Dynamic fiscal competition: a political economy theory - (online) supplementary appendix*

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Abstract

The online appendix includes: I) A description of the political economy mechanism, II) The detailed derivation of equilibrium policy functions, III) An extension to public spending in the utility, IV) A two-period version of the model extended to include source based taxation and therefore direct tax competition.

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Appendix I Political economy mechanism

This section presents in some detail the probabilistic voting model (Lindbeck and Weibull (1987), Persson and Tabellini (2000)). In country i, the population consists of two groups of voters, the young and the old, of unit measure each. Every period an electoral competition takes place between two office-seeking candidates A and B, where each candidate announces the vector of fiscal policies $\Theta_{i,t} = (\tau^L_{i,t}, \tau^K_{i,t}, G_{i,t}, B_{i,t+1})$ subject to the budget constraint $B_{i,t+1} + \tau^L_{i,t} w_t + \tau^K_{i,t} R_t s_{i,t-1} = G_{i,t} + R_t B_{i,t}$. Since the input prices are functions of the allocation of capital across countries $K_{i,t}$ all policies $\Theta_{i,t}$ are functions of the initial level of saving and debt in all countries $s_{j,t-1}, B_{jt},\ j \in \{1, 2, ...n\}$ as well as policies $\Theta_{j,t}$ in the other countries and which are taken as given. Also, due to repeated elections, candidates cannot commit over future fiscal policies. Nonetheless, they can influence policies chosen by future governments by setting current policies which in turn affect the future state of the economy $s_{j,t}, B_{jt+1}$. In the following, country subscripts are dropped whenever possible to save on notation.

Voters in each group are characterized by an individual level parameter that summarizes their bias towards a specific candidate. These parameters are drawn from a group specific symmetric distribution, which for simplicity is assumed uniform.

Thus, the young voter l will vote candidate A if:

$$u^{l,y}_t(\Theta^A_t) > u^{l,y}_t(\Theta^B_t) + \sigma^{l,y} + \delta,$$

where $u^{l,y}_t(\Theta^X_t) = \ln c^y_t(\Theta^X_t) + \beta \ln c^o_{t+1}(\Theta^X_t)$ represents the lifetime welfare of a young agent born at t when policies are those proposed by $X = \{A, B\}$. The idiosyncratic preference shock $\sigma^{l,y}$ is uniformly distributed on the support $[-1/(2\phi^y), 1/(2\phi^y)]$.

Similarly, the old voter l at t prefers candidate A if:

$$u^{l,o}_t(\Theta^A_t) > u^{l,o}_t(\Theta^B_t) + \sigma^{l,o} + \delta,$$

where $u^{l,o}_t(\Theta^X_t) = \ln c^o_t(\Theta^X_t)$ and $\sigma^{l,o}$ is uniformly distributed on the support $[-1/(2\phi^o), 1/(2\phi^o)]$.

Finally, δ is an aggregate shock drawn from the uniform distribution with support $[-1/(2\psi), 1/(2\psi]$, known after policies have been announced and representing the ex-post average bias in favor candidate B.

Within each group, the marginal voters are characterized by:

$$\begin{aligned}\sigma^y(\Theta_t^A, \Theta_t^B) &= u_t^{l,y}(\Theta_t^A) - u_t^{l,y}(\Theta_t^B) - \delta, \text{ and} \\ \sigma^o(\Theta_t^A, \Theta_t^B) &= u_t^{l,o}(\Theta_t^A) - u_t^{l,y}(\Theta_t^B) - \delta.\end{aligned}$$

The corresponding vote shares for A and B are, conditional on δ :

$$\pi^A(\Theta_t^A, \Theta_t^B \,|\delta\,) = 1 - \pi^B(\Theta_t^A, \Theta_t^B \,|\delta\,) =$$

$$\begin{aligned}&= \frac{1}{2}\phi^y\left(\sigma^y(\Theta_t^A, \Theta_t^B) + \frac{1}{2\phi^y}\right) + \frac{1}{2}\phi^o\left(\sigma^o(\Theta_t^A, \Theta_t^B) + \frac{1}{2\phi^o}\right) \\ &= \frac{1}{2} + \frac{1}{2}\left(\phi^y\left(u_t^y(\Theta_t^A) - u_t^y(\Theta_t^B) - \delta\right)\right) + \frac{1}{2}\left(\phi^o\left(u_t^o(\Theta_t^A) - u_t^0(\Theta_t^B) - \delta\right)\right).\end{aligned}$$

