larger than the ones obtained when the nominal interest rate is far from the ZLB. In one of their benchmark calibrations, CER (2011) have found an output multiplier close to two, compared to a multiplier close to unity when the
nominal interest rate is far above the ZLB.

Does the empirical evidence support such large government spending multipliers when nominal interest rates are close to zero? Only a few papers have attempted to answer this question, mostly because of the scarcity of ‘ZLB episodes’ across countries and over time. However, to the best of our knowledge, all the recent available evidence, using state-of-the-art econometric techniques, speaks in favor of output multipliers close to unity (or lower) even when interest rates are near zero. Ramey and Zubairy (2014) and Ramey (2011) provide this evidence for US and Canada while Crafts and Mills (2013) do so for the UK. Bruckner and Taludhar (2011) analyze the same issue using regional government spending data in Japan.\footnote{A much higher level of heterogeneity characterizes the results for the size of government spending multipliers during periods of slack or recessions. For example, Auerbach and Gorodnichenko (2012 and 2013) find larger multipliers during recessions compared to normal times, whereas Owyang et al. (2013) do not.}

In this paper, we focus on one specific mechanism that helps reduce the gap between the government spending multipliers obtained in CER (2011) and those resulting from the recent empirical analyses: the degree of substitutability between private and government consumption. Most macro models, including CER (2011), assume that government consumption is either pure waste or enters separably in the household’s utility function. However, this assumption has been questioned by several works. Among others, Aschauer (1985) and Ercolani and Valle e Azevedo (2014) find substitutability between private and government consumption in the US, as in the model suggested by Barro (1981). Ahmed (1986) finds the same relationship for the UK. Evans and Karras (1998) find, for many developed and industrialized countries, substitutability between private and (non-military) government consumption.\footnote{We agree that the debate on the degree of substitutability is still open in the literature. For example, Karras (1994), analyzing thirty countries, find that the two types of goods are best described as complements (but often unrelated), while Bouakez and Rebei (2007) find a relationship of complementarity for the US. Ercolani and Valle e Azevedo (2014) show that this latter result is driven by the no inclusion of government spending data in the estimation and by fixing relevant parameters in the utility function. Finally, Feve et al. (2013) estimate a relationship of complementarity for the US.} Several examples are compatible with the estimates of substitutability, e.g., rises in the number of physicians in the public health sector may reduce the need for privately provided medical examinations and treatments, or, boosts to public education services can reduce the need for private schools and tutors.

Substitutability has the potential to tame the size of the output multiplier, especially when
interest rates are stuck at zero, because the government spending shock becomes less inflationary. The reasoning goes as follows. An increase in government consumption makes private consumption less enjoyable, or, the marginal utility of private consumption decreases. This leads agents to partially substitute private consumption with newly available government consumption. Aggregate demand is lower with respect to the one in the ‘separable’ world, reducing competition among firms for inputs and, hence, input prices. As a consequence, marginal costs and inflation are lower. This mitigates the fall in the real interest rate, which is the key driving force for the expansion of aggregate demand during the ‘ZLB episode’. Eventually, output is lower in the ‘non-separable’ world because both demand and supply forces operate. On the one hand, the lower aggregate demand translates into the supply side if nominal rigidities are present. On the other hand, agents supply less labor in order to finance the lower level of consumption, negatively affecting labor’s contribution to production.

To perform our analysis, we use an otherwise standard NK model and allow government consumption to affect households’ marginal utility of consumption. The degree of substitutability is set using a recent estimate by Ercolani and Valle e Azevedo (2014). Conditional on the nominal interest rate at the ZLB, we show that the channel under scrutiny (i.e., substitutability) is able to significantly reduce the size of the government spending multiplier obtained in CER (2011). More precisely, the impact output multiplier generated by the ‘non-separable’ model is roughly half the one generated by the ‘separable’ model, ranging between 0.8 and 1. This finding is robust to different financing schemes, i.e., considering both one characterized by a debt-stabilizing fiscal rule and one complying with the Ricardian equivalence.

