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Capital mobility, public spending externalities and growth

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Abstract

I present a two-country dynamic model where (i) in each country public spending increases firm entry and (ii) capital is internationally mobile. I show that the difference between the aggregate output elasticity with respect to public spending and its firm level counterpart creates a positive cross-border externality in public spending. In contrast with the literature on cross-border spillovers, this externality arises only under fiscal competition between countries and may therefore lead to higher growth rates under strategic policies relative to coordination.

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1. Introduction

I present a two-country dynamic model where (i) in each country productive public spending increases firm entry and (ii) capital is internationally mobile. I show that under capital mobility the difference between the aggregate output elasticity with respect to public spending and its firm level counterpart creates a positive cross-border externality in public spending. In contrast with previous literature on cross-border spillovers from public spending, here the externality arises endogenously under fiscal competition between national governments. This has stark implications for the growth effects of fiscal policy coordination.

What is the role of public spending in open economies? What are the implications for international policy coordination? To answer such questions, starting with Alesina and Wacziarg (1999), the literature has extended the production function in Barro (1990) to allow for international spillovers, mainly motivated by the potential network effects derived from public infrastructure. For example, in Hashimzade and Myles (2010) public spending in one country increases the productivity of private capital in another country. In general such a positive externality implies public spending is too low and thus fiscal policy coordination can increase the growth rate. A more nuanced view emerges in Figuières *et al.* (2013) or Devereux and Mansoorian (1992) when in addition countries can strategically affect terms of trade.

While these contributions postulate the existence of technology based externalities in public spending, in this paper I show that international capital mobility induces strategic spending and thus a similar positive externality arises endogenously. However, given the externality stems directly from governments competing for private capital, coordinated policies maximizing joint welfare can lower balanced growth rates, in stark contrast to the results in the previous literature.

2. The Model

The world consists of two countries, $i = 1, 2$, with identical technologies and initial conditions. Countries are populated by unit mass identical, immobile, infinitely lived agents. In each country a benevolent government taxes income to fund public spending. Competitive firms produce a homogenous, costlessly tradable good taken to be the numeraire. This final good combines an endogenously determined range of intermediate goods supplied by monopolistically competitive firms using capital, labor and services stemming from the public good, provided at zero cost by the government. Private capital is perfectly mobile internationally but all household income can be taxed at source. Thus, higher domestic public spending can attract foreign capital whereas outright tax competition is excluded.

Households. An individual in country i solves:

$$U_i = \max_{c_{i,t}} \sum\nolimits_{t=0}^{\infty} \beta^t \ln c_{i,t} \text{ s.t. } a_{i,t+1} = (w_{i,t} + a_{i,t} r_t)(1 - \tau_{i,t}) - c_{i,t}, \tag{1}$$

where $\beta < 1$, $c_{i,t}$ denotes consumption, $a_{i,t}$ are the assets at the beginning of t, $w_{i,t}$ is the wage rate and r_t is the world before tax interest rate. Under full depreciation of capital, r_t equals the marginal product of capital q_t. Given prices and fiscal policy, households' optimal allocations are found using standard guess and verify (e.g. Glomm and Ravikumar 1994):

$$c_{i,t} = (1-\alpha\beta)(w_{i,t}+a_{i,t}r_t)(1-\tau_{i,t}), \quad (2)$$

$$a_{i,t+1} = \alpha\beta(w_{i,t}+a_{i,t}r_t)(1-\tau_{i,t}). \quad (3)$$

Production. Competitive firms in country i produce the final good using a range $v_{i,t}$ of intermediates $x_{j,i,t}$, $j \in (0, v_t)$:

$$Y_{i,t} = \left(\int_0^{v_{i,t}} x_{j,i,t}^{1-\sigma} dj\right)^{1/(1-\sigma)}, \quad (4)$$

where $\sigma \in [0,1]$ is the inverse of the elasticity of substitution between intermediate goods. Firms choose $x_{j,i,t}$ given prices $p_{j,i,t}$ to maximize profits $\Pi_{i,t} = Y_{i,t} - \int_0^{v_{i,t}} p_{j,i,t}x_{j,i,t}dj$. The corresponding demand functions are:

