On-Line Appendix of Commodity Taxation and Regulatory Competition

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A Theoretical Analysis

A .1 Strategic Interactions between Governments and Rent-Seeking Regulators

While in the main body of the paper we follow the public interest theory of regulation (Pigou [12]) and consider the regulator as a benevolent institution who cares about the product market functioning, our results also hold in the case of a bureaucrat-regulator endowed with a mixed objective function that encompasses the utility from workers' consumption as well as the utility power, patronage, image, prerequisites for his office, etc, (Niskanen [10]). Thies bureaucracy view of regulation can be conducted to the tollbooth view in which the regulator pursues his own interest (see Shleifer and Vishny [13] and Djankov *et al* [5]).[1]

Introducing this alternative view of regulation does not change anything in the structure of the economy. The characteristics of the demand of private good and public good follows in exact the same way as with the 'Helping Hand' regulator. The same is true for the behavior of firms and public agencies. Accordingly, the aggregate consumption level in the absence of taxes is still given by:

$$C = \frac{1}{\tau} C_0(n, n^*) \tag{A-1}$$

where

$$C_0(n, n^*) \equiv \frac{\sigma - 1}{\sigma} \left[n + \left(\frac{n}{n^*} \right)^{1-\frac{1}{\sigma}} n^* \right]^{\frac{1}{\sigma-1}} (n + n^*)^{\xi}$$

is the consumption level in the absence of taxes, which is a function of n and n^* only. It follows that $G = C_0 (\tau - 1) / \tau$.

Equation (A-1) is identical to $C_0(n, n^*)$ in the case of the benevolent regulator. It readily follows that stronger domestic regulation diminishes the level of domestic diversity n and therefore changes the utility from private consumption through the terms of trade W/W^*, and the reduction in total product diversity $n + n^*$. The effect of n on utility from product diversity depends on the consumers' taste for variety, ξ. This can be seen by computing the elasticity of private consumption with respect to n $\frac{\partial \ln C_0}{\partial \ln n}$, which is identical to the case of the benevolent regulator. As in the case of the benevolent regulator, this elasticity falls with foreign product diversity n^* if and only if

$$(n/n^*)^{-\frac{\sigma-1}{\sigma}} \left(\frac{1 + n/n^*}{1 + (n/n^*)^{\frac{1}{\sigma}}} \right)^2 > -\xi\sigma^2 (\sigma - 1) \tag{A-2}$$

[1] A different 'flavour' of the theory featuring regulation as a rent-seeking activity is the 'capture' view by Stigler [14] and Peltzman [11], where regulation is designed and operated primarily to benefit the whole regulated industry.

This condition holds when ξ is not too negative and does not hold for very negative ξ. About $n/n^* = 1$, it holds if and only if the love for variety is high enough, $\xi > -1/(\sigma^2(\sigma - 1))$.

As in the case of the benevolent regulator we model the interaction between governments and regulators as a sequential game in which regulators firstly set firms' entry requirements and then governments set their commodity tax rates. We thus take the view that regulatory processes and standards are less easy to restructure than commodity tax rates, and solve the game by backward induction.

We begin with the analysis of governments' competition in commodity taxes, which carries over identically as in the case of the benevolent regulator. After that, we turn to the analysis of regulatory competition, by relaxing the assumption of a benevolent regulator, and assuming bureaucrat-regulators instead, whose aim is to pursue their own interest as well as that of the consumers. Under this assumption, the regulation of product markets produces only red tape procedures that raise the fixed cost of firms.

Commodity Tax Competition

Each government sets the commodity tax rate that maximizes its residents' utility, holding a balanced budget and taking the other tax and the regulatory setting as given. Because the domestic government maximizes $U(C, G)$ or equivalently $U[C_0/\tau, C_0(\tau - 1)/\tau]$ and because C_0 is a function of only n and n^*, the optimal domestic commodity tax τ is independent from the foreign tax. Indeed, in this setup, firms pass the entire commodity tax τ "through" consumers and the destination principle rules out cross-border shopping.

Proposition 1 *Under the destination tax principle, there exists no strategic interaction in commodity tax rates.*

Proposition 1 holds identically for the case of rent-seeking regulator. In fact the (lack of) strategic interaction in commodity taxation under the destination principle is a well known result in the commodity taxation literature, which does not depend on the availability of other policy instruments (e.g. product market regulations).

The choice of commodity taxes is still described by $C + G = C_0(n, n^*)$. Thus, the government's problem is simply to find the private and public consumption bundles that maximize each individual's utility $U(C, G)$ subject to the total resource constraint $C + G = C_0$. This yields the standard Samuelson condition, as well as the condition

$$\left(\frac{\mathrm{d}\ln MRS}{\mathrm{d}\ln C} + \frac{\mathrm{d}\ln MRS}{\mathrm{d}\ln G}\right)\frac{\partial \ln C_0}{\partial \ln n} \geq 0$$

that needs to hold to guarantee the substitutability between commodity taxation and product market regulation (i.e. $d\tau/dn > 0$). Thus, we still have:

Proposition 2 *Suppose that private consumption increases with the number of domestic varieties ($n/n^* \leq \sigma^{\frac{\sigma}{\sigma-1}}$). Then, stronger product market regulation lowers commodity tax*

rates if and only if income has a stronger effect on the demand of public goods than on that of private goods.

Also Proposition 2 holds regardless of the characteristics of the welfare objective of the regulator, as it only features the choice of the commodity tax policy of the government, given a certain level of the fixed cost, thus a certain number of firms in the market.

Regulatory Competition

We now come to the interactions between regulators. From the previous section, we know that optimal commodity tax rates are independent instruments, but change according to the regulation intensity. For the sake of simplicity, we sterilize the effect of local regulation on local tax by assuming that the utility function of agents is log-linear, i.e., $U(C,G) = \alpha \ln C + (1-\alpha)\ln G$, where α is the specific domestic preference for private consumption. This utility function allows us to discuss the regulatory competition stage.[2] Under this assumption, the optimal commodity tax rate is equal to $\tau_0 = 1/\alpha$. The utility becomes $V(C_0) = \ln C_0 + \ln\left[\alpha^{\alpha}(1-\alpha)^{1-\alpha}\right]$. Similarly, the foreign country sets a tax $\tau_0^* = 1/\alpha^*$.

