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A Note on International Emissions Trading with Endogenous Allowance Choices.

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Abstract

In this note we extend the analysis developed by Helm (2003) and consider an international emissions trading system (ETS) where the initial allocation of tradeable permits may be chosen non cooperatively, as in Helm, or cooperatively. We first derive conditions guaranteeing that polluting firms located in a given country benefit from an increase in the received amount of emission permits; then, we compare the countries' allocation choices under both a non-cooperative (decentralized) and a cooperative (centralized) regime, showing that, both in each country and on aggregate, decentralization leads to a lower environmental quality than the "first best" that would arise under a centralized ETS. As a result, the equilibrium permits price in the latter case is higher than under decentralization. We show that this conclusions do not depend only on the presence of transboundary pollution, but also on the international dimension of emissions trading. Finally, although centralization leads to higher welfare and better environmental quality, we find that some countries might not consent to it and, moreover, we identify cases where consensus on centralization cannot be recovered by simply redistributing permits among countries.

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1. Introduction

There are two main theoretical arguments supporting the choice of a system of tradeable emission permits, namely cost effectiveness and low informational requirement. Indeed, as it has been shown in the seminal article of Montgomery (1972), a certain environmental target can be reached at minimum cost for society by allocating a corresponding number of pollution permits that can be exchanged on a perfectly competitive market. Moreover, permits' trading allows cost effectiveness even if the environmental regulator has no information on the marginal abatement cost functions of the polluting sources. However, as it is shown in Helm (2003), such appealing theoretical characteristics can be affected by the possibility of trading permits on an international market where there is no central authority and the power of determining the initial allocation of permits is appointed to independent sovereign states.

More specifically, Helm (2003) analyzes a theoretical framework where emission permits can be allocated under two alternative regulatory regimes - namely with and without the possibility of trading permits - finding that environmentally less concerned countries would choose more allowances when these are tradeable, while environmentally more concerned countries would choose less allowances. The overall effect on emissions is ambiguous in general, but the possibility of trading may induce more pollution when the higher number of permits chosen by environmentally less concerned countries offsets the choices of the more concerned ones.

In this paper we extend the analysis developed by Helm (2003) and consider an international emissions trading system (ETS) where the initial allocation of tradeable permits may also be chosen cooperatively, that is as if it were delegated to a central authority. This extension is valuable for at least two reasons. First of all, it allows us to embody into the model an important feature of some international ETS such as, for instance, the EU ETS where permits are traded at the Union level and - even if each member state has a certain degree of freedom in specifying both the national total amount of permits and how this amount must be divided among sectors and installations subject to regulation - the allocation process is ultimately subject to the European Commission approval (Directive 2003/87/CE). Further, the EU Commision is currently strenghtening the degree of control exerted on the EU wide cap, which implies taking the EU ETS even closer to a standard centralized ETS[1]. Secondly, by extending the analysis also to the case where the initial allocation of permits is chosen in a cooperative way, we can provide some results which are new with respect to the received literature on international ETS.

Indeed, by a two stage game based on the Helm's (2003) model, we first derive conditions guaranteeing that polluting firms located in a given

[1]See Directive 2009/29/CE, articles 9 and 10 bis.

country benefit from an increase in the received amount of emission permits; then, we compare the countries' allocation choices under both a non-cooperative (decentralized) and a cooperative (centralized) regime. This comparison would suggest that proposals of an international ETS based on "...a subsidiarity principle, with permits allocated domestically by the countries themselves..." (Tirole, 2009), should be carefully evaluated accounting for the related efficiency as well as environmental costs.