$$x_{j,i,t}(p_{j,i,t}) = p_{j,i,t}^{-1/\sigma} Y_{i,t}. \quad (5)$$

The intermediates $x_{j,i,t}$ are produced in a monopolistically competitive sector. Firms pay a fixed cost f every period to operate a constant returns technology in capital $k_{j,i,t}$ and labor $l_{j,i,t}$ and use services provided at no cost by the government:

$$x_{j,i,t} = G_{i,t}^{\delta} k_{j,i,t}^{\alpha} l_{j,i,t}^{1-\alpha}, \ 0 < \delta \leqslant \alpha < 1. \quad (6)$$

Each producer hires private inputs at given prices $w_{i,t}$ and $q_{i,t}$ to maximize profits:

$$\max_{l_{j,i,t},k_{j,i,t}} \pi_{i,t} = p_{j,i,t}x_{j,i,t}(p_{j,i,t}) - (w_{i,t}l_{j,i,t} + q_{i,t}k_{j,i,t}) - f \text{ s.t. (5)}. \quad (7)$$

Solving (7) yields:

$$w_{i,t} = (1-\sigma)(1-\alpha)\frac{p_{j,i,t}x_{j,i,t}}{l_{j,t}}, \quad (8)$$

$$q_{i,t} = (1-\sigma)\alpha\frac{p_{j,i,t}x_{j,i,t}}{k_{j,i,t}}. \quad (9)$$

Under free entry, substituting (8) and (9) into the profit function (7) yields $f = \sigma p_{j,i,t}x_{j,i,t}$. In a symmetric equilibrium $x_{j,i,t} = x_{i,t}$, $p_{j,i,t} = p_{i,t}$, $\forall j \in (0, v_{i,t})$ and thus:

$$Y_{i,t} = v_{i,t}^{1/(1-\sigma)} x_{i,t}, \quad (10)$$

which, combined with (5), yields $p_{i,t} = v_{i,t}^{\sigma/(1-\sigma)}$. Substituting the latter into the demand (5) yields the equilibrium intermediate input $x_{i,t} = f v_{i,t}^{-\sigma/(1-\sigma)}/\sigma$. Using this in (10) yields $Y_{i,t} = f v_{i,t}/\sigma$. Given unit labor supply, in equilibrium $k_{j,i,t} = K_{i,t}/v_{i,t}$ and $l_{j,i,t} = 1/v_{i,t}$ where $K_{i,t}$ is the aggregate stock of capital in country i. Using these allocations in the production function for $x_{i,t}$ (6) yields $v_{i,t} = \left(\sigma G_{i,t}^{\delta} K_{i,t}^{\alpha}/f\right)^{(1-\sigma)/(1-2\sigma)}$.

Denoting $z = (\sigma/f)^{\frac{\sigma}{1-2\sigma}}$, $\eta = \delta(1-\sigma)/(1-2\sigma)$, $\phi = \alpha(1-\sigma)/(1-2\sigma)$ output becomes:

$$Y_{i,t} = zG_{i,t}^{\eta} K_{i,t}^{\phi}. \quad (11)$$

Factor incomes (8) and (9) are then given by:

$$w_{i,t} = (1-\sigma)(1-\alpha)Y_{i,t} \text{ and } q_{i,t} = (1-\sigma)\alpha Y_{i,t}/K_{i,t}. \tag{12}$$

Assumption 1. $\eta + \phi \leqslant 1$.

If $\eta + \phi = 1$ there are constant returns to scale in reproducible inputs and balanced growth is feasible. Substituting the expressions for η and ϕ, assumption 1 implies $\sigma \leqslant (1-\alpha-\delta)/(2-\alpha-\delta) < 1/2$. This also ensures that the number of intermediate goods increases with the stock of capital. In equilibrium the aggregate output elasticity with respect to public spending is higher than the firm level counterpart ($\eta > \delta$), due to the indirect effect of the public spending on the entry in the intermediate goods sector and hence on the variety of such goods produced in equilibrium.[1]

Governments. Governments use an income tax to fund public spending. Budget constraint at t is

$$\tau_{i,t}(w_{i,t} + r_t a_{i,t}) = G_{i,t+1}. \tag{13}$$

The government is benevolent in the sense that it maximizes the utility of the representative domestic household. Given private income and the tax rate, the budget constraint defines public spending, so public policy is summarized by $\tau_{i,t}$.