Candidate A's probability to win the elections is thus:

$$\begin{aligned}p_A &= \Pr[\pi^A > 1/2] = \\ &= \Pr[\delta < \chi(u_t^y(\Theta_t^A) - u_t^y(\Theta_t^B) + (1-\chi)(u_t^o(\Theta_t^A) - u_t^o(\Theta_t^B)] \\ &= \frac{1}{2} + \psi\chi(u_t^y(\Theta_t^A) - u_t^y(\Theta_t^B) + \psi(1-\chi)(u_t^o(\Theta_t^A) - u_t^o(\Theta_t^B),\end{aligned}$$

where $\chi = \phi^y/(\phi^y + \phi^o)$.

It can be shown that in a Nash equilibrium, platforms announced by the two candidates converge to the policies that maximize the weighted average utility of the young and the old:

$$\Theta_t^{A*} = \Theta_t^{B*} = \arg\max_{\Theta_t}\left\{\chi u_t^y(\Theta_t) + (1-\chi)u_t^o(\Theta_t)\right\},$$

subject to the budget constraint. The parameter χ can be interpreted as a measure of political sensitivity to fiscal policies.

Appendix II Equilibrium policy functions

Strategic policies:

$$\max_{\Theta_{i,t}}\{U_{i,t}+\mu_{i,t}\left[B_{i,t+1}-R_tB_{i,t}-G_{i,t}+w_{i,t}\tau^L_{i,t}+s_{i,t-1}R_t\tau^K_{i,t}\right]\}$$

The solution of the non-cooperative game is found solving the game backwards.[1] Assume a terminal period of the economy T. The economy is characterized by the aggregate stock of capital K_T and the savings and bonds in each country: $s_{i,T-1}, B_{i,T}$. Since T is assumed to be the last period of the economy, no bonds are issued hence $B_{i,T+1}=0$ and young households consume their entire income, so $s_{i,T}=0$. Taxes in T are set to finance the repayment of outstanding debt, $R_TB_{i,T}$ and current public spending $G_{i,T.}$

Public policies are linked through the contemporaneous capital market, described by (9). Since the old age welfare of the agents that are young at T does not matter, the government's problem in country i is linked to the choices of the other governments only through the current fiscal competition in public spending.

Consumption flows at T are:

$$c^y_T=w_{i,T}(1-\tau^L_{i,T})=\alpha Y_T(1-\tau^L_{i,T});c^o_T=s_{i,T-1}R_T(1-\tau^K_{i,T}).$$

The government maximizes:

$$\max_{G_{i,T},\tau^L_{i,T},\tau^K_{i,T}}\{\chi\ln[w_{i,T}(1-\tau^L_{i,T})]+(1-\chi)\ln[s_{i,T-1}R_T(1-\tau^K_{i,T})]$$
$$+\mu_{i,T}\left[-R_TB_{i,T}-G_{i,T}+w_{i,T}\tau^L_{i,T}+s_{i,T-1}R_T\tau^K_{i,T}\right]\},$$

given the state variables $\{K_T,B_{i,T},s_{i,T-1}\}$, $i=\{1,2,...n\}$ and policies chosen by other governments. Finally, $\mu_{i,T}$ is the Lagrange multiplier associated with the budget constraint of country i.

[1] See Klein et al. (2008) refered in the main text for a similar solution technique.

Taking the first order conditions yields:

$$\tau^L_{i,T} : -\frac{\chi}{1-\tau^L_{i,T}} + \mu_{i,T} w_{i,T} = 0, \tag{II.1}$$

$$\tau^K_{i,T} : -\frac{1-\chi}{1-\tau^K_{i,T}} + \mu_{i,T} s_{i,T-1} R_T = 0, \tag{II.2}$$

$$G_{i,T} : \left(\frac{\chi}{w_{i,T}} + \mu_{i,T}\tau^L_{i,T}\right)\frac{\partial w_{i,T}}{\partial G_{i,T}} + \tag{II.3}$$

$$+\left(\frac{1-\chi}{R_T} - \mu_{i,T} B_{i,T} + \mu_{i,T} s_{i,T-1}\tau^K_{i,T}\right)\frac{\partial R_T}{\partial G_{i,T}} - \mu_{i,T} = 0.$$