We show that decentralizing an ETS brings about lower environmental quality in each country, regardless of its position in the permits market (i.e. net seller or net buyer). As we show, this result depends on a negative externality across countries arising as a consequence of the permits' market *per se* while the possibility that environmental damages cross national borders does not represent a necessary condition to have more emissions under the decentralized regime. In fact, the initial allocation of permits in one country affects the polluting activities of all countries *via* its effect on the permits' price and national environmental authorities do not take this aspect into account when they independently choose the number of permits to be assigned at home. This result suggests a possible theoretical rationale for the increasing control the EU is exerting on the initial allocation process. Nevertheless, when we focus on the welfare implications of a centralized ETS for single governments, we observe that, although centralization leads to higher welfare and better environmental quality, some countries might not consent to it, because their welfare may decrease under this regime. Moreover, even if the centralized regulator could reallocate permits in order to compensate the losing countries, there might be cases where no redistribution of permits leads to unanimity on centralization.

Other theoretical papers deal with questions which are related to the issue analyzed in this paper. Boom and Dijkstra (2006), for instance, expand the analysis of Helm (2003) by including also boundary solutions; however, they do not consider any form of cooperation among countries. Böhringer and Lange (2005), instead, deal with the optimal design for allocating tradeable emission permits showing how this depends on whether the system is either centralized or decentralized. The main focus of their paper, however, is not on the optimal emissions target but, rather, on the most appropriate metrics for the allocation of allowances - namely lump sum allocation versus assignment rules which allocate permits proportionally to the emissions or production of the preceding periods.

The main features of our model are presented in the next section whereas the rest of the paper is organized as follows. Section 3 derives the conditions characterizing the optimal emission choices by regulated firms. In section 4 we compare the optimal choices of allowances under the two regulatory regimes and emphasize the main international spillovers leading to inefficient outcomes under a decentralized ETS. Section 5 focuses on some welfare implications for single governments. Finally, section 6 contains some short concluding remarks.

2. The structure of the model

We consider a stylized model representing a set of I countries, indexed by $i = 1, .., I$. In each country there are a large number of atomistic firms that can be dealt with as I representative firms, one in each country. Each firm generates polluting emissions e_i. Benefits from pollution, $\pi_i(e_i)$, are assumed to be increasing and strictly concave in emissions, i.e. $\pi_i'(e_i) > 0$ and $\pi_i''(e_i) < 0$. Pollution is assumed to be uniformly mixing and the related damage in each country is assumed to depend on total emissions according to a function $v_i(e)$, $i = 1, .., I$, where $e = \sum_{i=1}^{I} e_i$ are total emissions. This assumption is retained for the sake of reality to represent an international emission trading scheme regulating a global pollutant like CO_2 but, as it will appear evident when we discuss the spillovers among countries, it is not needed for our results to hold. As it is standard, environmental damages are assumed to be increasing and strictly convex in total pollution, that is, $v_i' > 0$ and $v_i'' > 0$. The firm of each country i receives an amount of emission permits, ω_i, that can be traded on a perfectly competitive international market.

The interactions among firms and countries are defined by the following two stage game of complete (but imperfect) information. In the first stage each country i chooses the amount of emission permits, ω_i, to be issued to the representative firm i. We analyze such a decision under two alternative institutional frameworks, namely a *decentralized* and a *centralized* one. Under the *decentralized* framework, countries play a simultaneous-move "Cournot-Nash game": each country chooses the amount of permits to be issued to the firm located within its national borders and takes other countries' choices as given. In this case, each country i chooses ω_i in order to maximize the domestic welfare function

$$W_i = \pi_i(e_i(\omega)) - v_i(\omega) - p^*(\omega)(e_i(\omega) - \omega_i) \tag{1}$$

where $\omega = \sum_{i=1}^{I} \omega_i$, $p^*(\omega)$ is the equilibrium price arising in the permits market, and the term $-p^*(\omega)(e_i(\omega) - \omega_i)$ is the amount of money the representative firm in country i spends if it is a net buyer of permits (i.e. if $e_i - \omega_i$ is positive), or earns if it is a net seller of permits (i.e. if $e_i - \omega_i$ is negative). Under the *centralized* framework instead countries behave cooperatively, as if they were appointing the power of allocating permits to a single supranational authority maximizing the following aggregate global welfare function

$$W = \sum_{i=1}^{I} \pi_i(e_i(\omega)) - \sum_{i=1}^{I} v_i(\omega) - p^*(\omega) \sum_{i=1}^{I} (e_i(\omega) - \omega_i) \tag{2}$$

