GOVERNMENT SPENDING EFFECTS IN LOW-INCOME COUNTRIES

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ABSTRACT. Empirical studies of fiscal policy effects in low-income countries (LIC) are generally limited due to data availability. This paper takes a theoretical approach to assess government consumption and public investment effects. It highlights three factors important for assessing fiscal multipliers in LICs: 1) financing sources in terms of domestic and external funds, 2) public investment (in)efficiency, and 3) the degree of home bias in government purchases. With limited capital mobility, the output multiplier is generally bigger with external than domestic financing, as the former increases the resource envelope, mitigating the crowding-out effects. Traded output, however, can respond negatively, raising the Dutch disease concern. Although capital scarcity in LICs implies high returns to public capital, investment inefficiency substantially dampens the output multiplier. Also, public investment may not be much expansionary in the short run, because building infrastructure in LICs relies on imports of goods and skilled labor to a large extent and thus is less effective in stimulative domestic production.

Keywords: fiscal policy; low-income countries; public investment; aid; fiscal multipliers; small open DSGE models

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1. Introduction

Government spending is an important countercyclical tool for countries of all income levels. In low-income countries (LICs), pressing capital needs give government spending an additional role for promoting long-term economic growth. Limited data availability, however, restricts estimations of the fiscal policy effects in LICs. This paper takes a theoretical approach; it constructs a dynamic stochastic general equilibrium (DSGE) model, incorporating LIC-specific features, to study the government spending effects, distinguishing between government consumption and public investment.

Relative to a voluminous literature on fiscal policy effects, our analysis focuses on three important factors for assessing fiscal multipliers in LICs: 1) financing sources in terms of domestic and external funds, 2) public investment inefficiency, and 3) the share of nontraded goods in government purchases. These factors are generally overlooked among existing work assessing fiscal multipliers in developing countries.

In an environment of limited international capital mobility, external financing increases the resource envelope and thus mitigates the crowding-out effects of government spending, often documented in the literature (e.g., Coenen et al. (2012) and Traum and Yang (forthcoming)). In contrast to the long-lasting negative responses of private investment with domestic financing, it is less negative and can even turn positive in the longer horizon with external financing. The capital inflows resulted from external borrowing or aid, however, can appreciate the real exchange rate, which reduces the competitiveness of traded goods and raises Dutch disease concern, as shown in Berg et al. (2010). The very different government

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1The few papers that estimate government spending effects in LICs include Kraay (2012, forthcoming). Both papers use datasets of official creditors’ lending to developing countries, including LICs. In both papers, he estimates that the short-run output multipliers are around 0.4-0.5. Since loans from official creditors are mostly used to finance public investment rather than consumption, these estimates can be interpreted as the output multipliers for investment projects financed by official creditors.

2Berg et al. (2013) and Buffie et al. (2012) find the importance of investment efficiency in public investment effects.

3Factors that are commonly considered for estimating fiscal multipliers in developing countries include the degree of development, trade openness, the exchange rate regime, and indebtedness (Batini et al. (forthcoming) and Ilzetzki et al. (2013)).
spending effects between domestic and external financing diminish in an environment of high capital mobility, because households can counteract an increase in external public debt by de-leveraging their foreign debt, so that the amount of resources available is roughly the same as with domestic financing. While domestic versus external financing sources can be ignored in an environment of a fairly open private capital account, it is an important factor to account for studying government spending effects in LICs with fairly restricted capital mobility.

Overall, external financing produces larger output multipliers than domestic financing with limited capital mobility. Between the two external financing methods investigated, aid financing produces a higher output multiplier than commercial debt financing in the long run. Since debt financing requires fiscal adjustments later to service debt, the negative effects from higher taxes offset some of the expansionary effects of government spending. Also, the twin deficit hypothesis is more likely to hold with external financing as traded output falls substantially along with rising fiscal deficits.\(^4\)

As for public investment effects, we find that investment efficiency—defined as the ratio of the change in public capital to an increase in investment expenditures—plays a crucial role in determining public investment effects, as demonstrated in Berg et al. (2010), Buffie et al. (2012), and van der Ploeg (2012). Under the baseline calibration of an investment efficiency at 0.4 (in line with the estimate obtained by Pritchett (2000) for sub-Saharan African economies), the output multiplier for public investment is generally much below one, despite a reasonably high return at an annual rate of 25 percent in the steady state. Another factor important for the public investment effects in LICs is the degree of home bias in government purchases. Public investment in LICs relies on imports of material, machinery, and skilled labor to a large extent. The low degree of home bias implies that public

\(^4\)Easterly and Schmidt-Hebbel (1993) find strong evidence that fiscal deficits spill over into trade deficits among ten developing countries and the real exchange rate appreciates, as found in our analysis with external financing.
investment may not yield large stimulative effects in the short run, as a large proportion of the increases in government demand is met by foreign production.

The framework used here modifies a typical two-sector New Keynesian model, commonly used for analyzing fiscal policy effects in advanced economies (e.g., Erceg et al. (2005) and Ratto et al. (2009)), to include a large share of hand-to-mouth households, limited international capital mobility, and public investment inefficiency. Satisfying the subsistence needs renders many households unable to save in LICs. The disproportionally large share of hand-to-mouth households in LICs is important to account for, given the importance of non-savers in the expansionary effects of fiscal policy (Mankiw (2000)). To restrict capital mobility, we introduce a portfolio adjustment cost in foreign asset holding, which captures the high costs to obtain external finance to consume and invest (Gorodnichenko and Schnitzer (forthcoming)).

Low governance quality in LICs is reflected by an inefficient investment process, such that one dollar of investment expenditures yields much less than one dollar of public capital.

Following the model specification in Section 2, we calibrate the model to the recent economic condition of sub-Saharan African economies in Section 3. Sections 4 and 5 compute government consumption and public investment multipliers for output and its various components under different financing sources, public investment efficiencies, and the degrees of home bias in government purchases. Finally, Section 6 concludes.

2. A Quantitative Model

The framework, adapted from Berg et al. (2010), is a small open, New Keynesian model with nontraded (N) and traded (T) good sectors.

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5Private capital flows to sub-Saharan Africa have increased significantly from $16.1 billion to $55.2 billion in 2011, its share in global flows remains low (Hou et al. (2013)).

6The average scores of LICs lag behind those of developing countries in the public investment management index (Dabla-Norris et al. (2011)) and the Worldwide Governance Indicators (Kaufmann et al. (2013)). For example, the average government effectiveness and corruption control indices in the Governance Indicators for LICs are $-0.97$ and $-0.87$ for 2012, compared to the averages of $-0.24$ and $-0.29$ for developing countries on a scale of $-2.5$ to $2.5$. 

