Government size, institutions, and export performance among OECD economies

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Online Appendix

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Appendix A: The full model:

As mentioned, the model seeks to uncover the channels of influence of the size of the state sector on export performance. While the tax rate reduces competitiveness (Alesina and Perotti, 1997), it may also increase productivity via its support of productive public services (Barro, 1990). Such services include basic administration, support of the rule of law, health and education services, a clear delineation of property rights and contract enforcement. To bring these arguments to bear on export performance, we follow the dynamic Ricardian model of Dornbusch, Fischer and Samuelson (1977; see also Obstfeld and Rogoff, 1996, Chapter 4) coupled with monopolistic competition in the product and labour markets (something missing from the original model). We also combine this with productive public services in the manner of Barro (1990) so as to analyse the role of government and the welfare state in terms of export performance. In contrast to the supply-side model of Barro (19990), here we build a model in which demand is determined first, and then labour demand is determined residually. More technically, we shall also use a CES production function, which introduces the possibility of unemployment in the labour market, and hence a meaningful role for trade unionism. This links up with a rich literature on the effects of union behaviour. While these should be valuable extensions of DFS (1977) in their own right, the main focus here is to highlight the link between state size and taxation on the one hand and competitiveness and export performance on the other.

Accordingly, there is a continuum of goods, $i \in [0,1]$ that are internationally tradable. A fraction $0<z<1$ of them is produced by the Home economy (H), and the rest by the Foreign economy (F - the latter will be indicated by starred variables). We indicate by α_i and α_i* the unit labour requirements (inverse productivity) for each good i in each of the two countries. Thus, the ratio $A(i) \equiv \alpha_i^*/\alpha_i$ indicates the relative productivity of H concerning good i. Later on, we shall consider also broader interpretations of productivity and A(i) that bear on institutions. We index the goods such that A(i) falls as i rises; in other words, H has a relative productivity advantage for goods with a low i and F in those with a high i.

The utility of the representative domestic agent has the following structure:

$$U = \left(\int_0^1 C_i^{\frac{\theta-1}{\theta}} di\right)^{\frac{\theta}{\theta-1}} + (1-\delta)uR \qquad \text{(A.1)}$$

Utility is made up of two components, firstly a consumption aggregate and secondly a term reflecting the utility of leisure. The consumption sub-utility is a Dixit and Stiglitz (1977) aggregate of all globally produced, and consumed, individual goods; it is assumed that, globally, there exists a unit mass of differentiated goods, each subscripted by and characterised by elasticity of substitution $\theta>1$,produced by monopolistically competitive firms (see Blanchard and Kiyotaki, 1987). All quantities refer to the representative agent, and because of symmetry, they are identical to aggregate bundles.

We follow Alesina and Perotti (1997) in the treatment of leisure in utility: It is weighted by δ and it is valued at the exogenous utility of leisure R, if the individual is unemployed; if they work, there is no utility of leisure. There is no proper leisure-labour choice here; the unemployment rate ($0<u<1$) will be decided by the conditions in the labour market, and a fraction u of each individual's time is involuntarily spent out of work.

Given the monopolistic structure, the associated price level is:

$$P = \left(\int_0^1 (P_i \;)^{1-\theta} di\right)^{1/(1-\theta)} = 1 \qquad \text{(A.2)}$$

This is normalised to unity; in other words, the numeraire is the global basket of goods, but we shall keep it for completeness.

One innovation in relation to Alesina and Perotti (1997) concerns productivity, A. It has been recognised since at least Barro (1990) that productivity may be at least partly supported by public services such as administration and the maintenance of the rule of law, education, health, and infrastructure development; so, public capital augments labour in production. Public services are supported by levying a flat tax rate τ across all incomes; a balanced budget is assumed, so this rate also equals the public services-to-GDP ratio. The public services are assumed non-rival, so all producers enjoy the same level without congestion effects. Accordingly, individual good production is characterised by:

$$Y_i = \frac{BL_i}{\alpha_i} \tag{A.3}$$

Where B is productivity, supported by public services, and therefore specified as:

$$B = (\tau Y)^{\beta} \tag{A.4}$$

Taxation supports public services in the form of purchased goods; for tractability, the government is assumed to buy all goods (worldwide) in the same proportion as individual consumers. In this way, the price index of the government-consumed goods bundle is the same as the global price level P and no other changes need to be made to the way the global price level is calculated. The parameter 0<β<1 captures the production effectiveness of a given level of public services, and may therefore be interpreted as a measure of institutionally-determined efficiency in the model.

Due to the monopolistic structure of the goods market, producers in all sectors enjoy a monopolistic markup of price over marginal cost, as is standard; so, the generic producer j sets their price according to:

$$P_i = \frac{(1+\mu)\alpha_i W}{B} \tag{A.5}$$

Where W is the nominal wage producer i faces, common across the domestic economy, as will be specified below. In analyses of monopolistic markets, it is customary to define the mark-up as $\mu \equiv \frac{\theta}{\theta-1} - 1$, i.e. tightly linked to product market structure and the elasticity of substitution in utility (θ). Strictly speaking, the mark-up is closely connected to the elasticity of demand θ which is the same across all goods, so it should be assumed symmetric across the two economies. However, the elasticity of substitutions will be common across economies and goods, whereas a lot of interesting, real world-related possibilities arise if we let the mark-up differ across the two economies. Therefore, we shall let the mark-up be disconnected from the monopolistic structure, and assume that mark-ups across the two economies can differ because of idiosyncratic factors across the two economies which we do not need to model. Allowing for a different mark-up and nominal wage, symmetry applies to pricing in the foreign market.