In the present section, we relax the assumption of benevolent regulator that protects consumers from product uncertainty. Intsead, we consider a bureaucrat-regulator who has a mixed objective function: maximize consumers' utility as well as his own utility from power, patronage, image and perquisites of his office. The discussion of benevolent regulators is of little interest in the present section. Any additional burden on local firms reduces product diversity and harms local consumers. As a result, regulators who maximize the utility of their consumers each have an incentive to avoid imposing unnecessary costs on firms. They should set zero regulation (assuming that they cannot subsidize firms' fixed costs). The competition between domestic and foreign regulators will then result in a zero regulation level everywhere.

For the sake of exposition, we assume there exists a bureaucrat-regulator that extracts utility from regulatory activities on domestic firms in the form of power, patronage or reputation. These activities take ultimately the form of red tape procedures that impose an extra input z on each firm's fixed input f_0. Hence, the objective function of the bureaucrat-regulator is

$$V(C_0) + \rho Z(nz)$$

where Z is an increasing and concave function and nz is the total amount of resources captured by the regulator on the n firms and redirected to "produce" power or patronage for himself and ρ is the weight that the regulator puts on his own benefit. [3] For analytical tractability, we set $Z(nz) \equiv \ln nz$. As a result of regulation, each firm's entry requires a

[2]There exist other utility functions that also yield constant tax rates (e.g. Cobb Douglas).

[3]Notice that the bureaucrat-regulator's objective function is fully aligned with the government's objective function if $\rho = 0$.

total fixed cost of $f = f_0 + z$. By the definition of n and n^*, the extra input is equal to $z = 1/(\sigma n) - f_0$. The domestic regulator therefore chooses the regulatory setup that satisfies the following first order condition:

$$V' \frac{\partial \ln C_0}{\partial \ln n} + Z' \left(\frac{\partial \ln (nz)}{\partial \ln n} \right) nz = 0$$

which in the log linear case simplifies to

$$\frac{\partial \ln C_0}{\partial \ln n} - \rho \frac{n\sigma f_0}{1 - n\sigma f_0} = 0. \tag{A-3}$$

The regulator balances his marginal benefit from larger power $Z(nz)$ (second term) with the fall in workers' consumption C_0 (first term), which relates to diversity and the terms of trade.

Because of country symmetry, the equilibrium is also symmetric: $n = n^*$. The domestic regulator reduces n to a rise in n^* if and only if $\partial \ln C_0 / \partial \ln n$ falls with a higher n^*, which holds under condition (A-2). Applying the latter at equilibrium, we find that the domestic regulator reduces n after a rise in n^* if and only if the love for variety is high enough, $\xi > -1/(\sigma^2 (\sigma - 1))$. In this case, regulation policies are strategic substitutes. The converse holds for the opposite condition.

This allows us to state the following proposition:

Proposition 3 *Regulation policies are strategic complements for a low taste for product variety $\xi \leq -1/(\sigma^2 (\sigma - 1))$ and strategic substitutes otherwise.*

Proof. We first check the sufficient condition for the bureaucrate regulator's optimal decision. We then give more detail on strategic complementarity of regulation policies.

For the sufficient condition, it can first can be checked that $\partial \ln C_0 / \partial \ln n > 0$ is true for all admissible ξ if $\sigma > 1$. Also, the second order condition becomes

$$\frac{\partial}{\partial n} \left(\frac{\partial \ln C_0}{\partial \ln n} \right) - \rho \frac{\sigma f_0}{(n\sigma f_0 - 1)^2} < 0$$

which should be satisfied globally. It is satisfied globally if and only if

$$\left(-\sigma^2 \xi + \sigma^3 \xi + 1\right) (n\sigma f_0 - 1)^2 - 4\rho n \sigma^2 (\sigma - 1) \sigma f_0 < 0 \tag{A-4}$$

At the symmetric equilibrium, we compute

$$n = n^* = \frac{2\sigma + (\sigma - 1)\sigma\xi - 1}{\sigma^2 f_0 ((\sigma - 1)(\xi + 2\rho) + 2)}$$

which gives a local second order condition whose sign is given by,

$$-\left(2\sigma - \sigma\xi + \sigma^2 \xi - 1\right)$$

that is satisfied for all admissible parameters.

The global second order condition is always satisfied under the restriction that $\rho > \frac{1}{4}\frac{(n\sigma f_0-1)^2}{n\sigma^3 f_0(\sigma-1)}$. Indeed, for $\xi = 0$, it is equivalent to the condition: $(n\sigma f_0 - 1)^2 - 4\rho n\sigma^2(\sigma-1)\sigma f_0 < 0$. This is always true for $\rho > \frac{1}{4}\frac{(n\sigma f_0-1)^2}{n\sigma^3 f_0(\sigma-1)}$. Since the above expression $(A-4)$ is linear increasing in ξ and negative at upper boundary of the set $[-1/(\sigma-1), 0]$, it is negative for any $\xi \in [-1/(\sigma-1), 0]$ if $\rho > \frac{1}{4}\frac{(n\sigma f_0-1)^2}{n\sigma^3 f_0(\sigma-1)}$.

Regulation policies are strategic complement instruments if and only if $dn/dn^* > 0$. At the interior symmetric equilibrium,

$$\text{sign}\frac{dn}{dn^*} = \text{sign}\left(-\frac{1}{4n}\frac{1+\sigma^2(\sigma-1)\xi}{\sigma^2(\sigma-1)}\right) \tag{A-5}$$

where the denominator is positive for any value of σ. Then, regulation policies are strategic complement if and only if the numerator is negative: $1+\sigma^2(\sigma-1)\xi < 0$, which confirms the proposition. ■

The intuition behind Proposition 3 is similar to the case of benevolent regulator, in that the behavior of regulators in the two countries is driven by both terms of trade and global variety effects. A relaxation of domestic regulation (higher n) raises the local purchasing power, but reduces the local regulator's utility from power and patronage. The point is how the relaxation of foreign regulation affects this balance. Consider first the case where consumers and regulators put no value on product diversity. Then, what matters is the terms of trade. When the foreign regulator relaxes his regulation intensity, more foreign firms enter so that the foreign production is boosted and puts an upward pressure on foreign wages and prices. The domestic terms of trade W/W^* become less favorable, reduce the home purchasing power, C_0, and increase the marginal purchasing power resulting from additional local varieties ($\partial \ln C_0/\partial \ln n$ increases with a larger n^*). The domestic regulator then has incentives to give up power and relax domestic regulation, to allow more domestic entry and restore the terms of trade. Regulatory decisions are thus strategic complements. By contrast, consider the case where consumers put a high value on product diversity. Now, what matters is the number of varieties in the economy. When the foreign regulator relaxes his regulation intensity, more foreign firms enter. Despite the decrease in the domestic terms of trade, the larger number of varieties increases the consumption of the regulator, allowing him to enjoy more power. Regulation policies are now strategic substitutes.