The output expression (5) can be used to rewrite prices to reflect the interdependency between national policy choices by:

$$w_{i,T} = (1-\sigma)(1-\alpha)Y_{i,T} = (1-\sigma)(1-\alpha)zG_{i,T}^{\frac{\eta}{1-\phi}}\left(\sum_{j=1}^{n} G_{j,T}^{\frac{\eta}{1-\phi}}\right)^{-\phi} K_T^{\phi}, \tag{II.4}$$

$$q_T = R_T = (1-\sigma)\alpha\frac{Y_{i,T}}{K_{i,T}} = (1-\sigma)\alpha z\left(\sum_{j=1}^{n} G_{j,T}^{\frac{\eta}{1-\phi}}\right)^{1-\phi} K_T^{-1+\phi}, \tag{II.5}$$

Using these expressions to compute the marginal effect of domestic public spending yields:

$$\frac{\partial w_{i,T}}{\partial G_{i,T}} = \frac{(1-\sigma)(1-\alpha)z\eta}{1-\phi}\frac{G_{i,T}^{\frac{\eta}{1-\phi}-1}\left(\sum_{j=1}^{n} G_{j,T}^{\frac{\eta}{1-\phi}} - \phi G_{i,T}^{\frac{\eta}{1-\phi}}\right)}{\left(\sum_{j=1}^{n} G_{j,T}^{\frac{\eta}{1-\phi}}\right)^{\phi+1}} K_T^{\phi}, \tag{II.6}$$

$$\frac{\partial R_T}{\partial G_{i,T}} = (1-\sigma)\alpha z\eta\frac{G_{i,T}^{\frac{\eta}{1-\phi}-1}}{K_T}\left(\sum_{j=1}^{n} G_{j,T}^{\frac{\eta}{1-\phi}}\right)^{-\phi} K_T^{\phi}. \tag{II.7}$$

Under symmetry (II.6), (II.7) and (II.26) become:

$$\frac{\partial w_{i,T}}{\partial G_{i,T}} = \frac{(1-\sigma)(1-\alpha)z\eta}{1-\phi}\left(\frac{K_T}{n}\right)^{\phi} G_{i,T}^{\eta-1}\left(1-\frac{\phi}{n}\right), \tag{II.8}$$
$$\frac{\partial R_T}{\partial G_{i,T}} = (1-\sigma)\alpha z\eta\frac{1}{K_T}\left(\frac{K_T}{n}\right)^{\phi} G_{i,T}^{\eta-1},$$

and $K_{i,T} = K_T/n$, $s_{i,T-1} = S_{T-1}/n$ and $B_{i,T} = B_T/n$. Using these expressions in the first order conditions (II.1)-(II.3), together with the capital market clearing condition (15) yields the optimal policies at T:

$$\tau_{i,T}^{L} = 1-\frac{\chi\left(z(1-\sigma)-c^{s}\right)}{z(1-\alpha)(1-\sigma)}, \tag{II.9}$$
$$\tau_{i,T}^{K} = 1-\frac{(1-\chi)\left(z(1-\sigma)-c^{s}\right)}{z\alpha(1-\sigma)}\frac{s_{i,T-1}-B_{i,T}}{s_{i,T-1}}, \tag{II.10}$$
$$G_{i,T} = \left(c^{s}\right)^{\frac{1}{1-\eta}}\left(\frac{K_T}{n}\right)^{\frac{\phi}{1-\eta}}, \tag{II.11}$$

where $z = (\sigma/f)^{\frac{\sigma}{1-2\sigma}}$ is a constant depending on parameters and:

$$c^{s} = (1-\sigma)z\eta\left(\frac{1-\alpha}{1-\phi}\left(1-\frac{\phi}{n}\right)+\frac{\alpha}{n}\right).$$

Then, $Y_{i,T} = z\left(c^{s}\right)^{\frac{\eta}{1-\eta}}\left(\frac{K_T}{n}\right)^{\frac{\phi}{1-\eta}}$. Using the above allocations in the government budget constraint yields the shadow value of relaxing the government budget constraint at T:

$$\mu_{i,T} = 1/\left(Y_{i.T}(1-\sigma)-G_{i,T}\right). \tag{II.12}$$

At time $T-1$, the government takes as given the optimal policy rules in T (i.e. anticipates the reaction of next period government to current policies) and the state of the economy at $T-1$ given by $\{K_{T-1}, s_{i,T-2}, B_{i,T-1}\}$. Now, the maximization problem includes the old-age welfare of the agents that are young at T.