2.1. **Households.** The economy is populated by two types of households with a fraction \( f \) are savers \((a)\) and \(1 - f\) are hand-to-mouth \((h)\). Only savers have access to financial and capital markets, and the hand-to-mouth are liquidity constrained.

### 2.1.1. Savers. A representative saver chooses consumption \((c_t^a)\), the real money balance \((m_t^a)\), labor \((l_t^a)\), investment \((i_t^{N,a}\) and \(i_t^{T,a}\))\), capital \((k_t^{N,a}\) and \(k_t^{T,a}\)), domestic government debt \((b_t^{d,a})\), and external debt \((b_t^{h*,a})\) to maximize the expected utility,

\[
E_t \sum_{t=0}^{\infty} \beta^t \left[ \frac{(c_t^a)^{1-\sigma}}{1 - \sigma} - \frac{(l_t^a)^{1+\psi}}{1 + \psi} + \frac{(m_t^a)^{1-\xi}}{1 - \xi} \right],
\]

where \(\beta\) is the discount factor, \(\sigma\), \(\psi\), and \(\xi\) are the inverse of the elasticity of intertemporal substitution for consumption, labor, and money. The saver’s budget constraint is

\[
c_t^a + m_t^a + i_t^{N,a} + i_t^{T,a} + b_t^{d,a} + s_t R \frac{b_t^{h*,a}}{\pi^*} + ac_t^b + ac_t^i
\]

\[
= (1 - \tau_t) \left( w_t l_t^a + r_t k_t^{N,a} + r_t k_t^{T,a} \right) + \frac{R_t - 1}{\pi_t} b_t^{h*,a} + \frac{m_t^{d,a}}{\pi_t} + s_t b_t^{h*,a} + s_t r m^* + z_t + \Omega_t^a. \tag{2}
\]

Domestic government debt \(b_t^{d,a}\) pays a nominal rate of \(R_t\) at \(t + 1\), and \(\pi_t\) is the domestic inflation of consumption. Savers can borrow (lend) externally by issuing \(b_t^{h*,a} > 0\) (< 0) in units of foreign goods, denoted by \(*\). The real exchange rate \(s_t\) is in the units of domestic consumption per unit of foreign goods. \(R^*\) in the nominal interest rate demanded by foreign creditors, and \(\pi^*\) is foreign inflation, both assumed to be constant. Following Schmitt-Grohé and Uribe (2003), changing foreign liabilities is subject to portfolio adjustment costs

\[
ac_t^{b,a} = s_t v b_t^{h*,a} \left( \frac{b_t^{h*,a}}{b_t^{d,a}} - 1 \right)^2, \quad \text{where} \quad v \text{ governs capital account openness in the private sector.}
\]

These costs, together with a risk premium included in \(R^*\), represent the financial costs that prevent LIC households from engaging in a higher degree of consumption smoothing through borrowing and lending in international financial markets. A tax rate \(\tau_t\) is levied on labor and capital income, and \(w_t\) is the real wage rate. Foreign remittance \(r m^*\) is assumed to be constant.\(^7\) \(z_t\) is government transfers to households, and \(\Omega_t\) is dividends from firms.

\(^7\)Remittance helps pin down the foreign debt of savers in the steady state.
We assume that capital is sector specific, and \( r^N_t \) and \( r^T_t \) are the returns to capital in each sector. \( \Delta_k^i \equiv \frac{k}{2} \left[ \left( \frac{i^N_t}{k_{t-1}^N} - \delta \right) k_{t-1}^N + \left( \frac{i^T_t}{k_{t-1}^T} - \delta \right) k_{t-1}^T \right] \) is investment adjustment costs. The law of motion for capital is
\[
k^j_t = (1 - \delta) k^j_{t-1} + i^j_t, \quad j \in \{N, T\},
\]
where \( \delta \) is the depreciation rate. Total investment made by savers is \( i_t^a = i^N_t + i^T_t \).

Consumption and investment are constant-elasticity-to-scale (CES) aggregates of nontraded and traded goods with the intratemporal elasticity of substitution \( \chi \) and the degree of home bias \( \varphi \); e.g.,
\[
c_t = \left[ \varphi^\frac{1}{\chi} \left( c_t^N \right)^{\frac{1-\chi}{\chi}} + (1 - \varphi) \left( c_t^T \right)^{\frac{1-\chi}{\chi}} \right]^{\frac{\chi}{1-\chi}}.
\]

Nontraded goods are produced by a continuum of monopolistically competitive firms indexed by \( i \in [0, 1] \). Nontraded consumption varieties are aggregated by
\[
c_t^N = \left[ \int_0^1 c^N_i \left( \frac{\theta - 1}{\theta} \right) \theta \, di \right]^{\frac{\theta}{\theta - 1}},
\]
where \( \theta \) is the elasticity of substitution between varieties. The CES basket implies that the unit price of \( c_t \) (CPI) is
\[
1 = \left[ \varphi \left( p_t^N \right)^{1-\chi} + (1 - \varphi) (s_t)^{1-\chi} \right]^{\frac{1}{1-\chi}},
\]
where \( p_t^N \) is the relative price of nontraded goods to the CPI. We assume the law of one price holds for traded goods. Hence, the real exchange rate \( s_t \) is also the relative price of traded goods to the CPI.

Households supply labor to both sectors. Savers’ total labor supply is
\[
l_t^a = \left[ (\varphi^l)^{-\frac{1}{\chi^l}} \left( l_{t}^{a,N} \right)^{\frac{1 + \chi^l}{\chi^l}} + (1 - \varphi^l)^{-\frac{1}{\chi^l}} \left( l_{t}^{a,T} \right)^{\frac{1 + \chi^l}{\chi^l}} \right]^{\frac{\chi^l}{1 + \chi^l}},
\]
where \( \varphi^l \) is the steady-state share of labor in the nontraded good sector. Labor can move across the sectors, and \( \chi^l > 0 \) is the elasticity of substitution between the labor used in each sector. From the cost minimization problem, the aggregate real wage index is derived as
\[
w_t = \left[ \varphi^l \left( w_t^N \right)^{1 + \chi^l} + (1 - \varphi^l) \left( w_t^T \right)^{1 + \chi^l} \right]^{\frac{1}{1 + \chi^l}},
\]
where $w_i^N$ and $w_i^T$ are the real wage rate of each sector.