A .2 Competition between three countries

The main results of the theoretical model sketched above do not change in a scenario with three countries. We now concentrate on the case of three (symmetric) countries. Consider a third country denoted by a double star superscript **. The price indices now write as $\frac{P}{\tau} = \frac{P^*}{\tau^*} = \frac{P^{**}}{\tau^{**}} = \frac{\sigma}{\sigma-1}\left[nW^{1-\sigma} + n^*W^{*1-\sigma} + n^{**}W^{**1-\sigma}\right]^{\frac{1}{1-\sigma}}$. The entry condition writes as

$n = \frac{1}{\sigma f}$, $n^* = \frac{1}{\sigma f^*}$ and $n^{**} = \frac{1}{\sigma f^{**}}$. The consumption change writes as

$$C = \frac{1}{\tau} C_0(n, n^*, n^{**})$$

where

$$C_0(n, n^*, n^{**}) \equiv \frac{\sigma - 1}{\sigma} \left[n + \left(\frac{n}{n^*} \right)^{1-\frac{1}{\sigma}} n^* + \left(\frac{n}{n^{**}} \right)^{1-\frac{1}{\sigma}} n^{**} \right]^{\frac{1}{\sigma-1}} (n + n^* + n^{**})^{\xi}$$

is the consumption level in the absence of tax, which is a function of n, n^* and n^{**}.

Since C_0 does not depend on τ, commodity taxes are strategically independent policies, which confirms Proposition 1.

The choice of commodity taxes leads to the same standard Samuelson condition $U'_C/U'_G = 1$ and optimal tax rate. A government will set higher or lower tax rates depending on how the income effect affects private and public consumption as in Proposition 2.

The regulation policies are strategic complement under similar conditions as in the baseline model. The condition for complementarity is

$$\frac{\partial \ln C_0}{\partial \ln n} = \rho \frac{n\sigma f_0}{1 - n\sigma f_0} \tag{A-6}$$

where the RHS rises with higher n. Because of country symmetry, the equilibrium is also symmetric: $n = n^* = n^*$. The domestic regulator reduces n to a rise in n^* if and only if $\partial \ln C_0 / \partial \ln n$ falls with higher n^*. We compute at the symmetric equilibrium

$$\left[\frac{\partial}{\partial n^*} \frac{\partial \ln C_0}{\partial \ln n} \right]_{n=n^*=n^{**}} = -\frac{1}{9} \frac{\sigma^2 \xi (\sigma - 1) + 1}{n\sigma^2 (\sigma - 1)} < 0 \iff \xi > -\frac{1}{\sigma^2 (\sigma - 1)}$$

This is the same condition as in our main text. The case for three 'asymmetric' countries would follow those lines and those in the next response.

A .3 Different population size in Home and Foreign

The country size symmetry assumption helps the exposition of our model. However it turns out that asymmetry in country sizes does not qualitatively alter our results.

The main differences lie in the labor market and in the public good production. On the one hand, the labor supply L must clear with the labor demand and lead to the firm entry so that $n = \frac{L}{\sigma f}$ and the terms of trade are given by $\frac{W}{W^*} = \left(\frac{x}{x^*}\right)^{-\frac{1}{\sigma}} = \left(\frac{f}{f^*}\right)^{-\frac{1}{\sigma}} = \left(\frac{n/L}{n^*/L^*}\right)^{\frac{1}{\sigma}}$ where L and L^* are the country sizes. On the other hand, the production of public good G depends proportionally on the mass L of contributors so that $G = L(\tau - 1)C = LC_0 (\tau - 1)/\tau$. An individual in a larger country benefits from the contributions of a larger population in the public good provision. The private consumption becomes $C = \frac{1}{\tau} C_0$ where

$$C_0(n, n^*, \frac{L}{L^*}) \equiv \frac{\sigma - 1}{\sigma} \left[n + \left(\frac{n/L}{n^*/L^*} \right)^{\frac{\sigma-1}{\sigma}} n^* \right]^{\frac{1}{\sigma-1}} (n + n^*)^{\xi}$$

is the consumption level in the absence of tax, which is a function of n and n^*.

Since C_0 does not depend on τ, commodity taxes are strategically independent policies for any country size asymmetry, which confirms Proposition 1.

The optimal tax rate depends on the population sizes, which is not novel in public economics. The novelty may be that individuals' utility level increases with lower regulation since C_0 rises with higher L/L^*. But again, a government will set higher or lower tax rates depending on how the income effect influences private and public consumption in Proposition 2.

The regulation policies are strategic complement under similar conditions as in the model with same country sizes. We carried out the calculations finding that strategic complementarity occurs in the non-empty interval $\xi \in [-\frac{1}{(\sigma-1)}, -\frac{1}{(\sigma-1)}\frac{4b}{\sigma^2(b+1)^2}]$, where $b \equiv (L/L^*)^{\frac{1-\sigma}{\sigma}}$.

Given these results, for the readability of the paper, we have preferred not to include different country sizes in the main text.

A .4 Symmetric iceberg trade costs

In the main text we considered a setting with pure free trade (i.e. no transportation costs), because the introduction of trade costs does not yield very interesting results. We here briefly show the main changes and the invariance of our results.