Other papers have investigated alternative channels that eventually dampen the size of government spending multipliers when interest rates are at zero. Mertens and Ravn (2014) show that output multipliers can be below unity if the liquidity trap is caused by a self-fulfilling state of low confidence rather than preference shocks. Swanson and Williams (2014) focus on the term structure of interest rates, suggesting that 1- and 2-year Treasury yields were unconstrained

\(^3\)From now onwards, the notion of ‘separable’ economy indicates the case in which private and government consumption are unrelated through preferences. Instead, the ‘non-separable’ label refers to the the case where the two goods are substitute goods.
throughout 2008 to 2010, implying that fiscal multipliers retained normal values during this period. Drautzburg and Uhlig (2013) estimate an extended version of the Smets-Wouters (2007) New Keynesian model, focusing on both myopic consumers and distortionary taxation at the ZLB. Among other findings, they show that the more ‘aggressive’ is the debt-stabilizing fiscal rule, the lower is the government spending multiplier. We contribute to this debate by analyzing a competitive, but not mutually exclusive, channel based on the relationship in preferences between private and government consumption. More generally, our analysis can be viewed as a contribution to the literature that studies the stabilizing effects of government spending when the nominal interest rate is at the ZLB. Samples of this literature are Eggertson (2010 and 2011), Cogan et al. (2010), Woodford (2011), Aruoba and Schorfheide (2013) and Erceg and Lindé (2014). Finally, our results can inform the debate on the welfare effects of a government spending expansion during a ZLB period. Interestingly, Bilbiie, Monacelli and Perotti (2014) show that these effects depend in important ways on how government spending influences agents’ preferences.

The structure of the paper is as follows. Section 2 briefly describes the model. Section 3 presents the results. Section 4 concludes.

## 2 Model

We use an otherwise standard NK set-up similar to a vast class of models, e.g., Schmitt-Grohé and Uribe (2006), henceforth SGU (2006), and Smets and Wouters (2007). We deviate from these models in that we allow government consumption to affect the household’s marginal utility of consumption. We maintain various empirically plausible elements of these previous models which have proved useful in providing a good fit to the data. In what follows, we simplify the exposition of the micro-foundations of the model, as they are now standard.

### 2.1 Households

The economy is populated by a large representative household composed of a continuum of members indexed by $h \in [0, 1]$. The household derives utility from effective consumption, $\tilde{C}_t$,.
and disutility from working $L_t$, where $L_t = \left[ \int_0^1 L_t(h) \frac{\varepsilon_w - 1}{\varepsilon_w} \, dh \right]^{\varepsilon_w}$. $L_t(h)$ is the quantity of labor of type $h$ supplied and $\varepsilon_w$ is the elasticity of substitution across varieties. $L_t$ is supplied by labor packers to intermediate goods firms in a competitive market at cost $W_t = \left[ \int_0^1 W_t(h)^{1-\varepsilon_w} \, dh \right]^{\frac{1}{1-\varepsilon_w}}$, where $W_t(h)$ is the price of each labor variety. Effective consumption is assumed to be an Armington aggregator of private consumption, $C_t$, and government consumption, $G_t$:

$$\tilde{C}_t = \left[ \phi \left( C_t \right)^{\frac{\varepsilon-1}{\varepsilon}} + (1 - \phi) \left( G_t \right)^{\frac{\varepsilon-1}{\varepsilon}} \right]^\frac{1}{1-\varepsilon},$$

(1)

where $\phi \in [0, 1]$, and $\nu \in (0; \infty)$ is the elasticity of substitution between $C_t$ and $G_t$. Conditional on $\phi < 1$, large values of $\nu$ make $C_t$ and $G_t$ substitutes. If $\phi = 1$ then $\tilde{C}_t = C_t$ and the standard hypothesis of separability emerges. In turn, $C_t$ is a bundle of goods $C_t(j)$, with $j \in [0, 1]$, assembled by a final goods firm operating in competitive markets and given by $C_t = \left[ \int_0^1 C_t(j)^{\frac{\varepsilon-1}{\varepsilon}} \, dj \right]^{\frac{1}{\varepsilon}}$, where $\varepsilon$ is the elasticity of substitution across varieties of goods. This bundle costs $P_t = \left[ \int_0^1 P_t(j)^{1-\varepsilon} \, dj \right]^{\frac{1}{1-\varepsilon}}$, where $P_t(j)$ is the price of each variety. The lifetime expected utility of the representative household is given by:

$$E_0 \left\{ \sum_{t=0}^{\infty} \left( e^{\lambda_t} \beta \right)^t \left[ \frac{\left( \tilde{C}_t - \theta \tilde{C}_t^A \right)^{1-\sigma_c}}{1-\sigma_c} - \chi \frac{L_t^{1+\sigma_L}}{1+\sigma_L} \right] \right\},$$