All goods for which $P_i < (>) P_i^*$ will be produced by the Home (Foreign) economy. In view of the pricing rule, therefore, good i will be produced by H if:

$$(1+\mu)\alpha_i W/B < (1+\mu^*)\alpha_i^* W^*/B^*$$

The marginal good z is defined such that costs are the same across the two economies; it is hence defined implicitly from:

$$(1+\mu)\alpha_z W/B = (1+\mu^*)\alpha_z^* W^*/B^* \qquad \text{(A.6)}$$

Any good i<z will be produced by H and j>z will be produced by F. We may therefore interpret z (0<z<1)as the (endogenous) extent of 'market capture' by the Home economy.

Given the structure of utility, demand for good is given by:

$$C_i = (P_i/P)^{-\theta} C \qquad \text{(A.7}^{\text{H}}\text{)}$$

where C is total domestic consumption in real terms (in units of the numeraire good), and symmetrically

$$C_i^* = (P_i/P)^{-\theta} C^* \qquad \text{(A.7}^{\text{F}}\text{)}$$

Total aggregate demand comprises global consumption plus global government spending; the latter is assumed to be equal to $\tau Y + \tau^* Y^*$ under the assumption of balanced budget. Since the two governments buy goods in the same proportion to their relative prices as individual consumers, individual goods demand and production is:

$$Y_i = \left(\frac{P_i}{P}\right)^{-\theta} (C + C^* + \tau Y + \tau^* Y^*)$$

The model here features no investment or capital accumulation, therefore on a global scale, the sums of consumer and government spending should equal global output, $C + C^* + \tau Y + \tau^* Y^* = Y + Y^*$. Therefore, and in view of the pricing rule:

$$Y_i = \left(\frac{(1+\mu)\alpha_i W}{BP}\right)^{-\theta} (Y + Y^*) \tag{A.8}$$

Given this output, total employment in the i-th sector is:

$$L_i = \alpha_i Y_i = \alpha_i^{1-\theta} \left(\frac{(1+\mu)W}{BP}\right)^{-\theta} (Y + Y^*)$$

It is noteworthy that the effect of a rise in the unit labour requirement α_i on employment in sector iis twofold: positive since more labour is required per unit of good, and negative as demand will fall in the sector because of the higher price. Because of the assumption of θ>1, the latter effect dominates; it is worth contrasting that with the original DFS (1977) of Cobb-Douglas utility in which case the two effects exactly cancel out, so that employment is constant across sectors. As a result, total employment in the domestic economy is:

$$1 - u = L = \int_0^z \alpha_i^{1-\theta} di \left(\frac{(1+\mu)W}{BP}\right)^{-\theta} (Y + Y^*) \tag{A.9}$$

Where C+C* is total consumption expenditure across the two economies in real terms. This is to be taken as exogenous by the union, whose behaviour will be described shortly.

The next step in the analysis concerns the labour market and the determination of the real wage. As mentioned, our model is able to incorporate unemployment, in contrast to the essentially supply-side models of both DFS (1977) and Barro (1990). Before turning to the union's behaviour, we analyse Walrasian equilibrium; this will be a useful benchmark in what follows. In a Walrasian equilibrium, when no union behaviour is involved, the nominal wage is set at such a level that unemployment is eliminated. (Strictly speaking, this is not entirely accurate. Since at least Blanchard (1986), we know that imperfect competition even on one side of the labour market suffices to generate structural unemployment, and this should be the case here even without union presence, just by the monopolistic power of the firms. Since we are interested however on what effects the union behaviour will have, we may more accurately say that we normalise unemployment to zero when there are no unions, even though there are monopolistic firms; we then measure the effects of unions on the deviations of unemployment from this benchmark – zero – level.) Accordingly, the Walrasian equilibrium real wage would be determined by:

$$\frac{W^{WE}}{P} = \frac{B}{1+\mu}\left((\mathrm{Y} + \mathrm{Y}^{*}) \int_0^{z^{WE}} \alpha_i^{1-\theta} di\right)^{1/\theta} \quad \text{(A.10)}$$

Both demand (global demand) and supply (productivity, firm markup and international competitiveness) factors play a role here.

We next turn to union behaviour (see e.g. Nickell, 1990). If there is a single 'monopoly union' in the Home economy, its welfare is assumed to be:

$$\overline{U} \equiv \frac{(1-u)W}{P}(1-\tau) + uR \quad \text{(A.11)}$$

whereτ is the tax rate.The union has the specific aim of raising the mean take-home pay over the entire workforce; the only alternative to employment for an economy-wide union is only unemployment, which is valued above as leisure. Maximising (11) with respect to the real wage (w ≡W/P), we have:

$$(1-u)(1-\tau) = \frac{du}{dw}(\frac{W}{P}(1-\tau) - R) \quad \text{(A.12)}$$

The economy-wide union factors in the effect of the real wage on aggregate employment. We note that for any work to be offered at all, the take-home wage should be greater than the disutility of leisure, $\frac{W}{P}(1-\tau) - R > 0$. The union takes the tax rate and the level of global demand as given. Therefore, from equation (9) of unemployment, we get:

$$\frac{du}{dw} = (1-u)\left[\theta\frac{P}{W} + \varphi\right] \quad \text{(A.13a)}$$

where

$$\varphi \equiv -\frac{\alpha_z^{1-\theta}}{\int_0^z \alpha_i^{1-\theta} di} \frac{dz}{dw} > 0 \qquad \text{(A.13b)}$$

is the effect of the union's actions on the amount of goods z that the domestic economy produces. The positive sign follows from $\frac{dz}{dw} < 0$, the fact that a rising real wage makes the economy less competitive. In other words, the economy-wide union takes into account the fact that its policies will have significant side-effects on total production and indirectly therefore on unemployment. The internalisation of these externalities by a centralised union are some of the key findings of Calmfors and Driffill (1988). Here, we shall treat φ as parametric and interpret it as the degree of centralisation of the trade union and its concomitant extent of internalising the externalities it causes on the economy's productive structure. Inserting (13a) into (12), we can solve for the real wage that the union settles for:

$$\frac{W^{Union}}{P} = \frac{\theta R}{(\theta - 1)(1-\tau) + \varphi\left(\frac{W^{Union}}{P}(1-\tau) - R\right)} \qquad \text{(A.14)}$$

This implicitly defines the real wage set by the monopoly union. Since the tax rate is of interest, we may totally-differentiate and re-arrange to get:

$$\frac{d\frac{W^{Union}}{P}}{d\tau} = \frac{W^{Union}}{P} \frac{\theta - 1 + \varphi\frac{W^{Union}}{P}}{(\theta - 1)(1-\tau) + \varphi\left(2\frac{W^{Union}}{P}(1-\tau) - R\right)} \approx \frac{W^{Union}}{P} \frac{1}{1-\tau}[1 - \phi] > 0; \qquad \text{(A.15)}$$

where

$$1 > \phi \equiv \frac{\varphi\left(\frac{W^{Union}}{P} - \frac{R}{(1-\tau)}\right)}{(\theta - 1) + \varphi\left(2\frac{W^{Union}}{P} - \frac{R}{(1-\tau)}\right)} > 0$$

With $\phi'(\varphi)>0$, inherits from φ its properties and the interpretation of degree of centralisation of the union. The tax rate unambiguously increases the real wage set by the union. A greater centralisation and restraint of the union will lower the real wage – an effect discussed by Alesina and Perotti (1997).

The conditions in the product market also feature in the union-set wage – a more inelastic market (lower θ) will feature a higher real wage, quite independently of the markup that the firm sets.

In practice, no union unilaterally sets the wage, as the 'monopoly union' model postulates. The 'right to manage' model (Oswald, 1986; Nickell, 1990) is instead a lot more realistic, assuming as it does that the union and firm negotiate the wage and then the firm sets employment according to its labour demand curve or its profit-maximising objective more generally. To solve for that would be too complicated, though; instead, we resort to the convenient shortcut that the actual wage is a geometric average of the Walrasian and the Union wages as a way of approximating the real wage set in a 'right-to-manage' setup (see Manning, 1987):

$$\frac{W}{P} = \left(\frac{W^{Union}}{P}\right)^{\gamma} \left(\frac{W^{WE}}{P}\right)^{1-\gamma}$$

Where 0<γ<1 is the normalised strength (organisational, political, or other) of the union. Therefore, using (15), the semi-elasticity of the real wage with respect to the tax rate becomes:

$$\frac{d\frac{W}{P}}{d\tau} / \frac{W}{P} = \frac{\gamma(1-\phi)}{1-\tau} \qquad \text{(A.16)}$$

Since the global price level is normalised to unity by (2), the union cannot affect it; (16) then also equals the effect of the tax on the nominal wage:

$$\frac{dW/W}{d\tau} = \frac{\gamma(1-\phi)}{1-\tau} \qquad \text{(A.16')}$$

Having fixed the wage, and symmetrically for the Foreign economy, we can now pin down the extent of domestic production(and domestic capture of world markets), z. Given our definition of relative productivity, $A(i) \equiv \alpha_i^*/\alpha_i$, A'(i)<0, and the condition for the marginal good, z, (6), we have:

$$A_z = \frac{(1+\mu)W/B}{(1+\mu^*)W^*/B^*} \qquad \text{(A.17)}$$

Since A is an inverse function of i, the extent of H production (z) rises with the foreign product markup and nominal wage and falls with the domestic ones. These results are intuitive, as the product markup and wage costs directly affect product prices and therefore the relative competitiveness of the two economies. The exogenously given curvature of the A(i) function also plays a role: Apart from reflecting productivity in a narrow sense, this may also be interpreted as a country's institutional features that have a bearing on productivity, as alluded to above. Since 1/A(i) is the cumulative distribution function of relative productivity, a rise in relative productivity by the domestic economy (a shift in 1/A(i) such that the new distribution is first-order stochastically dominated by the old), implies that the domestic economy is more productive across the board. This may be interpreted as a technological improvement but it may also be a business-friendly institutional change. This type of change will induce a rise in A^{-1}(.)for each level of cost competitiveness $\frac{(1+\mu)W/B}{(1+\mu^*)W^*/B^*}$; therefore, *ceteris paribus*, the extent of H production (z) rises.