World capital market clearing. Denote world aggregate variables as $X_t = \sum_{i=1}^{2} X_{i,t}$, for $X = \{Y, K, G, c, a\}$. World capital market clearing implies that saving equals the aggregate stock of capital:

$$K_t = a_t. \tag{14}$$

A competitive capital market and full depreciation further imply the return on assets is equal to the international marginal product of capital:

$$r_t = q_t. \tag{15}$$

Finally, aside from σY_t entry costs, the world aggregate resource constraint is:

$$(1-\sigma)Y_t = C_t + K_{t+1} + G_{t+1}. \tag{16}$$

The (endogenous) public spending externality. Under capital mobility, (11) implies the marginal product of capital can be affected by fiscal policy: governments choose $G_{i,t}$ strategically to attract private investment given the policy of the other government. In order to focus on the interplay between public spending across countries I further assume income taxation is residence based so the tax competition channel is shut down.

With residence based capital taxation, the pre-tax return r_t is equalized across countries:

$$\frac{G_{1,t}^{\eta}}{K_{1,t}^{1-\phi}} = \frac{G_{2,t}^{\eta}}{K_{2,t}^{1-\phi}}. \tag{17}$$

[1] See Chakraborty and Dabla-Norris (2011) for a more detailed discussion about the difference between the macro and the micro level output elasticity with respect to public spending in this context.

Rewriting (17) yields the equilibrium allocation of capital across countries:

$$K_{i,t} = g_{i,t} K_t, \text{ where } g_{i,t} = G_{i,t}^{\frac{\eta}{1-\phi}} \left(\sum\nolimits_{i=1}^{2} G_{i,t}^{\frac{\eta}{1-\phi}} \right)^{-1}. \tag{18}$$

where K_t is the world stock of capital. Intuitively, the stock of capital installed in each country depends on its share in total public spending and the world capital stock. This relationship summarizes the fiscal competition among countries in each period.

Next, I define a competitive equilibrium, given fiscal policies.

Definition 1. *Given tax rates $\tau_{i,t}$ and initial conditions $a_{i,0}, G_{i,0}$, $i = 1, 2$, the competitive equilibrium is a sequence of allocations $\{c_{i,t}, a_{i,t+1}\}_{t=0}^{\infty}$, aggregate variables $\{K_{i,t+1}, G_{i,t+1}\}_{t=0}^{\infty}$, and prices $\{w_{i,t}, r_t\}_{t=0}^{\infty}$ such that households and firms behave optimally and markets clear.*

Substituting optimal allocations (2) in the household objective function (1) results in the indirect utility function:

$$W_i = \sum\nolimits_{t=0}^{\infty} \beta^t \ln \left[(1 - \alpha\beta)(w_{i,t} + a_{i,t} r_t)(1 - \tau_{i,t}) \right], \tag{19}$$

where assets are given by (3) and prices by (12) and (15).

3. Strategic vs. Coordinated Policies

Under strategic policies, governments choose national policies independently in order to maximize the utility of domestic agents given the policies in the other country:

$$V_i^S = \max_{\tau_{i,t}} \; W_i \text{ s.t. } \tau_{i,t}(w_{i,t} + a_{i,t} r_t) = G_{i,t+1}, \tag{20}$$

given optimal private decision rules (2), (3), market prices (12), the equalization of the returns to capital (17) and taking $a_{j,t}$, $\tau_{j,t}$, $G_{j,t}$, $j \neq i$ as given.