2.1.2. **Hand-to-Mouth Households.** We assume that the hand-to-mouth have an inelastic labor supply ($l_{ht} = l^h \forall t$) and consume all the disposable income every period as determined by the budget constraint

$$c_{ht}^h = (1 - \tau_t) w_{ht}^h + s_t r_m^* + z_t.$$  \hspace{1cm} (9)

2.2. **Firms.** The two production sectors have different market structures. Nontraded good firms are assumed to be monopolistically competitive, because nontraded goods can only be produced domestically. Since manufacturing in LICs often concentrates on resource-based and low-technology production, traded good firms are assumed to be perfectly competitive.\(^8\)

2.2.1. **Nontraded Sector.** The monopolistically competitive intermediate goods producer $i \in [0, 1]$ produces with technology

$$y_t^N(i) = z^N \left[ k_{t-1}^N(i) \right]^{1-\alpha_N} \left[ l_t^N(i) \right]^{\alpha_N} \left( k_{t-1}^G(i) \right)^{\alpha_G},$$  \hspace{1cm} (10)

where $z^N$ is total factor productivity (TFP) of nontraded good production, and $k_{t-1}^G$ is public capital with an output elasticity $\alpha_G$. Aggregating all nontraded goods $y_t^N = \int_0^1 y_t^N(i)^{\frac{\theta}{\theta-1}} di$ and solving the profit maximization problem yield the demand function for good $i$,

$$y_t^N(i) = \left[ \frac{p_t^N(i)}{p_t^N} \right]^{-\theta} y_t^N.$$  \hspace{1cm} (11)

A nontraded good producer $i$ chooses price, labor and capital to maximize its net present-value profits weighted by savers’ (firm owners’) utility $\lambda_t^i$,

$$E_t \sum_{i=0}^\infty \beta^i \lambda_t^i \left[ (1 + u) (1 - \iota) \left( p_t^N(i) y_t^N(i) - ac_t^P(i) \right) - w_t^N l_t^N(i) - r_t^N k_{t-1}^N(i) + (\iota - u + \iota u) p_t^N y_t^N \right],$$

\hspace{2cm} $\equiv \Omega_t(i), \text{ dividends}$  \hspace{1cm} (12)

subject to the production function (10) and the demand function (11). Price rigidity is introduced by adjustment costs $ac_t^P(i) \equiv \frac{\iota}{2} \left[ \frac{\pi_t^N(i)}{\pi_{t-1}^N(i)} - 1 \right]^2 p_t^N y_t^N$, a la Rotemberg (1982). $\pi_t^N \equiv$

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\(^8\)Based on data from 2000 to 2009, 74.5 percent of value added in total manufacturing is resource-based and low-technology production in Africa (UNIDO and UNCTAD (2011)).
\( \frac{p_t}{p_{t-1}} \) is nontraded good inflation. Total price adjustment costs, nontraded output, and dividends are \( ac_t^p = \int_0^1 ac_t^p(i) di, y_t^N = \int_0^1 y_t^N(i) di, \) and \( \Omega_t = \int_0^1 \Omega_t(i) di. \) To capture additional distortions in production (other than the explicit tax \( \tau \) on factor income), we introduce an implicit cost (tax) \( \iota \) in production. Unlike income taxes, the revenue collected by \( \iota \) does not enter the government budget and remains in the private sector. For simplicity, we assume the implicit cost is rebated back to firms (hence savers) in a lump-sum fashion.\(^9\) Also, to simplify the steady-state analysis, we introduce a subsidy \( u \) such that in the steady state the markup due to monopolistic power is zero.

2.2.2. Traded Good Sector. A representative traded good firm \( i \) produces with technology

\[
y(i)_T^T = zT \left[k(i)_{T-1}^T \right]^{1-\alpha_T} \left[l(i)_T^T \right]^{\alpha_T} \left[k_{T-1}^G \right]^{\alpha_G}.
\]

(13)

It chooses labor and capital to maximize periodic profits

\[
(1-\iota) s_t y(i)_T^T - w_t^T l(i)_T^T - r_t^T k(i)_{T-1}^T + \iota y_t^T,
\]

(14)

where \( y_t^T = \int_0^1 y_t^T(i) di. \)

Total output produced in the economy at period \( t \) is \( y_t = p_t^N y_t^N + s_t y_t^T. \)

2.3. Government. In each period, the government receives taxes and foreign aid \( (a_t^*), \) issues domestic and foreign debt \( (b_t^d \) and \( b_t^{\pi*}), \) and generates seigniorage revenue. Total expenditures include government consumption \( (g_t^C), \) public investment \( (g_t^I), \) transfers to households,\(^10\) and debt services. The flow budget constraint is

\[
tax_t + b_t^d + s_t b_t^{\pi*} + s_t a_t^* + m_t = p_t^G \left(g_t^C + g_t^I + z + \frac{R_{t-1} b_t^{d}}{\pi_t} \right) + s_t \frac{R_t b_t^{\pi*}}{\pi_t} + m_t \frac{m_t}{\pi_t},
\]

(15)

\(^9\)The implicit cost is a short cut for the model to rationalize why given the high marginal return to capital implied by capital scarcity, we do not observe a higher investment to output ratio in the steady state.

\(^10\)We do not study the effect of transfers; the constant transfers are calibrated to close the budget gap after calibrating other fiscal variables to match sample averages in the data.
where \( t = \tau_t \left( w_t l_t + r_t^N k_t^N + r_t^T k_t^T \right) \). We assume that the government faces the same nominal interest rate \( R^* \) as savers when borrowing externally.\(^{11}\)

Government purchases \( g_t = g_t^C + g_t^I \) are CES baskets of traded and nontraded goods with a degree of home bias \( \varphi^G \) and the elasticity of substitution \( \chi \). The relative price of government purchases to the CPI is

\[
p_t^G = \left[ \varphi^G \left( p_t^N \right)^{(1-\chi)} + (1-\varphi^G) \left( s_t \right)^{1-\chi} \right]^{\frac{1}{1-\chi}}. \tag{16}
\]

To capture low investment efficiency in LICs, we assume that one dollar of investment expenditure can deliver less than one dollar of public capital:

\[
k_t^G = (1-\delta^G) k_{t-1}^G + \epsilon g_t^I \quad 0 \leq \epsilon \leq 1. \tag{17}
\]

We assume government consumption and investment follow exogenous rules:

\[
\log \frac{g_t^j}{g_t^j} = \rho_G \log \frac{g_t^{j-1}}{g_t^j} + \varepsilon_t^j, \quad j \in \{C, I\}. \tag{18}
\]

Three financing methods are considered: domestic debt, external debt, and aid.\(^{12}\) When one of the three is employed to finance a spending increase, the other two are set to their steady-state levels. For example, when domestic debt is used for financing, \( b_t^d \) is endogenously determined by the government budget (15), and \( b_t^d = b_t^*, a_t^* = a^* \forall t \). With domestic or external debt financing, total government debt rises, which triggers gradual fiscal adjustments. We assume the tax rate adjusts to maintain debt sustainability.

\[
\log \frac{\tau_t}{\tau} = \rho_T \log \frac{\tau_{t-1}}{\tau} + \gamma \log \frac{s_{t-1}^b}{s_t^b}, \quad \gamma \geq 0 \tag{19}
\]

where \( s_{t-1}^b = \frac{b_{t-1}^d + s_{t-1}^b}{y_{t-1}}. \)\(^{13}\)

\(^{11}\)Our specification assumes that a constant risk premium. Empirically, the premium rises when a government becomes more indebted (e.g., Akitoby and Stratmann (2008)), but the relationship tends to be non-linear.