(2)

where $\sigma_c$ denotes the degree of relative risk aversion, $\sigma_L$ is the inverse of the Frisch elasticity of labor supply, $\theta \in (0; 1)$ measures the degree of habit formation in (aggregate) effective consumption $\tilde{C}_t^A$, $\beta \in (0, 1)$ is the subjective discount factor, and $\chi$ is a preference parameter. $\lambda_t$ represents a discount factor shock, assumed to follow a first-order autoregressive process with an i.i.d. error term: $\lambda_t = \rho_{\lambda} \lambda_{t-1} + \eta_{\lambda}^t$. As in CER (2011), this shock is crucial in bringing the economy to the ZLB. The representative household faces the following budget constraint in real terms:

$$(1 + \tau^c)C_t + I_t + B_t = \frac{R_{t-1}}{\pi_t} B_{t-1} + (1 - \tau_t) \frac{1}{F_t} W_t L_t + (1 - \tau_t) \left[ r_t^k u_t - a(u_t) \right] K_t + D_t - T_t,$$

(3)
where $R_t$ is the gross nominal interest rate on governments bonds, $B_t$, $\pi_t = \frac{P_t}{P_{t-1}}$ is the gross inflation rate (hence, the, gross ex-post real risk-free rate is given by $R_t^f = \frac{R_t - \pi_t}{\pi_t}$), $W_t L_t$ is labor income, $\bar{K}_t$ is the capital stock, $D_t$ are the dividends paid by household-owned firms, and $T_t$ are lump-sum taxes. $\tau^c$ and $\tau_t$ are tax rates on consumption and income, respectively. Following SGU (2006), the cost of using capital at intensity $u_t$ is given by

$$a(u_t) = \gamma_1 (u_t - 1) + \frac{\gamma_2}{2} (u_t - 1)^2.$$  

The effective capital, $\bar{K}_t = u_t \bar{K}_t$, is rented to firms in a competitive market at cost $r^k_t$ (return to capital). $\bar{K}_t$ evolves according to:

$$\bar{K}_t = (1 - \delta_k) \bar{K}_{t-1} + I_t \left[ 1 - \frac{\kappa}{2} \left( \frac{I_t}{I_{t-1}} - 1 \right)^2 \right],$$  

(4)

where $\delta_k$ is the depreciation rate and $\kappa$ governs the cost of changing the current level of investment $I_t$, relative to $I_{t-1}$.

The representative household maximizes her lifetime expected utility by choosing $C_t$, $B_t$, $\bar{K}_t$, $I_t$, and $u_t$ subject to (3) and (4). Each of the members of the household supplies $L_t(h)$ units of labor while re-optimizing the (nominal) wage, $W_t(h)$, with probability $1 - \xi_w$ in each period $t$, where $\xi_w \in [0, 1]$. Members re-optimizing their wage maximize their expected utility in all states of nature in which they are unable to re-optimize in the future, subject to (3) and the demand for labor services, $L_{t+s}(h) = \left( \frac{W_t(h)}{W_{t+s}} \right)^{-\xi_w} L_{t+s}$, generated by the labor packers. Households who do not re-optimize at time $t$ set their wages according to the rule $W_t(h) = W_{t-1}(h)$.

2.2 Firms

There is a continuum of household-owned monopolistic firms, indexed by $j \in [0, 1]$, each of which produces differentiated goods, $Y_t(j)$, using the following technology:

$$Y_t(j) = \max(K_t(j)\alpha L(j)^{1-\alpha} - \Phi, 0),$$  

(5)

where $Y_t(j)$ is the output of good $j$, $\alpha$ is the share of capital, and $\Phi$ represents a fixed cost of production. Capital, $K_t(j)$, and labor, $L(j)$, are obtained in competitive markets. At each period $t$, a share $1 - \xi_p$ of firms, where $\xi_p \in [0, 1]$, resets its price, $P_t(j)$. Firms resetting $P_t(j)$ in
period $t$ maximize the expected present discounted value of dividends in the states of nature in which they are unable to re-optimize, i.e., they solve:

$$
\max_{P_t(j)} \mathbb{E}_t \left\{ \sum_{s=0}^{\infty} \xi_p \beta_{t,t+s} Y_{t+s}(j) [P_t(j) - MC_{t+s}] \right\}, \quad (6)
$$

subject to the demand $Y_{t+s}(j) = \left( \frac{P_t(j)}{P_{t+s}} \right)^{-\epsilon} Y_{t+s}$ generated by the final goods firm, where $Y_{t+s} = \left[ \int_0^1 Y_{t+s}(j) \frac{\epsilon^{-1}}{\epsilon} dj \right]^{-\frac{\epsilon}{1-\epsilon}}$. $\beta_{t,t+s}$ is the stochastic discount factor of the households and $MC_t = \frac{\alpha^\omega (1-\alpha)^{1-\alpha}}{\alpha^\omega (1-\alpha)^{1-\alpha}}$ is the marginal cost. Those firms which cannot re-optimize will instead set their prices according to the rule $P_t(j) = P_{t-1}(j)$.