Definition 2. *(Strategic policies) Starting with identical initial conditions, a symmetric Markov perfect equilibrium path is a set of sequences $\left\langle \left\{ \tau_{i,v}^S(a_{i,v}) \right\}_{v=t}^{\infty} \right\rangle$, $i = 1, 2$ such that $\forall t \geqslant 0$ government i chooses $\tau_{i,t}$ to solve (20) given domestic households and firms behave optimally and taking as given current and future policies in the other country, $\tau_{j,l}^S, j \neq i, l \geqslant t$.*

Focusing on symmetric equilibria, the capital stock is equal across countries and $K_{i,t} = K_t/n = a_{i,t}$. Using standard value function tools, equilibrium policies, derived in appendix, are:

$$\tau_{i,t}^S = \tau^S = \frac{\beta\eta M \left(\frac{1-\alpha}{1-\phi} \left(1 - \frac{\phi}{2} \right) + \frac{\alpha}{2} \right)}{1 + \beta M \left(\frac{\phi+\alpha}{2} \right) + \beta\eta M \left(\frac{1-\alpha}{1-\phi} \left(1 - \frac{\phi}{2} \right) + \frac{\alpha}{2} \right)}, \tag{21}$$

where $M = (1 - \beta(\eta + \phi))^{-1}$. $G_{i,t+1}$ is given by (13) and $a_{i,t+1}$ by (3).

In contrast to strategic policies, under coordination, a planner maximizes the utilities of representative agents in the two countries, subject to the relevant budget constraints:

$$V^C = \max_{\tau_{1,t}, \tau_{2,t}} W_1 + W_2 \text{ s.t. } \tau_{i,t}(w_{i,t} + a_{i,t} r_t) = G_{i,t+1}, i = 1, 2 \tag{22}$$

Definition 3. *(Coordinated policies) Starting with identical initial conditions, a symmetric Markov perfect equilibrium path is a set of sequences* $\left\langle \left\{ \tau_{i,v}^{C}(a_{i,v}) \right\}_{v=t}^{\infty} \right\rangle$, $i = 1, 2$ *such that* $\forall t \geqslant 0$ *a planner chooses* $\tau_{i,t}, i = 1, 2$ *to solve (22) given budget constraints (13) and optimal decision rules of households and firms in both countries.*

As before, in a symmetric equilibrium $K_{i,t} = K_t/n = a_{i,t}$, while policies, derived in appendix, are:

$$\tau_{i,t}^{C} = \tau^{C} = \beta\eta. \tag{23}$$

Note that coordinated policies replicate the closed economy case derived in Glomm and Ravikumar (1994).

Proposition 1. *Under strategic policies, governments set higher public spending and tax rates than under coordination.*

Proof. Under Assumption 1, $(1-\sigma)/(1-2\sigma) > 1$ and thus $\phi = \alpha(1-\sigma)/(1-2\sigma) > \alpha$. This implies $D = (1-\alpha)/(1-\phi)(1-\phi/2) + \alpha/2 > 1$. Next, $\tau_{i,t}^{S} > \tau_{i,t}^{C} \Leftrightarrow MD > 1 + \beta M(\phi+\alpha)/2 + \beta M\eta D \Leftrightarrow D > 1 > 1 - \beta(\phi-\alpha)/(2(1-\beta\eta))$. From (13), $G_{i,t}^{S} > G_{i,t}^{C}$. □

Proposition 1 shows that capital mobility increases the role of public spending as countries compete to attract capital. This is in sharp contrast with models of exogenous externalities in public spending and immobile capital where governments free-ride by spending less.

The distinction between η and δ, the aggregate and respectively the firm level output elasticity with respect to public spending is critical for the results. Recall that $\eta = \delta(1-\sigma)/(1-2\sigma)$ where σ is the inverse of the elasticity of substitution between intermediate goods. Thus, if intermediate goods in (4) are perfect substitutes ($\sigma = 0$) the two elasticities are equal i.e. $\phi = \alpha$ and $\eta = \delta$. In this case strategic and coordinated tax rates are also equal, i.e. $\tau^{S} = \tau^{C} = \beta\delta$, as the wage and the interest rate effects of public spending exactly offset each other. Moreover, complementarity between intermediate goods increases with σ.[2] Thus, if $\sigma > 0$ ($\phi > \alpha$ and $\eta > \delta$), a public spending externality arises in each country irrespective of policy regime since higher entry due to public spending increases productivity in the final goods sector. National governments correct this externality via taxation under both coordinated and strategic policies (the term $\beta\eta$ in both τ^{C} and τ^{S}). On top of this however, in the case of strategic policies, capital mobility generates a cross-border externality, as higher public spending also attracts capital from the other country. By definition, coordinated policies correct this second externality. Thus $\tau^{S} > \tau^{C}$.