In view of our specification for productive public services (4), (17) becomes:

$$A_z = \frac{(1+\mu)W/(\tau Y)^{\beta}}{(1+\mu^*)W^*/B^*} \quad \text{(A.18)}$$

Totally-differentiating, we find that the tax rate will affect the degree of H production (z) as follows:

$$\frac{\partial z}{\partial \tau} = \frac{\frac{\gamma(1-\phi)}{1-\tau} - \frac{\beta}{\tau}}{A'(z)} \quad \text{(A.19)}$$

where $A'(.) \equiv \mathrm{dA(i)/di} < 0$. Therefore, we have the following sign:

$$sgn\left\{\frac{\partial z}{\partial \tau}\right\} = -sgn\{\tau - \bar{\tau}\}, \qquad \bar{\tau} \equiv \frac{\beta}{\beta+\gamma(1-\phi)} \quad \text{(A.20)}$$

(20) defines a threshold tax rate, $\bar{\tau}$, around which the balance of effects of the tax rate on the degree of specialisation changes sign: The two effects are a positive one via public services and a negative one via the effect on the union-bargained wage. We thus get a hump-shaped graph of z(τ), which parallels the graph of growth on thetax rate in Barro (1990), but does not seem to have been derived in the literature in its own right. We therefore get an optimal tax rate, and government size (because of the balanced budget), from the point of view of maximising z, the extent of Home production and its 'capture' of world markets. A rise in the level of productivity, technical or institutional, as captured by

A(i), raises the absolute value of dz/dτ (whatever its sign) in two mutually-reinforcing ways: firstly by reducing A'(.) for all i, and second, by increasing z, and therefore further decreasing A'(z).

We thus arrive at the Proposition 1 of the main text.

From (8), noting the definition of productivity as based on public services (4), domestic output is:

$$Y = \int_0^z P_i Y_i di = \left(\int_0^z \left(\frac{(1+\mu)\alpha_i W}{(\tau Y)^\beta P}\right)^{1-\theta} di\right)(Y + Y^*) \quad \text{(A.21)}$$

The effect of the tax rate is:

$$\frac{dY}{d\tau} = \frac{-(\theta-1)+\frac{Y_z}{A'(z)}}{1-\beta(\theta-1)-y}\left\{\frac{\gamma(1-\phi)}{1-\tau} - \frac{\beta}{\tau}\right\} \quad \text{(A.22)}$$

Where

$$0 < y \equiv \frac{Y}{Y + Y^*} < 1$$

is the relative size of H in the global economy, and will be assumed parametric and exogenous; correspondingly, the size of F is given (although there are two economies in the world).

Competitiveness manifests itself via the relative price of the domestically produced goods. If we consider the effect of a tax change on real output, we have five channels: Firstly, the negative effect of the real wage on domestic demand via higher prices (the θ in the numerator of the first ratio times β/τon the RHS in 22); secondly, the effect of the tax rate on public services and productivity (the θγ(1-ϕ)/(1-τ) term). Thirdly, the effect of the tax rate on the degree of domestic capture of markets (the rest of the same numerator); this involves in turn a dual effect, the effect of the tax rate on public services and productivity, and the effect of the tax rate on the real wage bargained for by the union (that is, noting 19). Fourthly, the tax rate reduces net disposable income and consumption; fifth, government spending will rise with the tax rate; in fact, the last two channels exactly cancel out under our assumptions (note that global consumer demand equals (1-τ)Y+(1-τ*)Y*, while government spending is τY+τ*Y*). We assume that 1-βθ-y>0, i.e. that the effect of public services on productivity is not too strong and that the domestic economic is not too large. Under this maintained assumption, $\frac{-(\theta-1)+\frac{Y_z}{A'(z)}}{1-\beta(\theta-1)-y} < 0$, and

$$sgn\left\{\frac{dY}{d\tau}\right\} = -sgn\left\{\frac{\gamma(1-\phi)}{1-\tau} - \frac{\beta}{\tau}\right\}$$

Maximising output entails setting dY/dτ=0. The tax rate that brings that about is found to be the same threshold, $\overline{\tau}$, as the one that maximises the extent of Home production in (20). Thus, the properties of the optimal tax rate with respect to Home output maximisation, are as described in Proposition 1. As with the extent of Home production (z), the tax rate exerts a hump-shaped effect on output, with output rising with tax below the threshold and falling beyond it. Again, these effects parallel Barro's (1990) effects of the tax rate on growth; but here, the variety of effects considered is richer. The main difference with Barro (1990) is that the negative effect is not due to the disincentive of taxation but to the effect of the tax on the real wage. Furthermore, the hump-shaped effect of tax on output mirrors its effect on Home production (z) except that it is exacerbated, comprising the effect of tax on both product capture plus the other channels discussed above.

Turning now to the external balance, it is useful to consider the 'export ratio', the ratio of domestic to foreign exports:

$$Exp \equiv \frac{\left(\int_0^z \left(\frac{(1+\mu)\alpha_i W/B}{(\tau Y)^\beta P}\right)^{1-\theta} di\right)(C^* + \tau^* Y^*)}{\left(\int_z^1 \left(\frac{(1+\mu^*)\alpha_i^* W^*}{(\tau^* Y^*)^\beta P}\right)^{1-\theta} di\right)(C + \tau Y)}$$

Exports of H in the numerator are generated by demand from F and is proportional to (7^F); symmetrically for the F exports (denominator).