\(^{12}\)One common financing source in LICs is external concessional borrowing, which is similar to aid but with a subsidized interest rate and a long maturity period. While not analyzed separately here, the effects of government spending financed by concessional borrowing would fall between the results with external (commercial) debt and aid financing.

\(^{13}\)In an environment with a large share of the hand-to-mouth, the effects of transfer adjustments are similar to income tax adjustments.
Given a less developed money and financial markets, many central banks in LICs target money in practice. To conduct monetary policy, the central bank follows a money growth rule with nominal reserve money grows at a constant rate $\mu$; real money balance follows a process

$$m_t = \mu \frac{m_{t-1}}{\pi_t}.$$  

(20)

2.4. Aggregation and market clearing. With two types of households, aggregate consumption and labor are computed as follows.

$$x_t = f x^a_t + (1 - f) x^h_t, \quad x \in \{c, c^N, c^T, l, l^N, l^T\}.$$  

(21)

Lump-sum transfers and remittance are identical for each household. Hence,

$$x^a_t = x^h_t = x_t, \quad x \in \{z, rm^*\}.$$  

(22)

Since only savers have access to asset and capital markets, aggregate real money balance, investment, capital, debt, and dividends are computed as

$$x_t = f x^a_t, \quad x \in \{m, i^N, i^T, k^N, k^T, b^d, b^{hs}, \Omega, ac^b, ac^i\}.$$  

(23)

Finally, the market clearing condition for nontraded goods is

$$y_t = (p_t^N)^{-\chi} \left[ \varphi (c_t + i_t + ac^i_t + ac^b_t + ac^p_t) + \varphi^G (p_t^G)^x g_t \right].$$  

(24)

The balance of payment condition is

$$c_t + i_t + p_t^G g_t + ac^i_t + ac^b_t + ac^p_t + s_t (R^* - 1) \frac{b^{hs}_{t-1} + b^{hs}_{t-1}}{\pi^*} - y_t - s_t rm^*$$

$$= s_t \left( a^* + b^{hs}_t + b^{hs}_{t-1} - \frac{b^{hs}_{t-1}}{\pi^*} \right).$$  

(25)

14An alternative rule to allow the money growth targets inflation can also be specified. This alternative rule with a reasonable response magnitude to inflation does not change materially the results presented here.
3. Solution and Calibration

To solve the model, we log-linearize the equilibrium system and use Sims’s (2001) algorithm for solving linear rational expectations models. Appendix A contains the optimality conditions to savers’ and firms’ maximization problems. The model is at a quarterly frequency and calibrated to an average LIC, based on the data of 45 SSA country from 2005 to 2012.\footnote{Most SSA countries are LICs or lower middle-income countries. We exclude South Sudan for non-exist data before 2011. The data used to calibrate the initial steady state are the average ratios of the following variables to GDP: private consumption, private investment, government consumption, public debt, CPI inflation, international grants and aid, and tax revenue (International Monetary Fund (2013)). The average public debt in the sample is 48 percent of GDP but a large share of it is likely to be concessional debt. Since our model only has external commercial debt, we assume that only a quarter of public debt is external commercial debt.}

Table 1 summarizes parameter values in the baseline calibration.

Based on the estimate by Ogaki et al. (1996) for developing countries, the intertemporal elasticity of substitution is set to 0.34, implying $\sigma = 2.94$. This suggests that consumption decisions are less on intertemporal smoothing considerations relative to households in developed countries with the typical values $\sigma = 1$ or 2. Without empirical evidence for the Frisch labor elasticity for SSA economies, we calibrate $\psi = 1$ for savers. Together with hand-to-mouth households’ inelastic labor supply, the average Frisch labor elasticity is 0.25.\footnote{Goldberg (2013) estimates that the intertemporal elasticity of working probability in a daily labor market in rural Malawi is 0.15-0.17. The concept of her estimated elasticity is different from the Frisch labor elasticity, though.}

The inverse of the intertemporal elasticity of real money balances ($\xi = 3.1$) is endogenously determined by (A.5), given the quarterly nominal interest rate and the money to output ratio.

The discount factor $\beta = 0.98$ is consistent with an annual real interest rate of 8 percent.

The share of savers $f$ is set to 0.25. Ardic et al. (2013) report that about 25 percent of the poor population has a bank account. Based on 2011 data, Demirgüç-Kunt and Klapper (2012) compute that on average about 24 percent of adults in SSA and 23 percent of people living under $2 a day have an account in a formal financial institution.\footnote{A wide variation in the degree of financial development exists across SSA countries. Based on the estimates using the Global Findex Database, the percentage of adults with an account in a formal financial
The degree of home bias in private consumption and investment $\varphi$ is set to 0.6 and in government purchases $\varphi^G$ is 0.7. Since distribution costs can be high in rural Africa, we assume a slightly higher share than the typical value of 0.5 (Burstein et al. (2005)). We follow the convention to assume a higher degree of home bias in government purchases because a large part of government spending goes to pay civil service. Together with calibrated private consumption and investment shares to output in data (see Table 1), the model implies that almost 60 percent of labor works in the nontraded good sector, and the value added by nontraded output is 65 percent of GDP in the steady state.

For the elasticity of substitution between traded and nontraded goods, we set $\chi = 0.44$, following Stockman and Tesar’s (1995) estimate based on a sample including developing and developed countries. The labor income shares in nontraded and traded production are set to $\alpha^N = 0.45$ and $\alpha^T = 0.6$, following Buffie et al. (2012) for calibrating an average African economy. Consistent with the common value used for the depreciation rate of private capital, $\delta = 0.025$ implies an annual depreciation rate of 10 percent. The elasticity of substitution between variety of goods is set to $\theta = 6$, so a steady-state markup in the goods market is 20 percent, as calibrated in Galí and Monacelli (2005) for a small open economy. To remove the monopolistic power in the steady state, this implies $u = 0.2$ for the subsidy rate provided to nontraded good firms. The intra-temporal elasticity of substitution between labor of the two sectors $\chi^l$ is set to 0.6. Horvath (2000) estimates this elasticity to be 1 using the U.S. sectoral data. Artuc et al. (2013) estimate that on average labor mobility costs are 4.26 times of annual wages in SSA countries, and only 2.41 times in developed countries. Thus, we assume less mobility in our model, compared to developed countries. The investment adjustment cost parameter $\kappa$ is set to 1.4, based on the only estimate we could locate for developing countries with the same specification (Mexico, Aguiar and Gopinath (2007)). For price rigidities, we assume that on average the price for nontraded goods is rigid for one year, implying $\zeta = 68.9$.