### 2.3 Fiscal and Monetary Policy

The government buys $G$ units of final goods each period. Its budget constraint is:

$$
G_t + \frac{R_{t-1}}{\pi_t} B_{t-1} = B_t + \tau^C C_t + \frac{W_t}{P_t} L_t + \tau_t \left[ \rho^k u_t - a (u_t) \right] K_t + T_t, \quad (7)
$$

We assume a first-order autoregressive process for $G_t$ with an i.i.d error term, i.e.:

$$
G_t = (1 - \rho_G) G_{ss} + \rho_G G_{t-1} + \eta^G_t
$$

where $G_{ss}$ is the steady state level for $G$. Following Traum and Yang (2011), we assume the income tax rate follows:

$$
\tau_t = (1 - \rho) \tau_{ss} + \rho \tau_{t-1} + (1 - \rho) \gamma \left( \frac{B_{t-1}}{Y_{t-1}} - b_{ss} \right), \quad (8)
$$

where $\tau_{ss}$ and $b_{ss}$ are the steady state values of $\tau_t$ and $\frac{B}{Y_t}$, respectively. Importantly, $\gamma$ controls the speed of adjustment of the debt to output ratio towards its steady-state. Whenever $\gamma \neq 0$, we assume that lump-sum taxes, $T_t$, remain fixed at their steady state value, $T_{ss}$, compatible with $G_{ss}$, $\tau^c$, $\tau_{ss}$ and $b_{ss}$ (i.e., only the income tax is used to stabilize the debt-ratio). We also analyze the Ricardian version of the model, i.e., we set $\gamma = \rho = 0$ and assume the government
balances the budget.

Finally, the monetary authority sets the nominal interest rate according to a Taylor rule:

$$R_t = \max(Z_t, 1), \text{ where } Z_t = (Z_{t-1})^{\alpha_z} (\pi_t - 1)^{\phi_x(1-\alpha_z)} \times \left( \frac{Y_t}{Y_{t-1}} - 1 \right)^{\phi_y(1-\alpha_z)}.$$ (9)

### 2.4 Market clearing

In equilibrium, all markets clear and the resource constraint, $Y_t = C_t + I_t + G_t + a(u_t) K_t$, completes the model.

All the equilibrium conditions required to solve the model and perform simulations can be found in the appendix.

### 3 Simulations and Results

In this section, we first parameterize our model by borrowing several values from existing literature that focuses on the US economy. Then, we perform our experiments, i.e., an increase in government spending conditional on the nominal interest rate having reached the ZLB. We evaluate two alternative financing schemes: one characterized by a debt-stabilizing fiscal rule on income taxes which identifies our baseline model, the other one by only lump-sum taxes adjusting.

### 3.1 Parameters Choice

The time unit is the quarter. Concerning the parameters of greatest interest, i.e., the ones influencing the relationship in preferences between private and government consumption, we proceed as follows. Whenever we consider substitutability between private and government consumption we set $\phi$ and $\log(v)$ equal to 0.66 and 7.9, respectively, which are the (mode) values estimated in Ercolani and Valle e Azevedo (2014). The high value of $v$ implies that the aggregator in (1) becomes almost linear ($\hat{C}_t \approx \phi C_t + (1 - \phi) G_t$), as in the specification estimated
by Aschauer (1985) or Ahmed (1986). On the contrary, imposing separability between $C$ and $G$ amounts to setting $\phi = 1$.