In the second stage, given the permits price $p^*(\omega)$ and the received amount of allowances ω_i, each firm chooses the level e_i^* maximizing the net benefit from pollution,

$$\Pi_i = \pi_i(e_i) - p(e_i - \omega_i). \tag{3}$$

and satisfying the after-trade market clearing condition $\sum_{i=1}^{I} \omega_i = \sum_{i=1}^{I} e_i^*$. We solve this game backward in order to identify the subgame perfect Nash equlibria.

3. Second stage: the firms

First order, necessary and sufficient, conditions for the maximization of (3) require:

$$\pi_i'(e_i^*) = p^* \qquad i = 1, .., I. \tag{4}$$

Together with the market clearing condition in the permits market, (4) implicitly defines the optimal emission level e_i^* and the equilibrium permits price p^*. Using standard comparative statics (see Helm, 2003) it can be easily shown that:

$$p'(\omega) = \frac{1}{\sum_{i=1}^{I} \frac{1}{\pi_i''(e_i^*)}} < 0 \tag{5}$$

that is, an increase in allowances decreases the equilibrium permits price, and

$$e_i'(\omega) = \frac{1}{\pi_i''(e_i^*)} \frac{1}{\sum_{j=1}^{I} \frac{1}{\pi_j''(e_j^*)}} \in (0, 1) \tag{6}$$

that is, a marginal increase in allowances increases emissions in any country i by less than the increase itself.

Before moving to the first stage, it can be worthwhile to analyze here how firms' maximum benefits vary with the initial endowment of permits. We have to consider two possible effects related to a change in the amount of emission permits. First of all there is a direct positive effect: getting more emission permits makes firms better off as they can either sell more or buy less permits. We call this the "wealth effect". On the other hand, firms' benefits are also indirectly affected by the number of issued allowances through the negative relationship between p^* and ω_i $(i = 1, ..., I)$. This second effect, that we define as the "price effect", is positive (negative) if the firm is a net buyer (seller) of permits. Therefore we can state the following result:

Proposition 1. *Increasing the amount of emission permits allocated in country i makes firm i better off*

- *always, when firm i is a net permits buyer*
- *only if the "wealth effect" dominates the "price effect" when firm i is a net permits seller.*

Proof. See the Appendix

□

Proposition 1 allows us to say what type of firms prefer the allocation regime leading to a higher number of issued allowances and what firms prefer the most stringent one. Note that a crucial role is played by the concavity of benefits from emissions. Indeed, a sufficiently small absolute value of $\pi_i^{''}(.)$ in one or more countries would bring about a low reactivity of the equilibrium price of permits, making positive net benefits for net sellers more likely.

4. First stage: the countries

We start by analyzing the *decentralized* setting. This regime corresponds to the emissions trading system analysed in Helm (2003), where the amount of emission allowances to be issued is set non cooperatively by sovereign states. Under this circumstance in the first stage of the game each country i chooses the amount of emissions allowances to maximize (1) leading to the following optimum conditions[2]:

$$\pi_i'(e_i^*(\omega^D))e_i^{*\prime}(\omega^D)-v_i'(\omega^D)-p^{*\prime}(\omega^D)(e_i^*(\omega^D)-\omega_i^D)-p^*(\omega^D)\left(e_i^{*\prime}(\omega^D)-1\right)=0 \tag{7}$$

As in equililbrium $\pi_i'(e_i^*(\omega)) = p^*(\omega)$, (7) can be rewritten as:

$$\pi_i'(e_i^*(\omega^D)) - v_i'(\omega^D) - p^{*\prime}(\omega^D)(e_i^*(\omega^D) - \omega_i^D) = 0 \tag{8}$$