We suppose an iceberg trade cost $t > 1$. The domestic price index is then related to the home location as $\frac{P}{\tau} = \frac{\sigma}{\sigma-1}\left[nW^{1-\sigma} + n^*W^{*1-\sigma}\phi\right]^{\frac{1}{1-\sigma}}$ where $\phi = t^{1-\sigma}$ is the *freeness of trade.* The terms of trade are given by $\frac{W}{W^*} = \left(\frac{f}{f^*}\right)^{-\frac{1}{\sigma}} = \left(\frac{n}{n^*}\right)^{\frac{1}{\sigma}}$, which are independent of trade costs. The private consumption is given by $C = \frac{1}{\tau}C_0$ where $C_0 \equiv \frac{\sigma-1}{\sigma}\left[n + \left(\frac{n}{n^*}\right)^{\frac{\sigma-1}{\sigma}} n^*\phi\right]^{\frac{1}{\sigma-1}} (n+n^*)^{\xi}$ is the consumption level in the absence of tax, which is a function of n, n^* and ϕ. It follows that $G = C_0(\tau-1)/\tau$. Consumption rises with freeness of trade. We show the following results:

First, since $C_0(n, n^*; \phi)$ does not depend on τ, commodity taxes are strategically independent policies under trade costs, which confirms Proposition 1.

Second, the choice of commodity taxes leads to the same standard Samuelson condition $U'_C/U'_G = 1$ and optimal tax rate. A maximum is guaranteed under the same assumptions. Proposition 2 remains valid if the condition $\frac{\partial \ln C_0}{\partial \ln n} > 0$ holds, which now depends on ϕ and implies mild restrictions on ϕ.

Finally, we have shown that regulations are strategic complement if and only if $\xi \in [-\frac{1}{(\sigma-1)}, -\frac{1}{(\sigma-1)}\frac{4\phi}{\sigma^2(\phi+1)^2}]$. This determines a non-empty interval that shrinks with larger freeness of trade ϕ. This extends Proposition 3. In practice, trade costs lead to very minor changes in this interval. For example, with the reasonable value $\sigma = 4$, the lower boundary of this interval is equal to -0.3333 while the higher boundary changes from $-0,0208$ with no trade cost ($t = 1$) to -0.0193 with a trade costs of 20% ($t = 1.2$).

To sum up, trade openness does not bring new results about the level of taxes and about the impact of local regulation on local taxes. Trade openness makes strategic complementarity of regulation less likely, but only to a small extent. Finally, it seems that trade openness does not add interesting testable empirical facts about the tax competition under destination principle in such a CES model.

A .5 Regulatory competition under other competition frameworks

The main paper discusses an economy with CES preferences and production and with monopolistic competition. This framework turns out to be useful for several reasons. Frameworks with CES and monopolistic competition are known to yield simple, closed form solution for price, profits and number of entrants, which dramatically simplifies the analysis of the regulation and entry. They are also used to obtain simple forms of demand and supply aggregations, which makes general equilibrium analysis easier to study analytically. In the following text, we discuss a similar version of the model with the standard Cournot competition model and show the additional complications of such models.

The economy consists of two countries: Home (H) and Foreign (F). In each country a perfectly differentiated good is produced, but both goods are globally consumed. The total number of workers/consumers in H is L_H and in F is L_F (size of the world equal to 1).

Consumer preferences

Preferences are represented by the function $U(x, y)$.Each consumer in country i, $i = H, F$ is endowed with one unit of labor that he supplies in the domestic market, for which he receives a wage. His budget constraint is $p_x x + p_y y = w_i, i$, $i = H, F$. Thus, the individual demand obtains by standard maximization problem

$$\begin{aligned} &\text{Max } U(x, y) \\ s.t.\ &p_x x + p_y y = w_i,\ i = H, F \end{aligned}$$

The general form of each individual's demand is

$$x = x(p_x, p_y, w_i) \quad \text{and} \quad y = s(p_x, p_y, w_i)$$

Total demands are

$$\begin{aligned} X(p_x, p_y, w_H, w_F) &= L_H x(p_x, p_y, w_H) + L_F x(p_x, p_y, w_F) \\ Y(p_x, p_y, w_H, w_F) &= L_H y(p_x, p_y, w_H) + L_F y(p_x, p_y, w_F) \end{aligned}$$

Inverse demands are the price function $P_x(X, Y, w_H, w_F)$ and $P_y(X, Y, w_H, w_F)$ that solve $X(p_x, p_y, w_H, w_F) = \overline{X}$ and $Y(p_x, p_y, w_H, w_F) = \overline{Y}$ for p_x and p_y.

Production

There are n firms in the domestic market and m firms in the foreign one. In each country, firms engage in Cournot competition, under which they decide on the quantities of supply to each country.

Let X_k be firm k's output. Each firm k in country i selects the quantity of the good to produce by solving the following problem:

$$\text{Max } \Pi_k(X_k, X_{-k}) = P_x(X, Y, w_H, w_F)X_k - F_H w_H$$

for a firm in country H. A similar problem writes for the firms that produce y :

$$\text{Max } \Pi_k(Y_k, Y_{-k}) = P_y(X, Y, w_H, w_F)Y_k - F_F w_F$$

At a symmetric Cournot equilibrium in each country, we find the optimal quantity produced by each firm k. This gives the equilibrium price

$$P_x^* = P_x(X^*, Y^*, w_H, w_F, n, m) \quad P_y^* = P_y(X^*, Y^*, w_H, w_F, n, m) \tag{A-7}$$

The entry condition for country H is

$$\Pi_k^* = 0 \iff P_x(X^*, Y^*, w_H, w_F, n, m)\frac{X^*}{n} = F_H w_H$$

with similar expression for country F. Solving this we get the equilibrium number of firms:

$$N = N(w_H, w_F, F_H) \quad \text{and } M = M(w_H, w_F, F_F) \tag{A-8}$$

Balanced trade

Trade is balanced so it must hold:

$$L_F x(P_x^*, P_y^*, w_F)P_x^* = L_H y(P_x^*, P_y^*, w_H)P_y^*$$

This conditions determines relative wages w_H/w_F as a function of the number of firms m and n. One wage can be used as the numeraire, say w_F. Using the above equation and the equilibrium level of wages w_H^* and w_F^*, we obtain a relationship between the countries size L_H, L_F and the number of firms in each country (n, m). The number of firms enter in P_x^* and P_y^*. So wages are found by the solution of this balance trace condition with $n = N(w_H, w_F, F_H)$ and $M = m(w_H, w_F, F_F)$. Let us denote them as

$$W_H = W_H(F_H, F_F)$$
$$W_F = 1$$

Bureaucrat regulator

A domestic bureaucrat regulator maximizes consumers' utility and his own patronage rents by setting z, a further fixed cost on each firm in the domestic market. So $F_H = F_0 + z_H$.