Regarding the parameters governing fiscal and monetary policy, we proceed as follows. Concerning the fiscal and the monetary policy rules, we follow Traum and Yang (2011). To what concerns the first one, we set $\rho = 0.92$ and $\gamma = 0.094$. For the monetary rule, we set $\alpha_z = 0.86$, $\phi_y = 0.12$ and $\phi_\pi = 2.0$. Further, $\tau_{ss}$ is set to 0.2 which is roughly the mean of the tax rates on wages and capital as calibrated by Leeper et al. (2010), while $\tau^c$ is set to 0.028 following the same source. Finally, $G_{ss}$ is set such that the government consumption-to-output ratio in steady state is the average of the ratio in the post 1984 period, i.e., roughly 0.16. The persistence parameter of the government spending shock, $\rho_G$, is set to 0.85. The steady-state value of debt, $b_{ss}$, is set such that the annualized government debt-to-output ratio is roughly that of the end of 2008, 0.65, when the nominal interest rate reached the ZLB.

The following parameters are set around values that are common in the literature, e.g., see CER (2011) or SGU (2006). Regarding the preference parameters, we set $\sigma_c = 2$, $\sigma_L = 1$, $\theta = 0.7$ and $\beta = 0.999$. Further, $\chi$ is set such that, in steady state, $L_t$ is 0.31. Regarding the nominal stickiness, we set $\xi_w = 0.72$ and $\xi_\pi = 0.75$. Concerning the elasticities of substitution for goods and labor, we set $\varepsilon_w = \varepsilon = 6$. Further, we set $\Phi$ such that the profits-to-output ratio is 10% in the steady state. Concerning the parameters affecting the formation of capital, we set $\delta_k = 0.025$, $\kappa = 2.48$ and $\gamma_2 = 0.0685$. Finally, notice that the persistence parameter of the discount factor process, $\rho_\lambda$, is set to the benchmark value of 0.5.

### 3.2 The Experiment

In order to make the nominal interest attain the ZLB, we follow a strategy similar to CER (2011) and assume that the economy is in its steady state level in quarter 0. Then, we shock

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4We acknowledge that Ercolani and Valle e Azevedo (2014) estimate the parameter of substitutability within a RBC model. Using this parameter in the present analysis, we are assuming that the degree of substitutability is largely independent of the presence of nominal rigidities. We believe this is a reasonable hypothesis. Further, we have assessed the sensitivity of the results to values of $v$ deemed “credible” in Ercolani and Valle e Azevedo (2014). For example, we set $v$ to the lower bound value of their 95% credibility interval, meaning that the degree of substitutability is somewhat decreased. These exercises deliver results that are very similar to the ones presented in Section 3.3 (results are available upon request).
\(\lambda_t\) at quarter 1, such that agents’ desire to save increases. We tune the shock such that, across all our simulations, the nominal interest rate hits the ZLB on impact and remains there for roughly 6 quarters.\(^5\) In the model with separable government consumption and fiscal rule, this generates a sizeable fall in aggregate demand, output and partly on prices, e.g., output and consumption fall by roughly 4.5% and 5%, respectively, absent any other shock. At quarter 1, we also generate an increase in government consumption of 1% of steady state output.\(^6\) Then, we assume that \(G\) follows a deterministic path, i.e., the autoregressive process described above without any uncertainty. We then calculate the (counterfactual) dynamic government-spending multipliers \(t\) quarters after the increase in \(G\) following:

\[
M_t^{ZLB} = \frac{\sum_{k=0}^t (R_{ss}^f)^{-k} \left( Y_{k}^{G,\lambda} - Y_{k}^{\lambda} \right)}{\sum_{k=0}^t (R_{ss}^f)^{-k} \left( G_{k} - G_{ss} \right)},
\]

(10)

where \(R_{ss}^f\) is the steady state (gross) real interest rate, \(Y^{G,\lambda}\) is the output reaction to both the government and discount factor shocks whilst \(Y^{\lambda}\) is the output reaction to the discount factor shock alone.\(^7\)

We compute the (non-linear) perfect foresight solution of the model using the algorithm in Juillard (1996).

### 3.3 Results

Figure 1 shows both dynamic multipliers and impulse responses generated by the above described government spending shock, within the model described in Section 2 (the baseline model). These reactions are ‘counterfactual’ in the sense described above (i.e., they are the difference between

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\(^5\)In several of the experiments it would be feasible to increase the number of quarters at the ZLB (say, to 12). However, numerical complications arise in many of them. Hence, we decided to consider a lower number of periods at the ZLB, while recognizing that this lowers, in general, the size of the multipliers. All in all, in our setting, the effect of substitutability on the size of the multipliers does not change significantly with the length of the ‘ZLB episode’.

\(^6\)This simulated increase in \(G\) is close to the maximum increase actually reached by government purchases as a result of the implementation of the American Recovery and Reinvestment Act.