institution in SSA is 45 percent in the richest quintile countries and only 12 percent in the poorest quintile (Demirguc-Kunt and Klapper (2012)).
Since public capital consists mostly infrastructure, which has a lower depreciation rate than equipments, we assume $\delta^G = 0.012$ or an annual rate of 5 percent. To calibrate public investment efficiency, we resort to the estimates by Pritchett (2000) for SSA economies and Hurlin and Arestoff (2010) for Colombia and Mexico. When the TFP growth rate is assumed to be zero, the former obtains an efficiency of 0.49 for SSA economies. The latter obtains an estimate around 0.4 for the two developing countries. Our baseline calibration assumes $\epsilon = 0.4$. To see the effects of investment efficiency on multipliers, analysis is also performed under higher marginal efficiency of 0.8 and 1. The public investment to output ratio is calibrated to be 0.045 to yield a public capital to annual output ratio of 0.37 in the steady state. The output elasticity with respect to public capital is selected to be $\alpha^G = 0.11$ such that the annual net rate of return to public capital is 25 percent in the steady state, close to the median return of 24 percent for World Bank projects in 2008 (International Bank for Reconstruction and Development and the World Bank (2010)).

The model has the income tax rate as a fiscal adjustment instrument. The adjustment magnitude, $\gamma = 0.015$, is chosen such that a minimal but sufficient adjustment is implemented to ensure debt sustainability. For capital account openness in the private sector, the baseline assumes fairly limited mobility by setting $v = 1000$. Sensitivity analysis explores less restricted mobility under $v = 0.01$ and 0.0001.

4. Government Consumption Effects

We analyze the effects of a government consumption shock and a public investment shock separately under three financing sources: domestic debt, external debt, and aid. A present-value, cumulative multiplier at $k$ quarters after the shock is computed for both types of
spending, as

\[ M^x(k) = \frac{\sum_{s=0}^{k} \left( \prod_{j=0}^{s} r_j^{-1} \right) \Delta x_s}{\sum_{s=0}^{k} \left( \prod_{j=0}^{s} r_j^{-1} \right) \Delta p^G g_j^s} \]

where \( \Delta \) denotes level changes from the steady state, \( r_0 \equiv 1 \), \( r_t \equiv E_t \frac{R_t}{\pi_{t+1}} \) is the real interest rate, and \( tb_t = y_t - c_t - i_t - p^G_t y_t \) is the trade balance. Tables 2 and 3 report the government consumption and public investment multipliers under the baseline calibration.

4.1. Domestic vs. External Financing Sources. Figure 1 compares the impulse responses to a government consumption increase with domestic (dotted-dashed lines), external debt (solid lines), and aid (dashed lines) financing under the baseline. The size of the government consumption shock is 1 percent of steady-state output at time zero and decreases overtime according to the AR(1) process in (18).

4.1.1. Domestic Financing. When capital mobility is limited (\( v = 1000 \)), domestic financing produces the effects similar to those implied by typical neoclassical or New Keynesian models for a closed economy (e.g., Baxter and King (1993), Forni et al. (2009), and Leeper et al. (2010)). Higher government consumption financed by domestic debt triggers a negative wealth effect among forward-looking savers as they anticipate higher future taxes to pay for the spending increase. The negative wealth effect drives up savers’ labor (hence aggregate labor due to the hand-to-mouth’s inelastic labor supply) and decreases consumption.

In contrast, hand-to-mouth households have the opposite consumption response for the first two quarters. Their positive consumption response is due to additional income from the government consumption increase. The short-run price rigidity prevents nontraded good prices from rising further, raising demand pressure on nontraded goods due to the government consumption increase. The real wage rate in the nontraded good sector rises initially, drawing labor to nontraded production. A higher wage rate in turn raises the hand-to-mouth’s income and thus supports higher consumption. Later, as higher government debt triggers
tax rate increases and nominal rigidities dissipate, hand-to-mouth’s disposable income and consumption fall accordingly.

With domestic debt financing, the standard crowding-out effects associated with government spending prevails. As the government increases domestic borrowing to finance its consumption increase, savers demand a higher interest rate to hold government debt. A higher interest rate then crowds out private investment. In later years, although investment declines become smaller, investment remains below the steady-state level because the income tax rate is persistently higher to maintain debt sustainability (see Figure 1).\footnote{The investment dynamics in the medium and long runs depend crucially on fiscal adjustment speeds. If \( \gamma \) in (19) is bigger, implying more aggressive adjustments, investment would fall more in earlier periods but return to the steady-state level sooner.}

On the external side, the government’s relatively high demand for nontraded goods pushes higher the relative price of nontraded goods, appreciating the real exchange rate. The real appreciation, however, produces little movement in the current account. Although the real appreciation reduces the competitiveness of the traded good sector, weak domestic demand, as shown by the negative multipliers of consumption and investment (the top panel of Table 2), also reduces demand for traded goods in the private sector, leaving the current account roughly unchanged.

With domestic debt financing, the impact output multiplier is 0.26 and the cumulative output multiplier falls to $-0.38$ five years after the initial shock (Table 2). In addition to the crowding-out effects of negative investment and consumption, government spending in an open economy has additional leak in its expansionary effects as part of the demand increase in government purchases is met by imports. When we assume that government purchases consist of almost all nontraded goods, the impact multiplier under domestic financing (not shown in the table) rises from 0.26 to almost 0.6 due to a much higher multiplier for nontraded output.\footnote{In the exercise of a high degree of home bias, we set \( \varphi^G = 0.97.\)}
4.1.2. *External Financing: Debt.* Compared to domestic financing, Figure 1 shows that government consumption effects differ substantially with external debt financing, particularly in consumption, investment, traded output, the real exchange rate, and the current account.

Large inflows of foreign exchange due to higher external borrowing appreciate the real exchange rate much more than with domestic financing. The more appreciated real exchange rate reduces traded output more in the first three years. The multiplier for traded output is \(-0.30\) on impact (compared to 0.02 with domestic financing). While our assumption that traded good firms do not have market power is extreme, the concentration of low-level technology manufacturing in LICs suggests that traded output can be quite susceptible to exchange rate fluctuations.\(^{20}\) In contrast to the little changes in the current account with domestic financing, trade deficits rise substantially with external debt financing. The much appreciated real exchange rate induces substitution of traded goods in private demand for nontraded goods, worsening the trade balance. The multiplier of trade balance is \(-0.49\) on impact, compared to almost zero with domestic financing.