Now, while global consumption equals global output (there is no saving or investment in this model), this need not be the case for each individual economy: GNP and GDP need not be equal. If one economy has accumulated claims on the other, then its GNP>GDP by the amount of interest payments on those assets; for the other economy, correspondingly, the opposite will be true. To model how these possibilities may arise is beyond the scope of this (it generally requires an intertemporal model of consumption spending). Here, we may take the relative GNP and therefore consumption that depends on it as parametric, and let $0 < c \equiv \frac{C}{C+C^*} < 1$ be the share of the domestic economy in global consumption, and correspondingly 1-c that of the foreign economy. In turn, global consumption is given by:

$$C + C^* = (1 - \tau)Y + (1 - \tau *)Y *$$

We thus have:

$$Exp = \frac{\left(\int_0^z \left(\frac{(1+\mu)\alpha_i W/B}{(\tau Y)^\beta P}\right)^{-\theta} di\right)}{\left(\int_z^1 \left(\frac{(1+\mu^*)\alpha_i^* W^*}{(\tau^* Y^*)^\beta P}\right)^{-\theta} di\right)} \bar{y} \tag{A.24}$$

where

$$\bar{y} \equiv \frac{(1-c)[(1-\tau)y+(1-\tau*)(1-y)]+\tau^*(1-y)}{c[(1-\tau)y+(1-\tau*)(1-y)]+\tau y} \tag{A.25}$$

is a measure of relative non-government aggregate demand (H relative to F), and:

$$\frac{d\bar{y}}{d\tau} = -\frac{1-c}{\{c[(1-\tau)y+(1-\tau*)(1-y)]+\tau y\}^2} \tag{A.26}$$

The negative arises as a rise in tax reduces the non government-related demand. In deriving the effect of the domestic tax rate on relative aggregate demand, we assume that this rate can affect global consumption – both Home and Foreign in proportion to relative country size. Note that the sign is unambiguously negative.

The effect of the tax rate on *Exp* is:

$$\frac{dExp}{d\tau} = Exp\left\{-(\theta-1)\frac{dW}{d\tau}\frac{1}{W} + (\theta-1)\beta\left[\frac{dY}{d\tau}\frac{1}{Y} + \frac{1}{\tau}\right] + \frac{(P_z/P)^{1-\theta}}{\int_0^z (P_i/P)^{1-\theta} di}\frac{dz}{d\tau} + \frac{d\bar{y}}{d\tau}\frac{1}{\bar{y}}\right\}$$

Using (16’), (19), (22) and (26), we get:

$$\frac{dExp}{d\tau} = Exp\left\{\begin{matrix}\left[-(\theta-1)\frac{1-\frac{Y_Z}{A'(z)}}{1-\beta(\theta-1)-y} + \frac{\left(\frac{P_Z}{P}\right)^{-\theta}}{y}\frac{1}{A'(z)}\right] \\ \left[\frac{\gamma(1-\phi)}{1-\tau} - \frac{\beta}{\tau}\right] + \frac{d\bar{y}}{d\tau}\frac{1}{\bar{y}}\end{matrix}\right\} \tag{A.27}$$

All terms in the curly brackets are proportional to $\frac{\gamma(1-\phi)}{1-\tau} - \frac{\beta}{\tau}$ except the final, positive, term. That term captures the effect of the domestic tax rate on relative demand in the two countries. If we were to ignore this effect, the same hum-shaped curve of *Exp* versus the tax rate would arise as the ones that characterise the extent of Home production and domestic output (cf.19 and 22). The new consideration here is the last term inside the curly brackets, which reflects the effect of the domestic tax rate on the relative global demand (negative, to show that Foreign demand falls and Home rises). This term causes a deviation in the *Exp*-tax rate graph from the other graphs, in the sense that the threshold tax rate at which d*Exp*/dτ changes sign is different than the one in the earlier graphs ($\bar{\tau}$).

The threshold tax rate in this case is:

$$\bar{\bar{\tau}} = \frac{\beta + \frac{\frac{d\bar{y}}{d\tau}\frac{1}{\bar{y}}}{(\theta-1)\frac{1-\frac{Y_Z}{A'(z)}}{1-\beta(\theta-1)-y} - \frac{\left(\frac{P_Z}{P}\right)^{-\theta}}{y}\frac{1}{A'(z)}}}{\beta+\gamma(1-\phi)} < \bar{\tau} \tag{A.28}$$

Hence, the threshold tax rate is lower than the ones that maximise Home production or output, essentially because of the added effect of domestic taxation on domestic demand and therefore imports. We thus have Proposition 2 of the main text.

Appendix B: Summary statistics and graphs

Table B1: Data Sources

Variable	Source
Exports as share to total OECD Exports(*Exp*)	UNCTAD
Exports as Ratio to GDP (*ER*)	World Bank Development Indicators
RULC	EUKLEMS
Tax share	OECD-National Accounts
Social Expenditure share	OECD-National Accounts
Private R&D share	OECD-Science and Technology Indicators
EPL	OECD-Employment Database
PMR	OECD- Product Market Regulation Database
Barriers to Entrepreneurship	OECD- Product Market Regulation Database
Barriers to Competition	OECD- Product Market Regulation Database
Barriers to FDI	OECD- Product Market Regulation Database
Gross Fixed Capital Formation (GFCF) as share to GDP	World Bank Development Indicators
Energy of oil Equivalent (ENE) per Capita	World Bank Development Indicators