\(^7\)The notion of ‘dynamic’ multiplier is taken from Uhlig (2010), and the one of ‘counterfactual’ multiplier from CER (2011).
the responses to both shocks, preference and spending, and the responses to only the preference shock). The solid lines represent the reactions conditional on imposing substitutability between \( C \) and \( G \) and are labeled as *Substitutability*. The dashed lines represent the reactions conditional on imposing separability between \( C \) and \( G \) and are labeled as *Separability*.

Irrespective of both the relationship in preferences between \( G \) and \( C \) and the nominal interest rate being stuck at zero, the increase in government spending generates the well-known “negative wealth effect”. Agents’ permanent income is reduced because the present value of taxes increases. As a consequence, agents optimally respond by consuming less and working more.

When the nominal interest rate is at the ZLB, the increase in \( G \) generates a negative real risk-free rate because of the (positive) impact on inflation. This induces agents to consume more and save less, ceteris paribus. However, and crucially, the real risk-free rate falls less in the non-separable economy and thus, in this economy, household are induced to consume less relative to the separable case. The behavior of the real risk-free rate is determined by inflation, which increases less in the non-separable economy.\(^8\) This happens because of the behavior of the marginal cost. Indeed, labor reacts less in the non-separable economy both because agents needs to supply less labor in order to finance a lower level of consumption and firms hire less labor to satisfy the lower aggregate demand (i.e., both consumption and investment are lower in the non-separable economy). This dynamic for labor generates a smaller reaction of the marginal product of capital, hence, of the return to capital \((r^k_t)\), in the non-separable economy. The same happens for the wage rate. As a consequence, marginal costs are lower in the non-separable world. Obviously, the behavior of consumption is also directly affected by the degree of substitutability, i.e., private consumption falls because it is partly substituted by the newly available government consumption.\(^9\)

Eventually, output is depressed in the non-separable economy through supply and demand

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\(^8\)Notice that we report the response of gross inflation. Hence, the difference in the reaction of net inflation between the two worlds is around 0.5 percentage points.

\(^9\)In the non-separable economy, we obtain a negative consumption multiplier for every time horizon. Notice that other channels, not considered in the present analysis, could have dampened (or reverted) this negative reaction. For example, the presence of liquidity constrained individuals as in Gali’ et al., 2007, could contribute to generate a positive response of private consumption despite the relationship of substitutability between private and government consumption.
Multipliers/Responses in the Baseline Model. The lines are computed in the version of the model where the fiscal rule is at work. Solid lines are obtained by imposing substitutability between $C$ and $G$. Dashed lines are obtained by imposing separability between $C$ and $G$. Counterfactual multipliers or responses are reported, i.e., the difference between the reactions generated by the government consumption and the discount factor shocks and those generated by the discount factor shock alone (refer to equation (10) for the multipliers). The y-axis for the ‘Responses’ is measured in percentage deviation, except in the cases of nominal interest rate (which refers to the level after both shocks) and $G$ (measured in percentage of steady-state output). The x-axis is in quarters.
forces. On the one hand, the lower aggregate demand translates into the supply side because of the presence of nominal rigidities. On the other hand, the lower level of inputs (both labor and capital) results in lower output. Quantitatively, the impact output multiplier is around 0.8 and 1.5 in the non-separable and in the separable economy, respectively.

Figure 2 shows the reactions of output, consumption and labor in the Ricardian version of the model, i.e., where the increased in $G$ is financed by only lump-sum taxes. Two things are worth noting. First, although the magnitude of these reactions is different vis-à-vis the economy with a fiscal rule at work, the gap in the output multipliers generated by the substitutability channel is almost the same, i.e., it is roughly 0.6 in both Figure 1 and 2. This confirms that the channel under scrutiny (substitutability) plays a crucial role in determining the size of the output multipliers. Second, the output multipliers in the Ricardian world are bigger than the ones generated in the economy with the fiscal rule. This result is in line with the recent findings of Drautzburg and Uhlig (2013): within a New Keynesian model with both price and wage stickiness, even if the economy is at the ZLB, the more ‘aggressive’ is the fiscal rule, the lower are the output multipliers. This happens because of the contrasting output effects generated by distortionary taxes. That is, the ‘neoclassical effect’ of distortionary taxes (e.g., see Uhlig, 2010) prevails over the one generated by the ZLB state (see, e.g., Eggertson, 2010).
4 Conclusions

In this paper, we have challenged the typical large size of government spending multipliers obtained when the ZLB binds the nominal interest rate, conditional on a liquidity trap caused by a taste shock.