$$\max_{\substack{\tau_{i,T-1}^{L},\tau_{i,T-1}^{K}\\ G_{i,T-1},B_{i,T}}} \left\{\chi\ln c_{T-1}^{y}+\chi\beta\ln c_{T}^{o}+(1-\chi)\ln c_{T-1}^{o}\right\} \tag{II.13}$$

Again, prices are given by expressions (6) and (7) with the time index adjusted properly. Moreover, countries interact through the aggregate capital stock K_T :

$$K_T = \sum_{i=1}^{n} (s_{i,T-1} - B_{i,T}). \tag{II.14}$$

As opposed to the fiscal competition channel, this is a dynamic externality, due to capital accumulation. Young agents in period $T-1$ save for the old age and their welfare at T depends on the interest rate R_T which in turn depends on the (strategic) policies implemented at T and $T-1$ in all countries. The private policy function for savings is:

$$s_{i,T-1} = \frac{\beta}{1+\beta}(1-\sigma)(1-\alpha)Y_{i,T-1}$$

Also, using the terminal period capital tax policy in the utility of the old agents at T yields their consumption flow anticipated at $T-1$:

$$s_{i,T-1} R_T (1 - \tau_{i,T}^K) = (1-\chi)/\mu_{i,T}.$$

Thus, using (II.12) and (II.14) the marginal change in the future welfare of this group from a change in public spending at $T-1$ is:

$$\begin{aligned} \frac{\partial \mu_{i,T}}{\partial G_{i,T-1}} &= \frac{\partial \mu_{i,T}}{\partial K_T} \frac{\partial K_T}{\partial s_{i,T-1}} \frac{\partial s_{i,T-1}}{\partial w_{i,T-1}} \frac{\partial w_{i,T-1}}{\partial G_{i,T-1}} = \\ & \left(- \frac{\phi}{1-\eta} \right) \frac{\mu_{i,T}}{K_T} 1 \frac{\beta}{1+\beta} \frac{\partial w_{i,T-1}}{\partial G_{i,T-1}}. \end{aligned}$$

Using again (II.12) and (II.14), the corresponding change from an extra unit of public debt issued at $T-1$ is:

$$\frac{\partial \mu_{i,T}}{\partial B_{i,T}} = \frac{\partial \mu_{i,T}}{\partial K_T} \frac{\partial K_T}{\partial B_{i,T}} = \frac{\phi}{1-\eta} \frac{\mu_{i,T}}{K_T}.$$

Substituting households allocations (2), prices (6), and the optimal policies at T

in (II.13) results in the Lagrangian:

$$\max_{\substack{\tau^L_{i,T-1},\tau^K_{i,T-1}\\G_{i,T-1},B_{i,T}}} \{\chi \ln[(w_{i,T-1}-s_{i,T-1})(1-\tau^L_{i,T-1})] + (1-\chi)\ln[s_{i,T-2}R_{T-1}(1-\tau^K_{i,T-1})] +$$
$$+\chi\beta \ln\left[s_{i,T-1}R_T(1-\tau^K_{i,T})\right] +$$
$$+\mu_{i,T-1}\left[B_{i,T} - R_{T-1}B_{i,T-1} - G_{i,T-1} + (w_{i,T-1}-s_{i,T-1})\tau^L_{i,T-1} + s_{i,T-2}R_{T-1}\tau^K_{i,T-1}\right]\}.$$

The first order conditions are given by:

$$\tau^L_{i,T-1} : -\frac{\chi}{1-\tau^L_{i,T-1}} + \frac{\mu_{i,T-1}}{1+\beta}w_{i,T-1} = 0, \tag{II.15}$$

$$\tau^K_{i,T-1} : -\frac{1-\chi}{1-\tau^K_{i,T-1}} + \mu_{i,T-1}s_{i,T-2}R_{T-1} = 0, \tag{II.16}$$