4. Growth Effects

In this section I compare the balanced growth paths that arise under strategic vs. coordinated policies.

Proposition 2. *Let* $\eta + \phi = 1$. *On a balanced growth path, strategic fiscal policies yield higher growth rates relative to coordination if* β *is low enough.*

[2] Recall assumption 1 implies $\sigma \leqslant (1-\alpha-\delta)/(2-\alpha-\delta) < 1/2$.

Proof. First, $\eta + \phi = 1$ imposes constant returns in reproducible factors and thus a constant growth rate. Substituting (13) and (3), the laws of motion for public and private capital respectively, into the production function (11) yields the output growth rate $g_y(\tau) = \tau^{1-\phi}(1-\tau)^{\phi}$. This is maximized at $\tau^* = 1 - \phi$. Next, using $D = (1-\alpha)/(1-\phi)(1-\phi/2) + \alpha/2 > 1$, $\tau^S < \tau^* \Leftrightarrow \beta M D < 1 + \beta M(\phi + \alpha)/2 + \beta M(1-\phi)D \Leftrightarrow \beta < \beta^* = 1/(1+\phi D - (\phi+\alpha)/2) < 1$ as $\phi D - (\phi + \alpha)/2 = (\phi - a)/(2(1-\phi)) > 0$. This is a sufficient condition since $g_y(\tau^S) > g_y(\tau^C)$ also for some τ^S such that $\tau^C < \tau^* < \tau^S$.[3]

□

On the one hand, public spending increases productivity. On the other hand, it is funded with taxes that lower capital accumulation. Intuitively, proposition 2 states that competition in public spending can deliver higher growth rates than coordinated policies if the productivity boosting effect of public spending is large relative to private capital accumulation. As shown in proposition 1, capital mobility generates under fiscal competition an additional cross-border externality that complements the existing local externalities in public spending. If β is low, private capital accumulates slowly and thus, the extra public spending arising under competition implies higher growth rates for output.

5. Concluding Remarks

The paper presented a model where public spending raises domestic productivity by increasing firm entry. Capital mobility magnifies this local externality leading to a race to the top in public spending and thus to an endogenous cross-border externality. Therefore, in contrast to the literature studying exogenous cross-border externalities, I find that strategic policies result in more public spending, higher taxes and possibly higher growth rates relative to coordination.

While results were derived under particular functional forms, the discussion suggests similar effects would arise as long as the local and the international public spending externalities are reinforcing each other. Given space constraints, a more general analysis of the links between capital mobility and different types of externalities arising from public spending as well as other fiscal policies is left for future research.

References

Alesina, A. and R. Wacziarg (1999) "Is Europe Going too Far?" *Carnegie-Rochester Conference Series on Public Policy* **51,** 1–42.

Barro, R. J. (1990) "Government Spending in a Simple Model of Endogenous Growth" *Journal of Political Economy* **98**, S103-26.

Chakraborty, S. and E. Dabla-Norris (2011) "The Quality of Public Investment" *The B.E. Journal of Macroeconomics* **11**, 1–29.

Devereux, M. and A. Mansoorian (1992). "International Fiscal Policy Coordination and Economic Growth" *International Economic Review* **33**, 249–68.

Figuières, C., F. Prieur, and M. Tidball (2013) "Public Infrastructure, Non-cooperative Investments, and Endogenous Growth" *Canadian Journal of Economics* **46**, 587–610.

[3] When $\phi + \eta < 1$, a similar condition can be derived for ranking transitional growth rates. Conditional on current stocks, $g_{yi}(\tau^S_{i,t}) > g_{yi}(\tau^C_{i,t}) \Leftarrow \beta < 1/((1-\alpha)/(1-\phi) - 1/2 + \eta + \phi) > 0$ since $(1-\alpha)/(1-\phi) > 1$.