His constraint is $p_x x + p_y y = N z_H w_H$ where $N z_H$ are the resources allocated by the regulator to his patronage rents.

The domestic regulator selects z_H that maximizes

$$Z_H = \max_{z_H} V(x, y) + \rho N \left(w_H, w_F, F_0 + z_H\right) * z_H * W_H \left(F_0 - z_H, F_0 - z_F\right)$$

The foreign regulator selects z_F that maximizes

$$Z_F = \max_{z_F} V(x^*, y^*) + \rho M \left(w_H, w_F, F_0 + z_F\right) * z_F * 1.$$

To analyze tax and regulation competition in the model above, we assumed that the utility function of a consumer is:

$$U_i(x, y) = x + y - \frac{1}{2}x^2 - \frac{1}{2}y^2$$

We are unable to obtain a closed form solution of the above model because the expressions of prices (A-7) and entry (A-8) can not be obtained analytically. Therefore, we are unable to complete our analysis. As said earlier, we leave this issue to future research.

B Empirical Analysis

B .1 Data sources and construction

The main variables of interest are drawn from the OECD International Regulation Database; the OECD National Accounts and Revenue Statistics; the World Value Survey and the European Value Study. The other variables used in the analysis as controls or for robustness checks come from multiple sources: the OECD Economic Outlook; the World Bank's Database on Political Institutions (DPI), World Development Indicators (WDI) and Doing Business (DOBUS); the International Monetary Fund's Direction of Trade Statistics (DOTS); and the CEPII Gravity Dataset (CEPII). The reader will find below a precise description of the variables.

Product Market Regulation. We resort on two main indicators. The first one is the OECD, *ETCR* index. We restrict our attention on the 'low level' ETCR indicator which measures the barriers to entry of new firms in seven non-manufacturing industries: electricity, gas, air passenger transport, rail transport, road freight, and postal services. In the *energy sector* indicators for entry regulation focus on terms and conditions for third party access (TPA) and the extent of choice of supplier for consumers. Entry regulation in *rail transport services* distinguishes i) free entry (with access fees to the rail network infrastructure), ii) franchising to several firms and iii) franchising to a single firm. Entry regulation in *passenger air transport services* covers, on the domestic side, the liberalization of internal routes and, on the international side, the participation in an agreement liberalizing access to routes within a region. Entry regulation in *road freight* looks at more subtle ways in which entry can be thwarted in this eminently competitive sector: through a restrictive or discretional licensing system and through the intervention of incumbents in decisions concerning entry or price setting. In the *communication sector*, indicators for entry regulation are based on legal limitations on the number of competitors allowed in each of the post and telecommunications markets covered by the analysis (see Conway and Nicoletti [3] for further details).

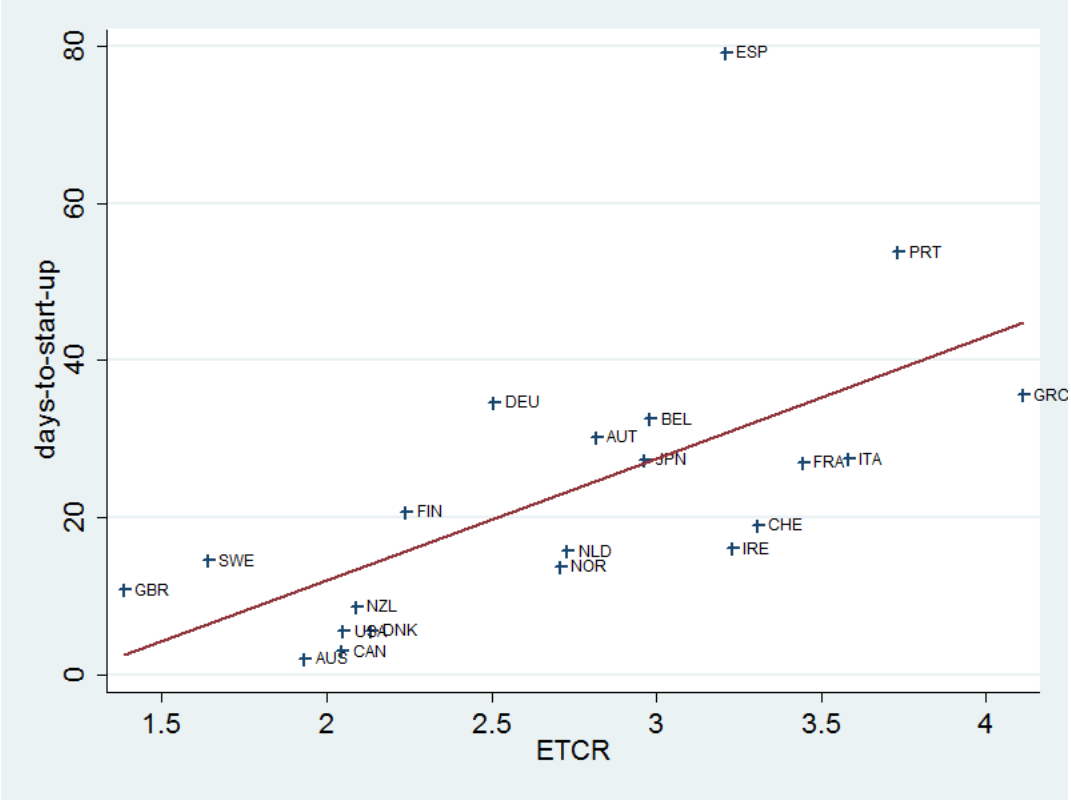
The second indicator is *days to start up* i.e. the number of days to set up a business. Compared to this indicator, drawn from Doing Business, World Bank, the ETCR variable covers a limited number of sectors. However, the ETCR measure is strongly correlated with the days-to-start-up measure in page 28 (towards the end of the first paragraph). This is shown in Figure 1 below. The correlation coefficient is 0.5 and significant at the 1% level.