Despite a much negative traded output multiplier with external debt financing, the output multiplier is much bigger than with domestic financing. The impact multiplier is 0.43, compared to 0.26 with domestic financing. Moreover, the five-year output multiplier remains positive at 0.07, versus \(-0.38\) with domestic financing. The expansionary effect of government consumption with external debt financing partly comes from less negative investment and more positive consumption responses. External financing expands the resource envelope for the domestic economy at least in the short run in the case of external borrowing. Thus, it relieves the severe crowding-out effect observed earlier with domestic financing. Investment in the nontraded sector (not shown in the figure) even turns positive for the first two years due to higher nontraded good demand. The investment multiplier is almost zero five years after the shock, compared to \(-0.85\) with domestic financing. Due to the much more positive

\(^{20}\)Rodrik (2008) finds empirical support that the real exchange rate has an important impact on traded good production hence growth in developing countries.
consumption responses of the hand-to-mouth, the consumption multiplier on impact rises from almost zero with domestic financing to 0.52 with external debt financing.

As the government spending effect wanes over time, the effects of fiscal adjustments dominant in later years. Like domestic debt financing, external borrowing also triggers higher income tax rates, exerting a negative influence on investment and nontraded output. As the government provides the debt service payment to foreign creditors, it leads to a small real depreciation starting year four, raising competitiveness of the traded good sector and its output.

Overall, government consumption is more expansionary with external than with domestic debt financing. A few caveats, however, are worth noting. Our analysis assumes a constant risk premium regardless of the debt level. Also, the thought experiment has the spending shock occur when the economy is in the steady state with relatively low government debt. When an economy is in a high-debt state, a debt-financed spending increase can prompt foreign creditors to demand a much higher premium. The magnitude of fiscal adjustments then has to be bigger to maintain debt sustainability. Under those circumstances, the negative effects of fiscal adjustments on output can offset further the expansionary effects of government consumption increases.²¹

4.1.3. External Financing: Aid. Another important source of external financing in LICs is aid from international donors. Figure 1 shows that the effects with aid financing (dashed lines) are similar to those with external debt financing (dotted-dashed lines) particularly in the short run. The main difference between these two financing methods comes from fiscal adjustments. Aid financing does not require subsequent repayments. Thus, the tax rate remains at the steady-state level. As savers do not anticipate higher future taxes, their consumption does not change much. In later years, investment with aid financing outperforms that with external debt financing because the income tax rate is lower. Among

²¹See Bi et al. (2013) for government spending effects when an economy is near its fiscal limits.
the three methods, the cumulative output multiplier is highest in the longer horizon with aid financing as persistent higher tax rates with either external or domestic debt financing keeps output below the steady state.

Like external debt, aid financing leads to substantial appreciation in the real exchange rate, lowering traded output. Spending aid domestically often raises the well-known concern of Dutch disease. Empirically, Rajan and Subramanian (2011) find that manufacturing production is negatively affected by aid inflows, as implied here by an aid-financed spending increase. In our specification, Dutch disease is a general equilibrium phenomenon that the real exchange rate appreciates to reallocate production factors from the traded to nontraded good sector to cope with higher nontraded good demand. If the loss of traded output is persistent, it is likely that Dutch disease can do actual damage to the traded good sector. Berg et al. (2010) captures this by learning-by-doing externality in the total factor productivity of the traded sector ($z^T$ in (13)). In that case, the loss in traded output induces productivity declines, generating a bigger and more persistent fall in traded output, reducing the overall output multipliers.

4.2. Twin Deficit Hypothesis. Our results that financing sources can matter for government spending multipliers have implications on the twin-deficit hypothesis for developing countries. In developed economies with high capital mobility, many factors, such as trade price elasticity (Erceg et al. (2005)) and non-Ricardian saving behaviors (Kumhof and Laxton (2009)) are found to be important for the co-movements between the two deficits. In an environment with limited capital mobility, the extent to which fiscal deficits are financed by external borrowing is crucial for the hypothesis to hold. As we have shown, the capital account does not move much along with the increase of government debt with domestic debt financing, but debt (due to fiscal deficits) and current account deficits both rise with external financing, consistent with the twin deficit hypothesis. We do not model exports
and imports separately here. Implicitly, with external financing higher domestic demand increases imports and the appreciated real exchange rate reduces exports, worsening the trade balance.

Ilzetzki et al.’s (2013) estimate for a large sample of developing countries find insignificant responses of current account balance to a government spending increase. Our finding provides a potential explanation why this may be the case. Since countries vary in capital mobility and in the shares of financing sources for each spending increase, the twin deficit hypothesis needs not hold for developing countries on average.

4.3. Sensitivity on Capital Mobility. So far, we have shown that domestic/external financing sources matter for government spending effects in the environment of limited capital mobility. The importance of accounting for financing sources, however, largely *vanishes* when capital mobility becomes high.

Figure 2 compares impulse responses for a government consumption shock (with the same size in Figure 1) with external debt financing across various capital account mobility: $v = 1000$ (baseline), $v = 0.01$, and $v = 0.0001$ representing the scenario of a nearly completely open capital account. With higher capital mobility, households counteract the government’s external borrowing, and the economy as a whole borrows less externally relative to limited mobility. An initial real appreciation from rising external public debt discourages households from borrowing externally because the marginal benefit of additional borrowing in units of local goods decreases. Since fewer resources are available for the domestic economy, government consumption with external financing has similar crowding-out effects as domestic debt financing, as shown in Figure 3 under $v = 0.0001$.

5. Public Investment Effects

Figure 4 plots the impulse responses with the three financing methods under the baseline calibration for a public investment increase equal to 1 percent of steady-state output at time
zero. Our analysis focuses on the role of investment efficiency and the degree of home bias in the multipliers for public investment.

Public investment spending differs from government consumption as it accumulates to public capital used in production. Within each financing method, the multipliers for public investment are slightly smaller in the short run but substantially bigger in later years as productive public capital builds up over time. Upon observing an increase in public investment, the negative wealth effect triggered by a government spending increase (as observed for a government consumption shock) is weakened because households expect more public capital, which would increase future production and income. Hence, consumption is more positive but investment is more negative compared to the effects of a government consumption increase. In later years, the productivity of private capital and labor increases because of more public capital, output of both sectors and hence consumption are higher relative to those for a government consumption shock. Despite a higher income tax rate, investment does not fall below the steady-state level, because the incentive to invest due to higher marginal product of private capital outweighs the disincentive from a higher tax rate on capital income.

From Figure 4, we see that various financing methods play a similar role here as for government consumption effects. Between domestic and external debt financing, private investment is crowded out more with domestic financing. Also, the public investment multipliers for output are bigger with the two external financing methods than with domestic financing.