$$\begin{gathered} G_{i,T-1} : \left(\frac{\chi}{w_{i,T-1}} + \frac{\mu_{i,T-1}}{1+\beta}\tau^L_{i,T-1}\right)\frac{\partial w_{i,T-1}}{\partial G_{i,T-1}} + \\ \left(\frac{1-\chi}{R_{T-1}} - \mu_{i,T-1}B_{i,T-1} + \mu_{i,T-1}s_{i,T-2}\tau^K_{i,T-1}\right)\frac{\partial R_{T-1}}{\partial G_{i,T-1}} - \\ \frac{\chi\beta}{\mu_{i,T}}\frac{\partial \mu_{i,T}}{\partial G_{i,T-1}} - \mu_{i,T-1} = 0. \end{gathered} \tag{II.17}$$

$$B_{i,T} : -\frac{\chi\beta}{\mu_{i,T}}\frac{\partial \mu_{i,T}}{\partial B_{i,T}} + \mu_{i,T-1} = 0. \tag{II.18}$$

Imposing symmetry of the states $\{s_{i,T-2}, B_{i,T-1}\}$ and using (II.15)-(II.18) together with the budget constraint yields:

$$\begin{aligned} G_{i,T-1} &= (c^s)^{\frac{1}{1-\eta}}\left(\frac{K_{T-1}}{n}\right)^{\frac{\phi}{1-\eta}}, \\ \tau^L_{i,T-1} &= 1 - \frac{\chi(1+\beta)}{z(1-\alpha)(1-\sigma)}D^s, \\ \tau^K_{i,T-1} &= 1 - \frac{(1-\chi)}{z\alpha(1-\sigma)}D^s\frac{s_{i,T-2}-B_{i,T-1}}{s_{i,T-2}}, \end{aligned}$$

where c^s has been defined above,

$$D^s = \frac{(1-\eta)\left(z(1-\sigma)-c^s\right)}{(1-\eta)+\chi\beta\phi/n},$$

and $Y_{i,T-1} = z\left(c^s\right)^{\frac{\eta}{1-\eta}}\left(\frac{K_{T-1}}{n}\right)^{\frac{\phi}{1-\eta}}$.

$$K_{i,T} = \frac{\beta\chi\phi}{1-\eta}\frac{D^s}{n}\left(c^s\right)^{\frac{\eta}{1-\eta}}\left(\frac{K_{T-1}}{n}\right)^{\frac{\phi}{1-\eta}}, \tag{II.19}$$

$$s_{i,T-1} = \frac{z\beta}{1+\beta}(1-\sigma)(1-\alpha)\left(c^s\right)^{\frac{\eta}{1-\eta}}\left(\frac{K_{T-1}}{n}\right)^{\frac{\phi}{1-\eta}}, \tag{II.20}$$

$$B_{i,T} = \frac{c^s+(1-\sigma)z\left(\frac{1-\alpha}{1+\beta}\left(\frac{(1-\eta)n}{\phi\chi}-1\right)-\alpha\right)}{1+\frac{1-\eta}{\beta\phi\chi}n}\left(c^s\right)^{\frac{\eta}{1-\eta}}\left(\frac{K_{T-1}}{n}\right)^{\frac{\phi}{1-\eta}}. \tag{II.21}$$

$$\mu_{i,T-1} = \left(c^s\right)^{-\frac{\eta}{1-\eta}}\left(\frac{K_{T-1}}{n}\right)^{-\frac{\phi}{1-\eta}}\left(D^s\right)^{-1}. \tag{II.22}$$

Substituting these time invariant allocations (II.19), (II.20), (II.21) and (II.22) in the set of first order conditions, one gets the equilibrium policies (16) - (19). These policies support a symmetric equilibrium given identical initial conditions. Moreover, letting $T\to\infty$ and using (II.22) repeatedly in periods $T-j$, where $j\to\infty$ yields the equilibrium policy functions, the implied capital stock (23) and the shadow price (24) in the infinite horizon setup.

Coordinated policies:

Fiscal policies under coordination are derived in a similar manner.

$$\max_{G_{i,T},\tau^L_{i,T},\tau^K_{i,T}} \sum\nolimits_{i=1}^{n}\{\chi\ln[w_{i,T}(1-\tau^L_{i,T})]+(1-\chi)\ln[s_{i,T-1}R_T(1-\tau^K_{i,T})]$$
$$+\mu_{i,T}\left[-R_T B_{i,T}-G_{i,T}+w_{i,T}\tau^L_{i,T}+s_{i,T-1}R_T\tau^K_{i,T}\right]\}$$