CTAX: We followed the methodology by Carey and Rabesona [2] which computes the effective tax rates relating the tax revenues to the relative tax base. We thus apply the following formula

$$CTAX = \frac{T5110}{(CP + CG - CGW)} * 100 \tag{B-9}$$

where:

Figure 1: days to start up a business vs ETCR measure of product market regulations



T5110: general taxes on good and services (includes VAT, sales taxes and other taxes on goods and services; OECD Revenue Statistics).

CP: Private final consumption expenditure (OECD National Accounts).

CG: Government final consumption expenditure (OECD National Accounts).

CGW: Government final wage consumption expenditure (OECD National Accounts).

Notice that (B-9) is different from the definition provided by Carey and Rabesona [2] in that it excludes those revenues which are most likely not to depend on value added taxation, and to reflect the application of the origin principle to consumers' transactions. So the definition of $CTAX$ excludes excise taxes, profits of fiscal monopolies, custom and import duties and taxes on specific services.

Demand for order, Distrust others: *Demand for order* is constructed as the percentage of respondents which gives answer 1 (i.e., 'maintaining order in nation') to questions E003 in WVS1-5, V201 in EVS4, V190 in EVS3, Q532A in EVS2, V460 in EVS1. *Distrust others* is constructed as the percentage of respondents which gives answer 2 (i.e., 'Can't be too careful') to questions A165 in WVS1-5, V62 in EVS4, V66 in EVS3, Q241 in EVS2, V208 in EVS1. We assigned country observations for the available years to five periods, each period broadly corresponding to the intended coverage of a EVS/WVS wave. Alternative measures of DisTrust are the percentage of respondents which gives answer 4 (i.e., 'none at all') to questions $E069\_8$ in WVS1-5, V212 in EVS4, V207 in EVS3, q553i in EVS2, v546 in

EVS1 (how much confidence in civil service) and the percentage of respondents which gives answer 4 (i.e., 'none at all') to questions $E069\_13$ in WVS1-5, v219 in EVS4, 027 in EVS3, q554K in EVS2, v547 in EVS1 (how much confidence in major companies). The period is as follows:

1980-89: coverage by EVS1/WVS1 but for CHE, CZR and SLK covered by EVS2. Surveys carried in 1981 for AUS, BEL, DEU, DNK, ESP, FIN, FRA, GBR, IRE, JPN, NLD; 1982 for CAN, HUN, NOR, KOR, NOR, SWE, USA; 1984 for ICE and 1989 for CHE, CZR, POL, SLK.[4]

1990-94: coverage by EVS2/WVS2. Surveys carried in 1990 for AUT, BEL, CAN, DEU, DNK, ESP, FIN, FRA, GBR, ICE, ITA, JPN, KOR, NLD, NOR, POL, PRT, SWE, USA; 1991 for CZR, SLK, HUN. Notice that we have two observations for ESP (1990 and 1990) corresponding to both WVS2 and EVS2 being carried that year.

1995-99: coverage by EVS3/WVS3. Surveys carried in 1995 for AUS, ESP, JPN, USA; 1996 for CHE, FIN, KOR, NOR, SWE; 1997 for DEU and POL; 1998 for CZR, GBR, HUN, BEL, GBR, NZL, SLK; 1999 for AUT, BEL, CZR, DEU, DNK, ESP, FRA, GBR, GRC, HUN, ICE, IRE, ITA, NLD, POL, PRT, SWE, USA. Notice that we have two observations for ESP (1995 and 1999), DEU (1997 and 1999), GBR (1998, 1999), HUN (1998, 1999) and USA (1999), corresponding to both WVS3 and EVS3 being carried in those countries.

2000-04: coverage by WVS4 but for FIN and NZL, covered by EVS3 and WVS5, respectively. This period is generally not covered by any EVS wave, thus the majority of European countries is not surveyed. Surveys carried in 2000 for CAN, ESP, FIN, JPN; 2001 for KOR; 2004 for NZL.

2005-08: coverage by EVS4/WVS5. Surveys carried in 2005 for AUS, FIN, ITA, JPN, KOR, POL; 2006 for CAN, DEU, FRA, GBR, NLD, SWE, USA; 2007 for CHE, ESP; 2008 for AUS, CHE, CZR, DEU, DNK, ESP, FRA, GRC, HUN, IRE, NLD, NOR, POL, PRT, SLK. Notice that we have two observations for AUS (2005 and 2008), CHE (2007 and 2008), DEU (2006, 2008), ESP (2007, 2008), FRA (2006, 2008), NLD (2006, 2008), POL (2005, 2008), corresponding to both WVS5 and EVS4 being carried.

Observations were averaged out by country and period thus obtaining an unbalanced panel of (up to) 27 countries for the covering the period 1990-2008 in five years averages. Missing observations were obtained by linear interpolation. The initial observation covering the period 1980-89, has not been used in the empirical analysis, but provided the basis to obtain the observation for the period 1990-94 by linear interpolation rather than extrapolation for countries where observations were missing for this period.

[4]Data for former Czechoslovakia actually refer to 1990 but we decided to assign them to this period as 1990 in these countries is still representative of the pre-transition (transition in former Czechoslovakia was launched in 1991).

VAT, **EUVAT93**: Dummies equal to 1 when the VAT system/VAT EU system is introduced (OECD Consumption Tax Trends, 2008).

Other variables used in the analysis:

Euro: Dummy variable equal to 1 when a country accesses the European Monetary Union.

Right: Rightwing Orientation of the Government (EXECRLC=1, World Bank's DPI).

POP: Total population (millions of individuals, World Bank's WDI).

GDP: Gross Domestic Product, current US dollars (World Bank's WDI).

GDPxc: Per capita GDP: Gross Domestic Product/Total population (World Bank's WDI).

CGSH: Government final consumption expenditure as a share of total GDP (OECD National Accounts).

Irate: Long-term interest rate on government's bonds (OECD Economic Outlook).

Output gap: Percentage deviation of output from trend (OECD Economic Outlook).