5.1. **Investment Efficiency.** Despite that public capital has an annual rate of return to public capital at 25 percent in the steady state, Table 3 shows that the output multipliers for public investment in the long run are much below 1. The small output multiplier is due to low investment efficiency assumed in the baseline ($\epsilon = 0.4$). This section explores the importance of investment efficiency on public investment effects.
The thought experiment assumes that the marginal efficiency of public investment is higher than the steady-state efficiency level of 0.4; $\epsilon$ in (17) is replaced by $\epsilon_t$ such that

$$\epsilon_t = \bar{\epsilon} \left( \frac{G_t^I - G_t^I}{G_t^I} \right) + \epsilon \left( \frac{G_t^I}{G_t^I} \right), \text{ if } G_t^I > G_t^I,$$

where $\bar{\epsilon} = 0.8$ is the marginal investment efficiency. For example, Chinese investment in Africa becomes increasingly diversified to include utilities, ports, roads, bridges, etc. Many of these projects are collaborated as joint ventures between Chinese companies and governments and are likely to have higher investment efficiency than traditional infrastructure projects implemented by governments alone.

Between the domestic and external debt financing, a higher marginal efficiency increases the output especially in later years. In particular, the 10-year multiplier increases from 0.58 to 1.10 with external debt financing, and the long-run (20-year) cumulative output multiplier increases to 1.53 with external financing, close to the long-run output multiplier estimated by Ilzetzki et al. (2013) for the developing countries (without LICs included in the sample).

The powerful role of investment efficiency in raising the multiplier suggests that the key to enhance the growth effects of public investment in LICs is to improve investment efficiency. This involves raises institution capacity and governance quality to reduce mistakes in selecting and supervising projects, corruption, and supply bottlenecks. Also, analysis involves a one-time public investment shock. While the effects are long lasting, without continuous investment to replenish depreciated capital, public capital eventually returns to the initial steady-state level. To sustain the growth benefits of public investment, a permanent increase in public investment is required such that the economy can move to a new steady state with more public capital and output.

5.2. Home Bias in Public Investment. Another important factor in determining public investment multiplier, especially in the short run, is the degree of home bias in government purchases. The baseline assumes that both types of spending consist of 70 percent of non-traded goods ($\varphi^G = 0.7$). This assumption seems reasonable for overall spending in high
income countries. In LICs, however, many public investment projects largely rely on imports of material, equipments, and skilled labor. As a result, the degree of home bias in investment spending can be much lower than 0.7. We explore an alternative assumption that home bias in public investment is 0.4 and remains at 0.7 in government consumption.

To formalize this exercise, let \( \varphi^{GC} = 0.7 \) and \( \varphi^{GI} = 0.4 \) be the degrees of home bias in \( g^C_t \) and \( g^I_t \). Then, (16) is replaced with the following relative prices of government consumption and public investment to the CPI:

\[
p_t^{GC} = \left[ \varphi^{GC} (p_t^N)^{(1-\chi)} + (1 - \varphi^{GC}) (s_t)^{1-\chi} \right]^{1/(1-\chi)},
\]

\[
p_t^{GI} = \left[ \varphi^{GI} (p_t^N)^{(1-\chi)} + (1 - \varphi^{GI}) (s_t)^{1-\chi} \right]^{1/(1-\chi)}.
\]

Also, the term \( p_t^G (g^C_t + g^I_t) \) or \( p_t^G G_t \) in (15) and (25) is replaced by \( p_t^{GC} g^C_t + p_t^{GI} g^I_t \). Figure 5 compares short-run effects under \( \varphi^{GI} = 0.7 \) (baseline, solid lines) and the current specification \( \varphi^{GI} = 0.4 \) (dotted-dashed lines) with domestic and external debt financing.\(^{22}\)

When the degree of home bias is small, traded output outperforms nontraded output, opposite to the pattern under a higher degree of home bias. With domestic debt financing, higher government demand for traded goods leads to a real depreciation, generating positive responses of traded output, reversing the real appreciation in earlier analysis.\(^{23}\) Consistent with Penati (1987), government purchases that consist of more traded goods can generate a real depreciation. Overall, a lower degree of home bias in public investment introduces implies that a higher share of the demand from government spending increases is met by imports. Thus, it is less effective in promoting domestic production, and hence a smaller output multiplier. With external debt financing, the impact output multiplier under \( \varphi^{GI} = 0.4 \) is 0.21, compared to 0.40 under \( \varphi^{GI} = 0.7 \).

\(^{22}\) Short-run dynamics with aid financing are similar to external debt financing.

\(^{23}\) Empirically, whether a government spending increase results in a real depreciation or appreciation is inconclusive. Many empirical studies using data of developed countries find real depreciation (e.g., Kim and Roubini (2008) and Monacelli and Perotti (2010)). Ilzetzki et al. (2013) find a brief but significant real appreciation for the developing country sample.
6. Conclusion

Fiscal policy is an important policy instrument in LICs, both to counteract business cycles and to promote economic growth. Despite its importance, few efforts in the literature have been devoted to study fiscal policy effects in LICs. This paper constructs a DSGE model to study the government consumption and public investment effects in LICs. The framework takes into account LIC-specific features, including a large share of hand-to-mouth households, fairly limited international capital mobility in the private sector, and low public investment efficiency.

The analysis highlights several important factors for assessing fiscal multipliers in LICs. With limited capital mobility, domestic/external financing sources for government spending matter for either type of spending effects. The output multiplier is generally bigger with external than with domestic financing. External financing increases the resources available for the economy, mitigating the crowding-out effects of government spending. A large inflow of foreign exchange with external financing, however, appreciates the real exchange rate and reduces traded output. The general impression that capital scarcity in LICs renders public investment a large positive growth effect may not be readily delivered. While the return to public capital can be high, the output multiplier can still be much below one if investment efficiency is low. Public investment is also unlikely to deliver strong short-run stimulative effects from public investment scaling-up due to a relatively low degree of home bias in investment spending.

The model is currently calibrated to an average LIC. When a sufficient length of quarterly data becomes available, the model could be fitted to data to evaluate the quantitative importance of LIC features introduced here. Moreover, as we have shown that some parameters, such as public investment efficiency and the degree of home bias in government purchases, are crucial in determining the size of public investment multipliers, micro evidence or efforts in estimating for country-specific parameters, such as investment efficiency estimated
by Hurlin and Arestoff (2010) for Mexico and Colombia, would be important for applying
the model to evaluate country-specific spending effects.

**Appendix A. Optimality Conditions**

This appendix describes the equilibrium conditions for optimization problems of the house-
holds and firms. When solving the savers’ utility maximization problem, let \( \lambda^a_t \) be the La-
grangian multiplier for the budget constraint, and \( Q^N_t \) and \( Q^T_t \) be the Lagrangian multipliers
for the law of motion of capita in each sector. Then, Tobin’s Q for \( k_t^N \) and \( k_t^T \) are \( q^N_t \equiv \frac{Q^N_t}{X_t} \)
and \( q^T_t \equiv \frac{Q^T_t}{X_t} \).