Adding up (8) across countries and using (4) we can finally conclude that, in the decentralized equilibrium,

$$\pi_i'(e_i^*(\omega^D)) = \frac{1}{I}\sum_{i=1}^{I} v_i'(\omega^D). \tag{9}$$

Under the *centralized* setting, instead, the number of allowances in each country is chosen in order to maximize (2). Given the market clearing condition, the last term of (2) cancels out in equilibrium and we get the following social optimum condition for each $i = 1, .., I$:

$$\sum_{i=1}^{I} \pi_i'(e_i^*(\omega^C))e_i'(\omega^C) - \sum_{i=1}^{I} v_i'(\omega^C) = 0 \tag{10}$$

[2] Both in the *centralized* and in the *decentralized* case we limit our attention to interior solutions.

Substituting from (6) and (4), we can show that:

$$\sum_{i=1}^{I} \pi_i'(e_i^*(\omega^C))e_i'(\omega^C) = p^*(\omega^C)\sum_{i=1}^{I} e_i^{*\prime}(\omega^C) = p^*(\omega^C)$$

and then (10) can be rewritten as:

$$\pi_i'(e_i^*(\omega^C)) - \sum_{i=1}^{I} v_i'(\omega^C) = 0 \tag{11}$$

By definition this is, in our setting, the first best.

In what follows we get some insights by the first order conditions derived in this section. First of all, we analyze the impact of a change in ω_i on any other country $j \neq i$. We can identify two spillovers among countries when the amount of emission allowances is chosen non cooperatively in order to maximize domestic welfare. Accounting, again, for (4), we get

$$\frac{\partial W_j}{\partial \omega_i} = -v_j'(\omega) - p^{*\prime}(\omega)(e_j^*(\omega) - \omega_j) \tag{12}$$

The term $-p^{*\prime}(\omega)(e_j^*(\omega) - \omega_j)$ identifies the first spillover. This is a *trade spillover* whose sign depends on firm j being a net buyer or seller of permits. An increase in ω_i makes country j better (worse) off if firm j is a net buyer (seller) of permits. However, we can conclude from Walras' law that the trade spillover must cancel out on aggregate and it is therefore expected to lead only to distributional consequences.

The term $-v_j'(\omega)$ identifies the second spillover. This is a negative, *environmental* spillover: indeed, an increase in ω_i decreases the equilibrium permits price, leading to an increase in emissions and, therefore, environmental damages in all countries. It is worthwhile to note that this is an international spillover that is not internalized under a *decentralized* emission trading system and that does not depend on the transboundary nature of pollution but rather on the *international dimension* of emissions trading. Indeed, since $v_j(\omega) = v_j(\sum_{i=1}^{I} e_i(p(\omega)))$, then

$$v_j'(\omega) = v_j'(\cdot)\sum_{i=1}^{I} e_i^{*\prime}(p^*)p^{*\prime}(\omega) \tag{13}$$

that is, an increase in ω_i decreases the equilibrium permits price, leading to an increase in emissions in all countries and, therefore, to an increase in environmental damages. Even in the absence of transboundary pollution, this spillover would survive since, in this case, the expression on the right hand side of (13) would collapse to $v_j'(\cdot)e_j^{*\prime}(p^*)p^{*\prime}(\omega)$ which is still positive.

The presence of negative spillovers that would not be internalized in a *decentralized* setting suggests that the emissions level and, therefore, the number of allowances chosen by independent sovereign states under the *decentralized* regime exceed the first best level. At first glance this inefficiency could be thought as an extension to an emissions trading context of the standard free riding problem arising, for example, in the private provision of public goods. The extension is, however, not straightforward. Indeed, given the nature of the *environmental* spillover $-v_j'(\omega)$, we can expect a lower environmental quality to arise under decentralization even in the absence of standard international externalities. Indeed, we can remove the initial assumption of transboundary pollution and prove the following result.