Real exchange rate: Ratio of home country's prices to a weighted average of competitor country's prices, relative to a base year (2000) and measured in US dollars. Therefore an increase is an appreciation of the home country's real exchange rate (OECD Main Economic Indicators).

Trade to GDP ratio: Ratio of trade flows over total GDP (OECD Main Economic Indicators).

Tax Morale: percentage of respondents which give score 8-10 (i.e., 'always') to the question 'do you think it is justifiable cheating on taxes' (WVS/EVS).

Variables used for the construction of the weights

Imp: Total Imports in 1980, US dollars importer report (IMF DOTS).

contig: dummy equal to 1 if countries share a border (CEPII gravity dataset).

smctry: dummy equal to 1 if countries were are the same country (CEPII gravity dataset).

collink: dummy equal to 1 if countries have had common colonizer after 1945 or have ever had a colonial link or are currently in a colonia relationship (CEPII gravity dataset).

comlang: dummy equal to 1 if countries share a common official language or if a language is spoken by at least the 9% of the population in both countries. (CEPII gravity dataset).

legorig: dummy equal to 1 if countries share the same legal origin (Data on regulation used in Botero *et al.* [1]).

dist: distance between the most important cities/agglomerations (in terms of population) of the two countries (CEPII gravity dataset).

distwces: distance between the most important cities/agglomerations (in terms of population) of the two countries weighted by the share of the city in the overall country's population

according to the general formula by Head and Mayer [6] with sensitivity of trade flows to bilateral distance equal to -1 (CEPII gravity dataset).

B .2 False evidence of strategic interaction in commodity taxation in OLS estimates

In this Appendix we discuss the determinants and direction of the bias to OLS estimates in relation to both time invariant and time varying unobserved factors, in Table 1 of the main text in the paper.

In particular, in this section we demonstrate that the negative significant coefficient of $CTAX_{-i}$ in Column [5] is false evidence of strategic interaction (strategic substitutability in commodity taxation). As we will argue below, this negative coefficient is explained by the economic turmoil that followed the reunification of Germany i.e. the crisis of the European Monetary System and the systemic banking crises in Finland, Sweden and France (See Kovzanadze, I. (2010) "Systemic and Borderline Banking Crises: Lessons Learned for Future Prevention ", iUniverse). Governments hit by these shocks simultaneously increased their spending without increasing their tax revenues, which is reflected by a spatially correlated decrease of effective tax rates.

To support the above interpretation, in Table B-1 below we present a battery of robustness checks performed on the negative coefficient of $CTAX_{-i}$. First, we checked how the size and significance of the negative coefficient of $CTAX_{-i}$ is affected by the gradual exclusion of each year, starting from the first year in our sample i.e. 1990. The main findings from this first set of robustness is presented in Rows (2) and (3). The negative coefficient of $CTAX_{-i}$ loses significance once we exclude the years 1990-1995, and becomes not significant when we exclude years 1990-1997. These findings suggest that the negative effect of $CTAX_{-i}$ is driven by some unobserved event that occurred between 1990 and 1997. These were indeed the years of political and economic turmoil that followed in Europe after the reunification of Germany (1990), and that culminated with the crisis of the European Monetary System (1992-93), and the systemic banking crises of Sweden (1990-93), Finland (1991-94), and France (1991-98).

To further check whether this interpretation is plausible, we perform a second set of robustness checks, and run OLS FE estimates for the full period 1990-2008, but we exclude one-by-one each country in the sample. This second set of robustness is presented in Rows (4)-(9). These results are also very consistent with our interpretation: the negative sign of $CTAX_{-i}$ becomes not significant in Row (4), when we exclude from the sample Germany (thus the average of its trade partners). The negative coefficient of $CTAX_{-i}$ also becomes not significant when we drop Finland (Row (5)), Sweden (Row (6)), and France (Row (7)). Finally, the coefficient loses significance when we drop Switzerland (Row (8)) characterized

Table B-1: Coefficient of $CTAX_{-i}$ in the commodity tax response function: OLS FE specification

	Coefficient of $CTAX_{-i}$	(Standard Errors)	Observations
(1) baseline specification	–0.61**	(0.30)	390
Drop years			
(2) without 1990-1995	–0.67*	(0.35)	271
(3) without 1990-1997	–0.57	(0.38)	230
Drop countries			
(4) without Germany	–0.49	(0.31)	372
(5) without Finland	–0.23	(0.30)	372
(6) without Sweden	–0.36	(0.27)	372
(7) without France	–0.48	(0.31)	372
(8) without Switzerland	–0.52*	(0.31)	372
(9) without Italy	–0.52*	(0.30)	372

Note: the baseline specification is the one in Table 1, Panel a, Column [5] of the paper.

by strong trade relationship with Germany and Finland, and Italy (Row (9)) that was seriously hit by the EMS crisis.

B .3 Heterogeneity exercise: EU vs. non-EU countries

In this section we check for any heterogeneous effects between EU and non-EU countries. In Table B-2 below, we report 2SLS results when we distinguish between the effect of average trade partners' commodity taxes for EU and non-EU countries. The equation is exactly identified as it has three instruments for three endogenous regressors. Our result concerning the lack of strategic interaction in commodity taxes is preserved, and the interaction term $CTAX_{-i} * EU$ is not significantly different from zero. For this reason we decided not to add this robustness in the paper.

B .4 Ancillary tables

In this section we find other Tables that refer to the baseline analysis, which we did not include in the main body of the paper to save space.

Table B-2: commodity tax response: heterogeneous effects EU vs. non-EU countries

$CTAX_{-i}$	4.45
	(3.62)
$CTAX_{-i}$*EU	–3.78
	(3.74)
PMR	–0.56**
	(0.26)
EU	33.98
	(34.04)
R sq.	0.97
N	390

Table B-3: Means and standard deviation of VAT_{-i}

Trade partners of:	**mean**	**sd**
Australia	0.59	0.02
Austria	0.90	0.05
Belgium	0.94	0.02
Canada	0.29	0.01
Switzerland	0.94	0.00
Germany	0.87	0.06
Denmark	0.89	0.02
Spain	0.77	0.02
Finland	0.86	0.02
France	0.85	0.04
UK	0.70	0.03
Greece	0.85	0.02
Ireland	0.82	0.02
Italy	0.87	0.05
Japan	0.68	0.04
Netherlands	0.93	0.02
Norway	0.86	0.03
New Zealand	0.54	0.06
Portugal	0.85	0.02
Sweden	0.85	0.05
USA	0.97	0.07
Total	0.80	0.16

Notes: Average of the VAT dummy across each country's trade partner, weighted by the predicted import shares reported in Table C-2.