Table B2: Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Export share	438	5.71	5.61	0.27	21.99
Export Ratio	450	32.53	17.94	7.21	97.34
RULC	450	1.00	0.18	0.74	1.69
Tax share	450	35.70	8.40	15.65	52.26
Social Expenditure share	450	20.98	6.28	3.00	36.20
Private R&D share	450	1.01	0.63	0.03	2.96
EPL	450	2.14	0.91	0.21	3.63
Barriers to Entrepreneurship	450	2.25	0.45	1.45	3.05
Barriers to Competition	450	2.41	0.52	1.72	3.22
Barriers to FDI	450	1.59	0.74	0.09	2.92

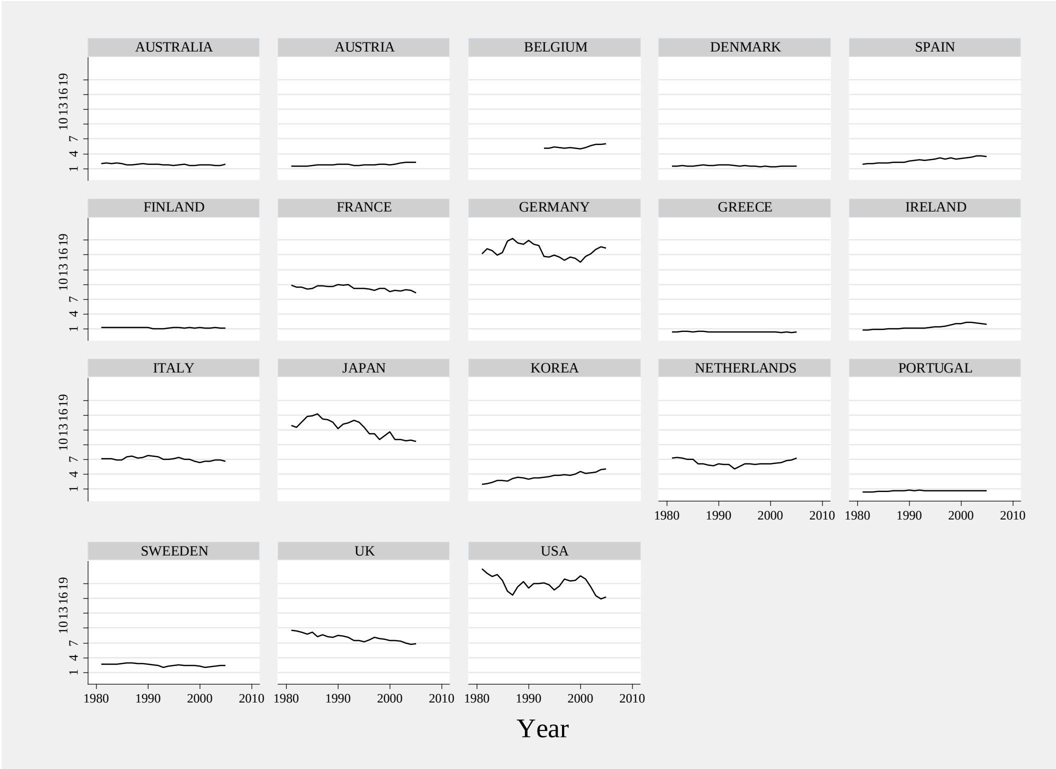
Table B3: Indices of Institutional Rigidities, Mean Values (1985-2008) (OECD)

Country	EPL	Barriers to Entrepreneurship	Barriers to Competition	Barriers to FDI
Australia	1.11	1.56	2.20	1.72
Austria	2.12	2.19	3.22	2.14
Belgium	2.53	2.33	2.31	1.20
Denmark	1.74	1.82	2.77	1.23
Spain	3.16	2.39	2.03	1.61
Finland	2.09	2.41	1.94	1.70
France	3.01	3.05	3.06	2.83
Germany	2.55	2.31	1.91	0.09
Greece	3.26	2.68	3.16	2.34
Ireland	0.99	1.60	1.72	1.20
Italy	2.69	2.74	2.95	2.92
Japan	1.59	2.97	3.01	1.85
Korea	2.32	2.73	2.24	2.35
Netherlands	2.40	2.05	1.92	1.06
Portugal	3.63	2.15	2.36	1.43
Sweden	2.47	2.11	1.89	1.45
UK	0.66	1.45	1.73	0.24
USA	0.21	2.02	2.94	1.18
Total	2.14	2.25	2.41	1.59

Notes: EPL refers to Employment Protection Legislation. All these indices are from the OECD; their values range from 0 to 6. Values close to zero indicate a market that is less stringent while values closer to the upper bound indicate a restrictive market.