While first order conditions for tax rates are similar to (II.9) and (II.10), the planner takes into account cross country effects of public spending on the interest rate:

$$G_{i,T}: \left(\frac{\chi}{w_{i,T}} + \mu_{i,T}\tau^L_{i,T}\right)\frac{\partial w_{i,T}}{\partial G_{i,T}} + \sum\nolimits_{j=1,j\neq i}^{n}\left(\frac{\chi}{w_{j,T}} + \mu_{j,T}\tau^L_{j,T}\right)\frac{\partial w_{j,T}}{\partial G_{i,T}} \tag{II.23}$$

$$+\sum\nolimits_{j=1}^{n}\left(\frac{1-\chi}{R_T} - \mu_{j,T}B_{j,T} + \mu_{j,T}s_{j,T-1}\tau^K_{j,T}\right)\frac{\partial R_T}{\partial G_{i,T}} - \mu_{i,T} = 0.$$

Imposing symmetry and solving for $G_{i,T}$ yields

$$G_{i,T} = (c^c)^{\frac{1}{1-\eta}}\left(\frac{K_T}{n}\right)^{\frac{\phi}{1-\eta}},$$

where $c^c = (1-\sigma)z\eta$. Note that $c^c = c^s$ for $n = 1$. The coordinated solution mirrors indeed policy choices in a one economy world. At $T-1$ the planner solves:

$$\max_{\substack{\tau^L_{i,T-1},\tau^K_{i,T-1}\\ G_{i,T-1},B_{i,T}}} \sum\nolimits_{i=1}^{n}\{\chi\ln[(w_{i,T-1}-s_{i,T-1})(1-\tau^L_{i,T-1})] + (1-\chi)\ln[s_{i,T-2}R_{T-1}(1-\tau^K_{i,T-1})] +$$
$$+\chi\beta\ln\left[s_{i,T-1}R_T(1-\tau^K_{i,T})\right] +$$
$$+\mu_{i,T-1}\left[B_{i,T} - R_{T-1}B_{i,T-1} - G_{i,T-1} + (w_{i,T-1}-s_{i,T-2})\tau^L_{i,T-1} + s_{i,T-2}R_{T-1}\tau^K_{i,T-1}\right]\}.$$

For any $t < T$ first order conditions for tax rates are similar to (II.15) and (II.15) and the planner takes into account cross country effects of both national public spending and debt:

$$G_{i,T-1}: \left(\frac{\chi}{w_{i,T-1}} + \mu_{i,T-1}\tau^L_{i,T-1}\right)\frac{\partial w_{i,T-1}}{\partial G_{i,T-1}} + \sum\nolimits_{j=1,j\neq i}^{n}\left(\frac{\chi}{w_{j,T-1}} + \mu_{j,T-1}\tau^L_{j,T-1}\right)\frac{\partial w_{j,T-1}}{\partial G_{i,T-1}} \tag{II.24}$$

$$+\sum\nolimits_{j=1}^{n}\left(\frac{1-\chi}{R_{T-1}} - \mu_{i,T-1}B_{i,T-1} + \mu_{i,T-1}s_{i,T-2}\tau^K_{i,T-1}\right)\frac{\partial R_{T-1}}{\partial G_{i,T-1}} -$$
$$\chi\beta\sum\nolimits_{j=1}^{n}\frac{1}{\mu_{j,T}}\frac{\partial \mu_{j,T}}{\partial G_{i,T-1}} - \mu_{i,T-1} = 0.$$

$$B_{i,T}: -\chi\beta\sum\nolimits_{j=1}^{n}\frac{1}{\mu_{j,T}}\frac{\partial \mu_{j,T}}{\partial B_{i,T}} + \mu_{i,T-1} = 0. \tag{II.25}$$

where the effect of public debt on the cost of future public resources in all countries is internalized as is the effect of the public spending on foreign countries:

$$\frac{\partial w_{i,T}}{\partial G_{j,T}} = \frac{-\phi\eta}{1-\phi} z(1-\sigma)(1-\alpha) G_{i,T}^{\frac{\eta}{1-\phi}} \left(\sum\nolimits_{j=1}^{n} G_{j,T}^{\eta/(1-\phi)}\right)^{-\phi-1} G_{j,T}^{\frac{\eta}{1-\phi}-1} K_T^{\phi}. \tag{II.26}$$

Following similar steps as in the case of strategic policies yields the equilibrium policy functions (24) - (27).