Savers’ first order condition (FOC) for \( c^a_t \):

\[
\lambda^a_t = (c^a_t)^{-\sigma} \tag{A.1}
\]

Savers’ FOC for \( b^a_t \):

\[
\lambda^a_t = \beta E_t \left( \frac{\lambda^a_t R_t}{\pi_{t+1}} \right) \tag{A.2}
\]

Savers’ FOC for \( b^{hs,a}_t \):

\[
s_t \lambda^a_t \left[ 1 - v \left( b^{hs,a}_t - 1 \right) \right] = \beta E_t \left( \frac{\lambda^a_{t+1} s_{t+1} R^*}{\pi^*} \right) \tag{A.3}
\]

Savers’ FOC for \( m^a_t \):

\[
(m^a_t)^{-\xi} = \lambda^a_t - \beta \frac{\lambda^a_{t+1}}{\pi_{t+1}} \tag{A.4}
\]

Combining (A.3) with (A.4) yields

\[
(m^a_t)^{-\xi} = \lambda^a_t \left( \frac{R_t - 1}{R_t} \right) \tag{A.5}
\]

In its log-linearized form (denoted variables in percentage deviation from steady state by \( \hat{\cdot} \)),
the demand function for the real money balance is

\[
\hat{m}^a_t = \frac{\sigma}{\xi} \hat{c}^a_t - \frac{1}{\xi (R - 1)} \hat{R}_t, \quad \xi, \sigma > 0, R > 1, \tag{A.6}
\]

where \(-\frac{1}{\xi (R - 1)}\) is the interest elasticity for the demand of the real money balance.
Savers’ FOC for $l_t^a$:

$$(l_t^a)^\psi = \lambda_t^a w_t (1 - \tau_t) \quad (A.7)$$

Savers’ FOC for $k_t^N$:

$$q_t^N = \beta_t E_t \frac{\lambda_{t+1}^a}{\lambda_t^a} \left[ (1 - \tau_{t+1}) r_{t+1}^N - \frac{\kappa}{2} \left( \frac{i_{t+1}^N}{k_{t+1}^N} - \delta \right)^2 + \kappa \left( \frac{i_{t+1}^N}{k_{t+1}^N} - \delta \right) \left( \frac{i_{t+1}^N}{k_{t+1}^N} \right) + q_{t+1}^N (1 - \delta) \right] \quad (A.8)$$

Savers’ FOC for $k_t^T$:

$$q_t^T = \beta_t E_t \frac{\lambda_{t+1}^a}{\lambda_t^a} \left[ (1 - \tau_{t+1}) r_{t+1}^T - \frac{\kappa}{2} \left( \frac{i_{t+1}^T}{k_{t+1}^T} - \delta \right)^2 + \kappa \left( \frac{i_{t+1}^T}{k_{t+1}^T} - \delta \right) \left( \frac{i_{t+1}^T}{k_{t+1}^T} \right) + q_{t+1}^T (1 - \delta) \right] \quad (A.9)$$

Savers’ FOC for $i_t^N$

$$q_t^N = 1 + \kappa \left( \frac{i_{t-1}^N}{k_{t-1}^N} - \delta \right) \quad (A.10)$$

Savers’ FOC for $i_t^T$

$$q_t^T = 1 + \kappa \left( \frac{i_{t-1}^T}{k_{t-1}^T} - \delta \right) \quad (A.11)$$

Labor supplied to the traded good sector:

$$l_t^N = \phi_l \left( \frac{w_t^N}{w_t} \right)^{\chi^l} l_t \quad (A.12)$$

Labor supplied to the nontraded good sector:

$$l_t^T = \phi_l \left( \frac{w_t^T}{w_t} \right)^{\chi^l} l_t \quad (A.13)$$

The aggregate real wage rate:

$$w_t = \left[ \phi_l \left( \frac{w_t^N}{w_t} \right)^{1+\chi^l} + (1 - \phi_l) \left( \frac{w_t^T}{w_t} \right)^{1+\chi^l} \right]^{\frac{1}{1+\chi^l}} \quad (A.14)$$

Nontraded good firms’ FOC for $p_t^N$:

$$\Pi_t^N = \beta E_t \frac{\lambda_{t+1}^a}{\lambda_t^a} \left[ \Pi_{t+1}^N y_{t+1}^N y_t^N p_{t+1}^N p_t^N \right] + \frac{\theta}{\alpha^N \zeta (1 - \iota) (1 + u)} \frac{w_t^N l_t^N}{p_t^N y_t^N} + \frac{1 - \theta}{\zeta} \quad (A.15)$$

where $\Pi_t^N = \frac{\pi_t^N}{\pi_{t-1}^N} \left( \frac{\pi_t^N}{\pi_{t-1}^N} - 1 \right)$.
The capital-labor ratio of nontraded good production:

\[(1 - \alpha^N)w_t^N l_t^N = \alpha^N r_t^N k_{t-1}^N \quad \text{(A.16)}\]

Traded good firms’ FOC for \(l_t^T\):

\[w_t^T l_t^T = (1 - \iota) s_t \alpha^T y_t^T \quad \text{(A.17)}\]

Traded good firms’ FOC for \(k_t^T\):

\[r_t^T k_t^T = (1 - \iota) s_t (1 - \alpha^T) y_t^T \quad \text{(A.18)}\]
## Parameters and Values

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<tr>
<th>Parameter</th>
<th>Value</th>
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**Table 1.** Baseline Calibration and Some Steady-State Values
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Table 2. Cumulative multipliers for government consumption: baseline calibration.

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<td>0.00</td>
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<td>0.02</td>
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Table 3. Cumulative multipliers for public investment: baseline calibration.

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Table 4. Cumulative multipliers for public investment: higher efficiency with $\epsilon = 0.8$ for the investment increase.
Figure 1. **Impulse responses to a government consumption increase: baseline calibration.** The x-axis is in years. The y-axis is in percent deviation from the steady state unless noted in parentheses.
Figure 2. Government consumption effects under different capital mobility. The x-axis is in years. The y-axis is in percent deviation from the steady state. The size of the government consumption shock is the last figure.

Figure 3. Government consumption effects with nearly open capital account. The x-axis is in years. The y-axis is in percent deviation from the steady state.
Figure 4. Impulse responses to a public investment: baseline calibration. The x-axis is in years. The y-axis is in percent deviation from the steady state unless noted in parentheses.
Figure 5. Public investment effects with different degree of home bias. Solid lines assume $\varphi^{GC} = \varphi^{GI} = 0.7$ (baseline); dotted-dashed lines assume $\varphi^{GC} = 0.7$ and $\varphi^{GI} = 0.4$. The x-axis is in years. The y-axis is in percent deviation from the steady state unless noted in parentheses.
References
Bi, H., Shen, W., Yang, S.-C. S., 2013. Fiscal limits, external debt, and fiscal policy in developing countries. Manuscript, International Monetary Fund.