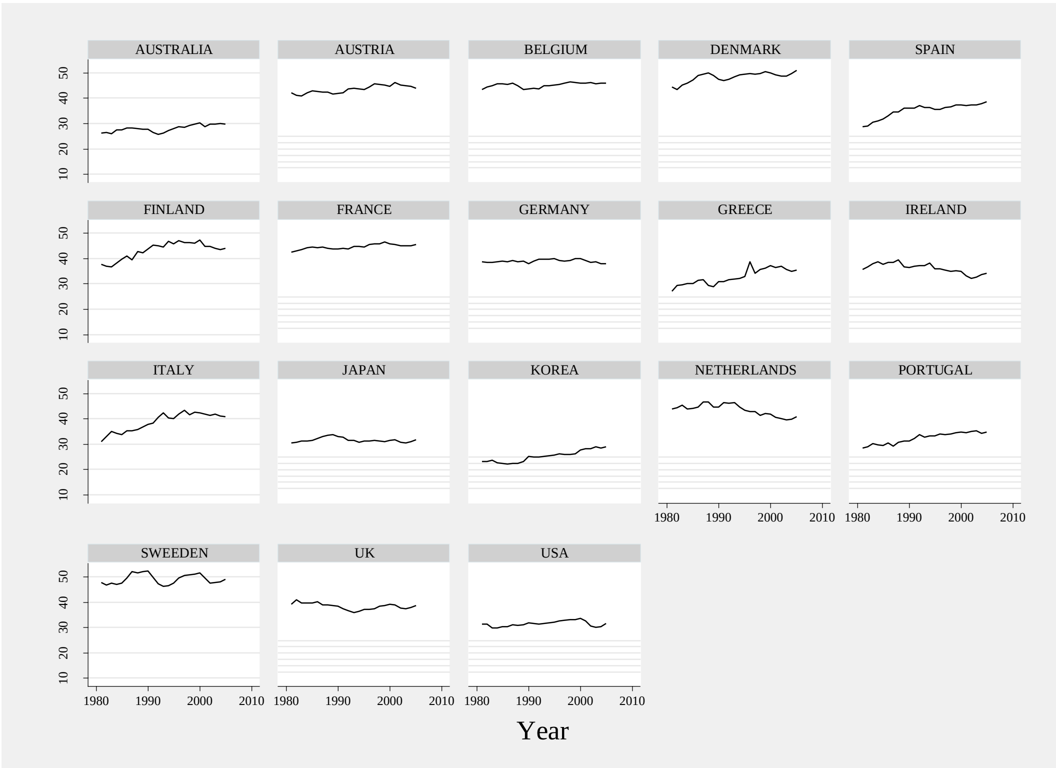
Figure B1 illustrates time trends of export shares and tax shares for our sample. A remark that can be made is that export shares have a high degree of persistence while tax shares are stable indicating mainly the pro-cyclical nature of tax revenue. Interestingly, one can state that tax revenue follows an upward trend in the majority of countries with Scandinavia countries (Sweden, Finland, and Denmark) to have the highest share.

Figure B1: Export share of 18 OECD Countries



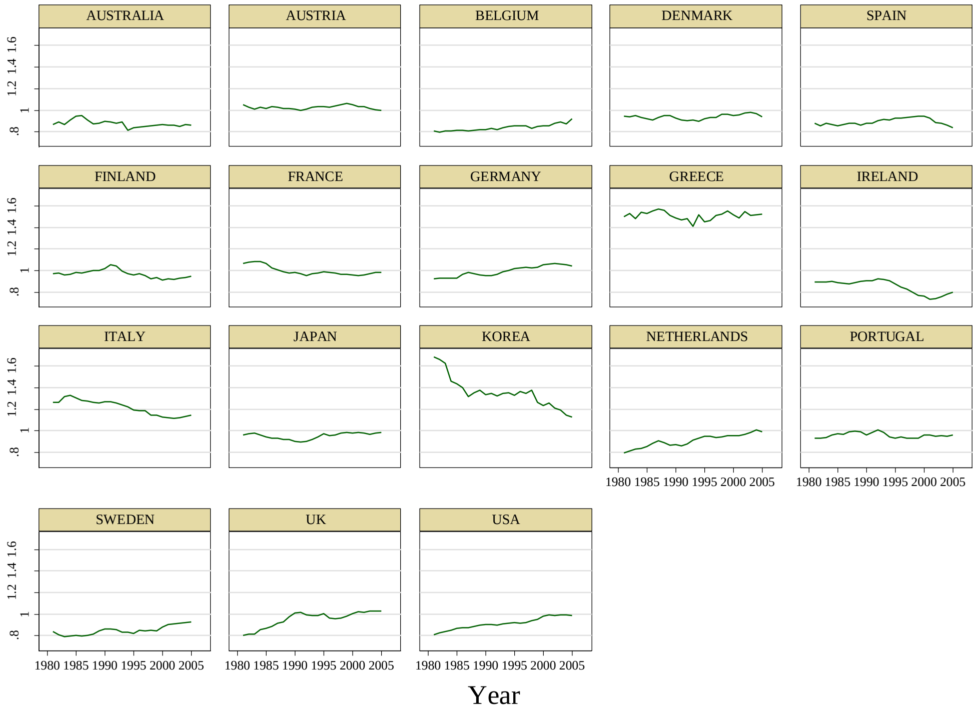
Note: Country exports as a percentage of world exports