Proposition 2. *Even if we assume that no transboundary pollution takes place, that is $v_i(e) = v_i(e_i)$ for any $i = 1,..,I$, the environmental target under a decentralized emission trading system is always larger than under first best and the resulting equilibrium permits price is lower. As a result, decentralized emissions trading equilibrium features larger emissions in each country.*

Proof. See the Appendix

□

Proposition 2 shows that decentralizing an ETS brings about lower environmental quality in each country, regardless of its position in the permits market (i.e. net seller or net buyer). Moreover, it shows that the international externality due to transboundary pollution does not represent a necessary condition to have excessive emissions under the decentralized regime. Indeed, such inefficiency is due to the international dimension of the permits' market *per se*, even if, of course, it would be reinforced in the presence of transboundary pollution.

Finally, following Helm (2003) and defining countries with $\pi_i'(e_i^*(\omega)) - v_i'(\omega) > 0$ as low-damage countries, and those with $\pi_i'(e_i^*(\omega)) - v_i'(\omega) < 0$ as high-damage countries, we can easily verify, from (8), that Helm's Proposition 1 holds, i.e. in the *decentralized* equilibrium all permit sellers are located in low-damage countries and all permit buyers are located in high-damage ones. Further, we can use (9) to restate Helm's result as follows: countries featuring *lower than average* marginal damages are net sellers and countries featuring *higher than average* marginal damages are net buyers in the decentralized equilibrium. On the other hand, Helm's line of reasoning cannot be extended straightfowardly to the *centralized* setting. Indeed, (11) can be rewritten as

$$\pi_i'(e_i^*(\omega^C)) - v_i'(\omega^C) = \sum_{j\neq i}^{I-1} v_j'(\omega^C) > 0$$

implying that Helm's definition is not very informative in assessing the net selling or buying behaviour of firms under centralization. This disappointing result comes from the standard conclusion that the initial allocation of permits by a single authority does not matter for efficiency in a fully functioning ETS[3].

5. Welfare effects of centralization

This section investigates the incentives of governments to agree on a centralized ETS vs. a decentralized setting. To this end, we focus on the welfare implications for single governments choosing between a decentralized ETS and a centralized one.

Proposition 3. *Even if centralization implies higher welfare and lower aggregate emissions,* a*) some countries might not consent to it, and* b*) redistribution of permits among countries could not be enough to guarantee unanimity on centralization.*

Proof. See the Appendix

□

Proposition 3 shows that unanimity on a centralized ETS might not be reached even though it would be welfare improving. Indeed, we cannot rule out the possibility that centralization could be opposed by countries which lose in terms of net benefits more than they gain in terms of lower damages from centralization. Moreover, even if the higher total welfare under the centralized regime could, in principle, be redistributed in such a way to compensate those countries that would be better off under a decentralized regime and to achieve unanimity on centralization, we have shown that this might not be always possible. Specifically, redistribution of permits could be an ineffective policy tool in recovering unanimity.

6. Concluding remarks

This note provides some new insights on the international emissions trading analysis of Helm (2003). By extending the Helm's model and comparing it to an alternative setting where the initial allocation of permits is chosen in a cooperative/centralized way, we have shown that decentralization leads to a lower environmental quality, in each state as well as on aggregate, with respect to "first best", i.e. to a *centralized* ETS. We have investigated the channels through which this inefficiency arises, identifying an international price related externality which does not depend on the transboundary nature of the pollutant at hand. Moreover we have shown how firms' profits are affected by the choice of the degree of centralization. Finally, although centralization seems to be better both under a social welfare and under an environmental quality point of view, some governments might oppose it on

[3] See, for example, Tietenberg (2006, Chapter 6).

the ground that it lowers their welfare. Such opposition might be "robust" to any redistribution of permits, suggesting limits to the flexibility of an ETS in compensating countries losing from centralization. Altogether our theoretical results carry an important policy implication, advocating the need for centralization to be imposed to countries involved in an international ETS and not left open to the lobbying pressure of national governments or firms that might prefer the less stringent decentralized regime.