Table B-4: Commodity tax and regulation regulation response functions: other controls

	[1] OLS	[2] OLS FE	[3] 2SLS FE	[4] OLS	[5] OLS FE	[6] 2SLS FE
Panel a: Commodity tax response						
Total population	–0.03***	–0.07**	–0.05	–0.02***	–0.04***	–0.02**
	(0.00)	(0.03)	(0.07)	(0.00)	(0.01)	(0.01)
GDP per capita	0.09***	0.17**	0.91***	0.01	0.23***	0.25***
	(0.02)	(0.09)	(0.26)	(0.03)	(0.02)	(0.04)
Rightwing government in office	–0.69*	–0.04	0.26	–0.63***	0.02	0.01
	(0.37)	(0.11)	(0.23)	(0.22)	(0.08)	(0.09)
Government consumption	0.40***	–0.17**	–0.08	0.45***	0.12***	0.13***
	(0.06)	(0.08)	(0.13)	(0.04)	(0.03)	(0.03)
Real interest rate	1.04***	–0.04	–0.08	0.18***	–0.21***	–0.21***
	(0.19)	(0.14)	(0.20)	(0.07)	(0.03)	(0.03)
Real exchange rate	0.01	–0.01	–0.00	–0.05***	0.00	0.00
	(0.04)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)
Member of European Union				–0.64	0.19	–0.21
				(0.53)	(0.28)	(0.34)
Member of EURO area				0.14	–0.33***	–0.53***
				(0.32)	(0.12)	(0.14)
Applies European VAT with hybrid DP/OP				0.35	–0.47***	–0.54***
				(0.40)	(0.17)	(0.19)
Panel b: Regulation response						
Total population	0.04	1.63***	0.39	–0.00***	0.03***	0.03***
	(0.03)	(0.60)	(0.64)	(0.00)	(0.00)	(0.00)
GDP per capita	–1.76***	8.98***	5.74**	–0.01	0.09***	0.10***
	(0.40)	(2.19)	(2.30)	(0.01)	(0.02)	(0.02)
Rightwing government in office	3.05	8.09**	8.76***	–0.11*	–0.12**	–0.12**
	(3.09)	(3.16)	(3.26)	(0.07)	(0.05)	(0.05)
Government consumption	–1.59***	–1.82	–0.50	–0.06***	0.05*	0.04
	(0.50)	(1.70)	(1.59)	(0.01)	(0.03)	(0.02)
Real interest rate	–8.13***	1.55	0.08	–0.02	0.01	0.01
	(1.24)	(2.47)	(2.29)	(0.02)	(0.02)	(0.02)
Real exchange rate	–0.41**	0.04	–0.18	–0.00	–0.01**	–0.01**
	(0.18)	(0.17)	(0.20)	(0.00)	(0.00)	(0.00)
Member of European Union				0.02	0.19	0.17
				(0.18)	(0.19)	(0.18)
Member of EURO area				–0.06	–0.50***	–0.53***
				(0.11)	(0.11)	(0.10)
Applies a VAT system				–0.01	–0.39**	–0.38**
				(0.14)	(0.16)	(0.15)
Applies European VAT with hybrid DP/OP				–0.28	–0.31**	–0.32**
				(0.18)	(0.14)	(0.13)

Notes: These are the coefficients of the control variables in estimates reported in Table 1. Estimates in Columns[1]-[3] use the days to start up a business measure of PMR, while estimates in Columns [4]-[6] use the ETCR measure. Significance levels: $*$: 10% $**$: 5% $***$: 1%.

Table B-5: Simultaneous equations models - trade partners' equations

	[1] **SUR**		[2] **SUR, FE**		[3] **3SLS, FE**	
	$CTAX_{-i}$	PMR_{-i}	$CTAX_{-i}$	PMR_{-i}	$CTAX_{-i}$	PMR_{-i}
CTAX	0.03***		–0.04***		–0.01	
	(0.00)		(0.01)		(0.01)	
PMR_{-i}	0.36***		–0.16***		–0.49***	
	(0.06)		(0.05)		(0.09)	
VAT_{-i}	–0.65		0.51**		0.90**	
	(0.50)		(0.21)		(0.21)	
PMR		0.25***		0.08***		0.13***
		(0.02)		(0.01)		(0.01)
Demand order (%) $-i$		0.02***		0.02***		0.02***
		(0.01)		(0.00)		(0.00)
Distrust others (%) $-i$		–0.05***		0.06***		0.05***
		(0.01)		(0.00)		(0.00)
N	389	389	389	389	389	389

Notes: Foreign counterparts of SUR and 3SLS estimates of four equations' system with four endogenous variables (*CTAX*, *PMR*, PMR_{-i}, PMR_{-i}). estimates for the domestic country are reported in Table D-2. Robust standard errors in parentheses. Significance levels: $*$: 10% $**$: 5% $***$: 1%.

Table B-6: Additional controls for the estimates with alternative specifications

	[1]economic cycle	[2]trade openness	[3]tax morale	[4]regulation competition
Panel a: Commodity tax response				
Output gap	0.01			
	(0.03)			
Trade-to-GDP ratio		0.01		
		(0.01)		
Tax morale			–0.01**	
			(0.00)	
PMR_{-i}				-0.00
				(0.23)
Panel b: Regulation response				
Output gap	–0.05***			
	(0.02)			
Trade-to-GDP ratio		0.00		
		(0.00)		
Tax morale			0.01**	
			(0.00)	

Notes: 2SLS estimates with robust standard errors in parentheses. Column [1] in the present table completes estimates presented in Table D-5, Column [3]; Column [2] in the present table completes estimates presented in Table D-5, Column [4]. Column [3] in the present table completes estimates presented in Table D-5, Column [5]. Column [4] in the present table completes estimates presented in Table D-5, Column [7] Significance levels: $*$: 10% $**$: 5% $***$: 1%.

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