In particular, we have shown that using a set-up similar to that of CER(2011) - but allowing for substitutability between private and government consumption - generates output multipliers around unity on impact which are close to the ones measured by some recent empirical papers. In particular, the substitutability channel limits the fall in the real interest rate during the ‘ZLB periods’. Our finding is robust to the consideration of different taxation schemes.

This paper contributes to the current academic debate that aims at better understanding and carefully measuring the effects of fiscal policy when the nominal interest rate is at ZLB. Further, given our focus on the role of government spending in agents’ preferences, our results can inform analyses of the desirability of a government spending expansion during the ‘ZLB episode’.
References


Appendix: Equilibrium Conditions

We restrict attention to the model with distortionary taxation. The version with lump-sum taxation obtains by setting all marginal tax rates equal to zero and by balancing the budget. Equilibrium conditions follow from the first order conditions (F.O.C.s) of households’ and firms’ problems while imposing symmetry, fiscal policy equations, market clearing conditions and processes for the exogenous shocks. The Lagrange multipliers associated with the budget constraint and the capital accumulation equation are, respectively, $\mu_t$ and $q_t$ (Tobin’s q).

- **Aggregator (consumption):**

  \[
  \bar{C}_t = \left[ \phi (C_t)^{1-v} + (1 - \phi) (G_t)^{1-v} \right]^{\frac{1}{v-1}} \tag{11}
  \]

- **Consumption F.O.C.:**

  \[
  (1 + \tau^c) \mu_t = e^{\lambda_t} \left[ \phi \left( \frac{\bar{C}_t}{C_t} \right)^{\frac{1}{v}} \left[ \left( \bar{C}_t - \gamma \bar{C}_{t-1} \right)^{-1} \right] \right] \tag{12}
  \]

- **Labor supply F.O.C.:**

  \[
  \mu_t = \frac{e^{\lambda_t} L_t^{\sigma_n}}{(1 - \tau_t) W_t} \tag{13}
  \]

- **Risk-free asset F.O.C.:**

  \[
  \beta E_t \left[ \frac{\mu_{t+1} R_t}{\mu_t \pi_{t+1}} \right] = 1 \tag{14}
  \]

- **Investment F.O.C.:**

  \[
  \mu_t = \mu_t q_t E_t \left\{ \left[ 1 - \kappa \left( \frac{I_t}{I_{t-1}} - 1 \right)^{2} \right] - \frac{I_t}{I_{t-1}} \kappa \left( \frac{I_t}{I_{t-1}} - 1 \right) \right\} + \beta e^{\lambda_t} E_t \left[ \mu_{t+1} q_{t+1} \left( \frac{I_{t+1}}{I_t} \right)^{2} \kappa \left( \frac{I_{t+1}}{I_t} - 1 \right) \right] \tag{15}
  \]
• **Next period capital F.O.C.:**

\[ \mu_t q_t = E_t [\beta e^{\lambda_t^2} \mu_{t+1} r_{t+1}^k u_{t+1} - a(u_{t+1})](1 - \tau_t) + q_{t+1} (1 - \delta) ] \]

where \( a(u_t) = \gamma_1 (u_t - 1) + \frac{\gamma_2}{2} (u_t - 1)^2 \) represents the cost of using capital at intensity \( u_t \).

• **Capital law of motion:**

\[ K_{t+1} = (1 - \delta) K_t + I_t \left[ 1 - \frac{\kappa}{2} \left( \frac{I_t}{I_{t-1}} - 1 \right)^2 \right] \]

• **Capacity utilization F.O.C.:**

\[ r_t^k = a'(u_t) = \gamma_1 + \gamma_2 (u_t - 1) \]

• **Marginal rate of substitution consumption/labor:**

\[ mrs_t = \frac{\chi L_t^{\sigma_\alpha}}{(1 + \tau^c) \lambda_t} \]

• **Wage markup:**

\[ \lambda_{w,t} = \frac{w_t (1 - \tau_t)}{mrs_t} \]

• **Production function:**

\[ Y_t = (u_k L_t)^{\alpha}(L_t)^{1-\alpha} - \Phi \]