Appendix III Public spending in the utility

The benchmark model focuses on the productive effects of public spending. Below I show that policy functions remain qualitatively the same if governments provide public goods that are directly valued by all voters in the same way. Denote the spending in country i at time t by $Q_{i,t}$ and the attached welfare weight κ. Under fiscal competition, (see Definition 1 in the main text), the government's problem becomes:

$$V_{i,t}^{s} = \max_{\Theta_{i,t}} \left\{ \begin{array}{c} \chi \ln[(w_{i,t} - s_{i,t})(1-\tau_{i,t}^{L})] + (1-\chi)\ln[s_{i,t-1}R_t(1-\tau_{i,t}^{K})] + \kappa \ln Q_{i,t} \\ +\beta\chi \ln[s_{i,t}R_{t+1}(1-\tau_{i,t+1}^{K})] + \beta\chi\kappa \ln Q_{i,t+1} \end{array} \right\}, \tag{III.1}$$

$$\text{subject to } B_{i,t+1} + \tau_{i,t}^{L} w_{i,t} + \tau_{i,t}^{K} R_t s_{i,t-1} = Q_{i,t} + G_{i,t} + R_t B_{i,t}, \tag{III.2}$$

where $\Theta_{i,t}$ denotes the policy vector $(\tau_{i,t}^{L}, \tau_{i,t}^{K}, G_{i,t}, B_{i,t+1})$.

Following the steps outlined in section I above, I solve (III.1) for the terminal period T:

$$\tau^L_{i,T} = 1 - \frac{\chi\left(z(1-\sigma) - c^s\right)}{z\left(1+\kappa\right)\left(1-\alpha\right)(1-\sigma)}, \tag{III.3}$$

$$\tau^K_{i,T} = 1 - \frac{(1-\chi)\left(z(1-\sigma) - c^s\right)}{z\left(1+\kappa\right)\alpha(1-\sigma)} \frac{s_{i,T-1} - B_{i,T}}{s_{i,T-1}}, \tag{III.4}$$

$$G_{i,T} = \left(c^s\right)^{\frac{1}{1-\eta}} \left(\frac{K_T}{n}\right)^{\frac{\phi}{1-\eta}}, \tag{III.5}$$

$$Q_{i,T} = \frac{\kappa}{1+\kappa} \left(c^s\right)^{\frac{\eta}{1-\eta}} \left(\frac{K_T}{n}\right)^{\frac{\phi}{1-\eta}} \left(z(1-\sigma) - c^s\right), \tag{III.6}$$

where as before $z = (\sigma/f)^{\frac{\sigma}{1-2\sigma}}$ and $c^s = (1-\sigma)z\eta\left(\left(1-\alpha\right)/\left(1-\phi\right)\left(1-\phi/n\right) + \alpha/n\right)$. Then, $Y_{i,T} = z\left(c^s\right)^{\frac{\eta}{1-\eta}}\left(K_T/n\right)^{\frac{\phi}{1-\eta}}$ and:

$$\mu_{i,T} = \left(1+\kappa\right)/\left(Y_{i.T}(1-\sigma) - G_{i,T}\right). \tag{III.7}$$

Comparing these policies against (II.1)-(II.12) the only change appears in the shadow value of the budget constraint which increases due to the extra spending on $Q_{i,T}$. This leads to higher taxes both on capital and labor while productive spending stays the same. A similar logic applies for periods $T-1, T-2, \ldots$.Given that $Q_{i,T}$ can be optimally financed with taxes on labor and capital every period, there is no additional effect on public debt either.

Appendix IV Direct tax competition

In the following I consider the effects of direct tax competition in addition to competition in public spending and the interest rate externality from public debt in a simplified two country, two-period version of the benchmark model. Time periods are denoted with $t = 1, 2$ and countries with i and j.

The demographics, preferences and production structure as well as the political economy mechanism are the same. Thus the world is inhabited by overlapping generations of two-period lived agents and policy makers maximize the lifetime utility of the living generations (nationally if policies are strategic or across countries if policies are coordinated).

I assume that countries compete only in public spending during the second period. Since this is the terminal period, there is no new debt issued. In this environment policies are identical to the those arising in the benchmark model at time T (see section 1 above).