Glomm, G. and B. Ravikumar (1994). "Public Investment in Infrastructure in a Simple Growth Model" *Journal of Economic Dynamics and Control* **18**, 1173–1187.

Hashimzade, N. and G. D. Myles (2010) "Growth and Public infrastructure", *Macroeconomic Dynamics* **14**(Supple), 258-274.

Appendix

Derivation of strategic tax rates. Given $a_{i,0}, G_{i,0}$, denote $t+1$ variables with a prime ($\prime$), drop time subscripts for variables at t, denote household income with $I_i = w_i + a_i r$ and recast (20) as the following value function problem:

$$V(I_i) = \max_{\tau_i} \{\ln c_i(I_i) + \beta V(I_i')\}$$

subject to (3) and (13) and guess $V(I_i) = M \ln I_i$. Taking the first order condition yields:

$$\frac{1}{1-\tau_i} = \frac{\beta M}{I_i'}\left(\left(\frac{\partial w_i'}{\partial G_i'} + a_i'\frac{\partial r'}{\partial G_i'}\right)\frac{\partial G_{i,}'}{\partial \tau_i} + \frac{\partial w_i'}{\partial \tau_i} + a_i'\frac{\partial r'}{\partial \tau_i} + r'\frac{\partial a_i'}{\partial \tau_i}\right). \tag{A.1}$$

In a symmetric equilibrium $I_i = (1-\sigma)Y_i, a_i = K_i = K/2$ and:

$$\begin{aligned}\frac{\partial w_i'}{\partial G_i'} &= (1-\sigma)z\eta\frac{Y_i'}{G_i'}\frac{(1-\alpha)}{1-\phi}\frac{2-\phi}{2}, \frac{\partial r'}{\partial G_i'} = (1-\sigma)z\eta\frac{\alpha}{2K_i'}\frac{Y_i'}{G_i'}, \\ \frac{\partial G_i'}{\partial \tau_i} &= (1-\sigma)Y_i, \frac{\partial a_i'}{\partial \tau_i} = -\alpha\beta(1-\sigma)Y_i.\end{aligned} \tag{A.2}$$

Substituting (A.2), (3) and (13) into (A.1) and simplifying yields (21). Substituting optimal policies into $V(I_{i,t})$ and matching terms yields $M = 1/(1-(\beta+\phi))$.

Derivation of cooperative tax rates. Given $a_{i,0}, G_{i,0}, a_{j,0}, G_{j,0}$, (22) is rewritten as:

$$V(I_i, I_j) = \max_{\tau_i,\tau_j}\left\{\ln c_i(I_i) + \ln c_j(I_j) + \beta V(I_i', I_j')\right\}$$

subject to (3) and (13), $i = 1, 2$. Next, guess $V(I_i, I_j) = M_i \ln I_i + M_j \ln I_j$. Focusing on τ_i:

$$\frac{1}{1-\tau_i} = \beta\left(\sum_{l=1}^{2}\frac{M_l}{I_l'}\left(\frac{\partial w_l'}{\partial G_i'} + a_l'\frac{\partial r'}{\partial G_i'}\right)\frac{\partial G_{i,}'}{\partial \tau_i} + \sum_{l=1}^{2}\frac{M_l}{I_l'}\left(\frac{\partial w_l'}{\partial \tau_i} + a_l'\frac{\partial r'}{\partial \tau_i}\right) + r'\frac{M_i}{I_i'}\frac{\partial a_i'}{\partial \tau_i}\right). \tag{A.3}$$

The additional effect on wages in country $j \neq i$, $\partial w_j'/\partial G_i'$ becomes, in a symmetric equilibrium:

$$\frac{\partial w_j'}{\partial G_i'} = (1-\sigma)z\eta\frac{Y_i'}{G_i'}\frac{(1-\alpha)\phi}{2(1-\phi)}. \tag{A.4}$$

As before, substituting (A.4), (A.2), (3) and (13) into (A.3) and simplifying yields (23) where $M_i = M_j$ are found similarly to above.