Figure B2: Tax shares of 18 OECD Countries



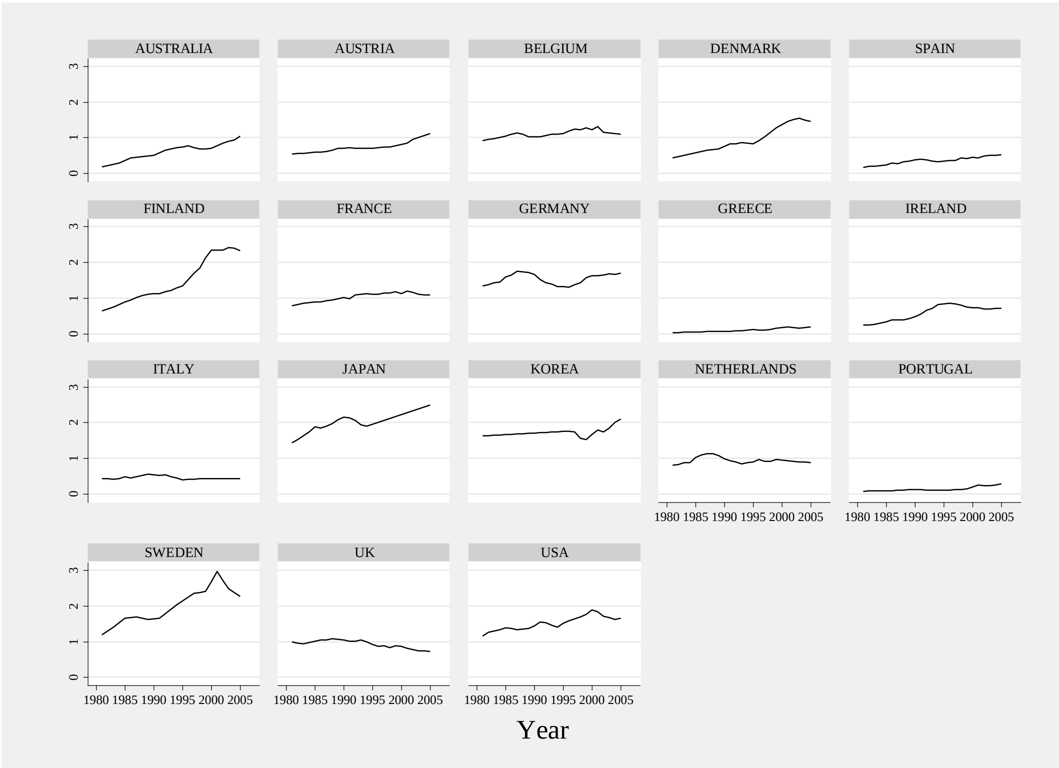
Note: Total tax receipts as a percentage over GDP

Figure B3: Relative Unit Labour Costs (RULC)



Note: The methodology of construction is reviewed in Appendix A.

Figure B4: R&D Expenditure (%) to GDP in 18 OECD Countries



Appendix C: Methodology of construction of RULC

Unit Labour Cost (ULC) combines information on (a) cost per unit of labour input and (b) an index of labour productivity. For country c at time t, we define *ULC* as follows (without subscripts):

$$ULC = \frac{W}{Y / N} \tag{C1}$$

W represents wages per worker measured as labour compensation per working hour while the lower ratio (Y/N) indicates labour productivity defined as value added per hour worked.[1] RULC aim to reflect cost competiveness in country *c* relative to cost in other countries of the sample. For that purpose, we weight ULC by the arithmetic mean of *ULC* in all countries of the sample (denoted by an overbar):

$$RULC_{c,t} = \frac{ULC_{c,t}}{\overline{\overline{ULC_t}}} \tag{C2}$$

For comparisons to be meaningful across countries, values in (C2) must be expressed in a common currency. We use Purchasing Power Parity (ppp)-exchange rate to express all values in constant 2000 USD; additionally, the mean unit labour cost is computed as:

$$\overline{ULC_t} = \frac{\frac{1}{c-1}\sum_{c=18} W}{\frac{1}{c-1}\sum_{c=18} (Y / N)} \tag{C3}$$

[1] The difference between *H* and *N* is that the former refers to total number of hours including self-employed while *N* refers only to total hours worked by employees.

Table D: Export performance among OECD countries: Tax receipts versus productive government spending

VARIABLES	1	2
RULC	-3.867***	-5.278***
	[-6.09]	[-5.87]
R&D	0.36**	0.111
	[2.41]	[0.68]
Tax	0.289***	
	[5.17]	
$(Tax)^2$	-0.003***	
	[-4.56]	
G^{pr}		0.198
		[0.59]
$(G^{pr})^2$		-0.006
		[-0.44]
Implied $\hat{\tau}$	42.9	16.03
Soc	-0.042***	-0.078***
	[-3.86]	[-4.27]
Country Dummies	Yes	Yes
Year Dummies	Yes	Yes
Observations	438	438
R-squared	0.99	0.98
F(24, 392)	1.0.8	0.72
Prob>F	(0.33)	(0.83)
F(17, 392)	918.20***	
Prob>F	(0.00)	

Notes: $G^{pr}_{c,t} \equiv G_{c,t} - Soc_{c,t}$ with $G_{c,t}$ being total government spending (consumption) – all variables as shares of GDP. 'Implied $\hat{\tau}$' is the export performance-maximising size of the respective measure of government size (total tax receipts or productive government spending).

Numbers in brackets below coefficients refer to absolute t-statistics. Asterisks denote significance as follows, *** at 1%, ** at 5%. In all specifications, the dependent variable is the share of exports of country *i* to total OECD exports. The estimator used in all specifications is OLS with country and year dummies where specified. The first F-statistic refers to the joint significance of year dummies and the second refers to the joint significance of country dummies. All estimates are consistent for cluster robust standard errors at the country level. $\hat{\tau}$ is the optimal (export performance maximising) tax share implied by the estimated coefficients with up to six decimal points.