During the first period, tax, public spending and debt are used strategically. I therefore assume source based capital taxation so both capital taxes and public spending are used to attract private capital. Thus *after tax* returns equalization implies $(1-\tau^K_{i,1})R_{i,1} = (1-\tau^K_{j,1})R_{j,1}$ or:

$$\frac{(1-\tau^K_{i,1})G^{\eta}_{i,1}}{K^{1-\phi}_{i,1}} = \frac{(1-\tau^K_{j,t})G^{\eta}_{j,1}}{K^{1-\phi}_{j,1}}. \tag{IV.1}$$

Moreover, at $t = 1$ national governments can only tax the local tax base $K_{i,1}$. Thus starting with $s_{i,0}$, $B_{i,1}$ strategic policies imply government i chooses $\Theta_{i,1} = (\tau^L_{i,1}, \tau^K_{i,1}, G_{i,1}, B_{i,2})$ to solve:

$$V^s_{i,1} = \max_{\Theta_{i,1}} \left\{ \chi \ln[(w_{i,1}-s_{i,1})(1-\tau^L_{i,1})] + (1-\chi)\ln[s_{i,0}R_{i,1}(1-\tau^K_{i,1})] + \beta\chi \ln[s_{i,1}R_{i,2}(1-\tau^K_{i,2})] \right\}, \tag{IV.2}$$

$$\text{subject to } B_{i,2} + \tau^L_{i,1}(w_{i,1}-s_{i,1}) + \tau^K_{i,1}R_{i,1}K_{i,1} = G_{i,1} + R_{i,1}B_{i,1}(1-\tau^K_{i,1}) \text{ and (IV.1)}. \tag{IV.3}$$

Capital market clearing reads:

$$K_{i,2} + K_{j,2} - B_{i,2} + B_{j,2} = s_{i,1} + s_{j,1}.$$

At $t = 2$, under public spending competition, a symmetric equilibrium implies:

$$V^c_{i,2} = \max_{\Theta_{i,2}} \left\{ \chi \ln[w_{i,2}(1-\tau^L_{i,2})] + (1-\chi)\ln[s_{i,1}R_{i,2}(1-\tau^K_{i,2})] \right\}, \tag{IV.4}$$

$$\text{subject to } \tau^L_{i,2}w_{i,2} + \tau^K_{i,2}R_{i,2}s_{i,1} = G_{i,2} + R_{i,2}B_{i,2} \text{ and (IV.1)}. \tag{IV.5}$$

Following the strategy described in section I of this appendix, I solve the model backwards. As before, under coordination:

$$\tau^K_{i,2} = 1 - \frac{(1-\chi)(1-\eta)\left(z(1-\sigma)-c^s\right)}{z(1-\sigma)\alpha}\frac{K_{i,2}}{s_{i,1}},$$

where $c^s = (1-\sigma)z\eta\left(\frac{1-\alpha}{1-\phi}\left(1-\frac{\phi}{n}\right)+\frac{\alpha}{n}\right)$. Thus, the the old age utility of the current young is :

$$s_{i,1}R_{i,2}(1-\tau^K_{i,2}) = (1-\sigma)(1-\chi)(1-\eta)z(c^c)^{\eta/(1-\eta)}K_{i,2}^{\phi/(1-\eta)}.$$

Plugging this expression into $V^s_{i,1}$, one can now solve for the strategic policies under the benchmark conditions (public spending competition, implying residence based taxation) vs. the case when countries are also subject to direct tax competition (and thus source based capital taxation). Since there are no analytical solutions to the latter case, the model is solved numerically.

Table 1: The effects of direct tax competition

	Fiscal competition with multiple instruments		
	Benchmark (no tax competition)	Including tax competition	Coordinated policies
Policy variable			
$\tau^K_{i,1}$	0.0811	−0.1640	0.1616
$G_{i,1}$	0.8748	0.8534	0.8357
$B_{i,2}$	0.8785	0.9366	0.6166

$s_{i,0} = 10$, $B_{i,1} = 0.6$. The other parameters are set at $\alpha = 0.35$, $\delta = 0.2$, $\sigma = 0.1$, $\chi = 0.5$ and $\beta = 0.95$.

As expected, capital taxes are lower when direct tax competition is allowed in addition to the strategic use of public spending. In fact with under the chosen parametrization, tax competition leads to a capital subsidy. At the same time, public spending is lower while public debt is higher. Nonetheless, the level of public spending chosen under both sets of strategic policies is larger than the coordinated level.