• **Factor demands:**

\[ (1 - \alpha) \frac{Y_t}{L_t (1 + \lambda_{p,ss})} = W_t \]

\[ \frac{Y_t}{K_t (1 + \lambda_{p,ss})} = u_t r_t^k \]
• Marginal cost:

\[ MC_t = \left( u_t r_t^k \right)^\alpha W_t^1 - \alpha^\alpha \frac{1 - \alpha}{(1 - \alpha)} \]  

(24)

• Price markup:

\[ \frac{1}{MC_t} = \lambda_{p,t} \]  

(25)

• Taylor Rule

\[ R_t = \max(Z_t, 1), \quad \text{where} \quad Z_t = (Z_{t-1})^{\alpha z} (\pi_t - 1)^{\phi_y(1 - \alpha_z)} \left( \frac{Y_t}{Y_{t-1}} - 1 \right)^{\phi_y(1 - \alpha_z)} \]  

(26)

• Fiscal Rule

\[ \tau_t = (1 - \rho)\tau_{ss} + \rho\tau_{t-1} + (1 - \rho)\gamma \left( \frac{B_{t-1}}{Y_{t-1}} - b_{ss} \right), \]  

(27)

where \( \tau_{ss} \) and \( b_{ss} \) are the steady state values of \( \tau_t \) and \( \frac{B_t}{Y_t} \), respectively.

• Government Budget Constraint

\[ G_t + \frac{R_{t-1}}{\pi_t} B_{t-1} = B_t + \tau_c C_t + \tau_t W_t P_t L_t + \tau_t \left[ r_t^k u_t - a (u_t) \right] K_t + T_{ss} \]  

(28)

• Market Clearing

\[ Y_t = C_t + I_t + G_t + a (u_t) K \]  

(29)

• Shocks processes:

\[ G_t = (1 - \rho_G)G_{ss} + \rho_G G_{t-1} + \eta_t^G \]  

(30)

\[ \lambda_t = \rho_\lambda \lambda_{t-1} + \eta_t^\lambda \]

Finally, following SGU (2006) we report the equilibrium conditions related to wage and price setting, expressed in recursive form:
• $f_1$

\[
f_t^1 = \mu_t (1 - \tau_t) L_t \left( \frac{W_t}{\bar{W}_t} \right)^{\varepsilon_w} + \left( \xi_w \beta e^{\lambda_t} \right) \left( \frac{\bar{W}_{t+1}}{W_t} \right)^{\varepsilon_w} \pi_{t+1}^{w \varepsilon_w} f_{t+1}^{1}
\]

where $\bar{W}_t$ is the wage in $t$, if set optimally.

• $f_2$

\[
f_t^2 = \mu_t (1 - \tau_t) L_t \left( \frac{W_t}{\bar{W}_t} \right)^{\varepsilon_w+1} + \left( \xi_w \beta e^{\lambda_t} \right) \left( \frac{\bar{W}_{t+1}}{W_t} \right)^{\varepsilon_w+1} \pi_{t+1}^{w \varepsilon_w} f_{t+1}^{2}
\]

• Wage aggregator $\bar{W}$

\[
(1 - \varepsilon_w) \bar{W}_t f_t^1 + \varepsilon_w f_t^2 = 0
\]

• Wage aggregator $W$

\[
W_t^{1-\varepsilon_w} = \xi_w \pi_t^{w - 1} W_{t-1}^{1-\varepsilon_w} + (1 - \xi_w) \bar{W}_t^{1-\varepsilon_w}
\]

• $x_1$

\[
x_t^1 = MC_t \left( \bar{p}_t \right)^{-1-\varepsilon} Y_t + E_t \xi_p \mu_{t+1} \left[ \left( \frac{\bar{p}_t}{\bar{p}_{t+1}} \right)^{-1-\varepsilon} \pi_{t+1}^{\varepsilon} \right] x_{t+1}^1
\]

where $\bar{p}_t$ is the wage in $t$, if set optimally.

• $x_2$

\[
x_t^2 = \left( \bar{p}_t \right)^{-\varepsilon} Y_t + E_t \xi_p \beta e^{\lambda_t} \mu_{t+1} \left( \frac{\bar{p}_t}{\bar{p}_{t+1}} \right)^{-\varepsilon} \pi_{t+1}^{\varepsilon - 1} x_{t+1}^{2
\]

• Price aggregator 1

\[
\varepsilon x_t^1 + (1 - \varepsilon) x_t^2 = 0
\]

• Price aggregator 2

\[
1 = \xi_p \left( \pi_t \right)^{\eta - 1} + (1 - \xi_p) \bar{p}_t^{1-\varepsilon}
\]