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Appendix

Proof of Proposition 1 Differentiating Π_i w.r.t. ω_i we get:

$$\frac{\partial \Pi_i}{\partial \omega_i} = \frac{d\pi_i}{de_i}\frac{de_i}{dp}\frac{\partial p}{\partial \omega_i} - \frac{\partial p}{\partial \omega_i}e_i^* + \frac{\partial p}{\partial \omega_i}\omega_i - \frac{de_i}{dp}\frac{\partial p}{\partial \omega_i}p^* + p^*$$

that, by using (4), can be simplified to

$$\frac{\partial \Pi_i}{\partial \omega_i} = p^* - \frac{\partial p}{\partial \omega_i}(e_i^* - \omega_i). \tag{14}$$

The first term on the right hand side is the "wealth effect" related to an increase in the initial endowment of permits, while the second is the "price effect", whose sign depends on the firm being net buyer or seller of permits. It is clear that $\frac{\partial \Pi_i}{\partial \omega_i} > 0$ if $e_i^* > \omega_i$, while the sign of $\frac{\partial \Pi_i}{\partial \omega_i}$ is ambiguous if $e_i^* \leq \omega_i$.

Proof of Proposition 2 Assume no transboundary pollution takes place. This implies $v_i(.) = v_i(e_i(\omega))$ for all i.We first show that $\omega^C < \omega^D$. We can rewrite (9) as:

$$\pi_i'(e_i^*(\omega^D)) - \sum_{i=1}^{I} v_i'(.)e_i^{*\prime}(\omega^D) = \left(\frac{1}{I} - 1\right) \sum_{i=1}^{I} v_i'(.)e_i^{*\prime}(\omega^D) < 0$$

and (11) as:

$$\pi_i'(e_i^*(\omega^C)) - \sum_{i=1}^{I} v_i'(.)e_i^{*\prime}(\omega^C) = 0.$$

Comparing the two conditions it is straightforward to conclude that, if second order conditions for strict concavity under centralization are satisfied, it must be $\omega^C < \omega^D$. As, from (6), $e_i'(\omega) > 0$, it must be $e_i^*(\omega^C) < e_i^*(\omega^D)$ for all countries i. The proof is concluded by noting that, from comparative statics, $p'(\omega) < 0$.

Proof of Proposition 3 Consider a two countries case and assume a quadratic shape for firms' and countries' objective functions, such that $W_1 = e_1 - \alpha_1 \frac{e_1^2}{2} - p\left(e_1 - \omega_1\right) - \frac{\beta_1}{2}\left(\omega_1 + \omega_2\right)^2$ and $W_2 = e_2 - \alpha_2 \frac{e_2^2}{2} - p\left(e_2 - \omega_2\right) - \frac{\beta_2}{2}\left(\omega_1 + \omega_2\right)^2$ where α_i and β_i $(i = 1, 2)$ measure the effect of emissions on benefits and damages in the two countries. Just for the sake of simplicity and without loss of generality for the aim of this proof, let us focus on a specific normalization of these parameters such that $\alpha_1 = \alpha$, $\alpha_2 = 1 - \alpha$, $\beta_1 = \beta$ and $\beta_2 = 1 - \beta$, $\alpha, \beta \in [0, 1]$.

Solving the model under these specifications, we obtain the following values: $\omega_1^D = \frac{\alpha(1-\alpha)(3-4\alpha)+1-2\beta}{\alpha(1-\alpha)(1+\alpha(1-\alpha))}$, $\omega_2^D = \frac{2\beta-1-\alpha(1-\alpha)(1-4\alpha)}{\alpha(1-\alpha)(1+\alpha(1-\alpha))}$, $p^D = \frac{1-\alpha(1-\alpha)}{1+\alpha(1-\alpha)}$, $e_1^D = \frac{2(1-\alpha)}{1+\alpha(1-\alpha)}$, $e_2^D = \frac{2\alpha}{1+\alpha(1-\alpha)}$ under the decentralized regime, and $\omega^C = \omega_1^C + \omega_2^C = 1$, $p^C = 1 - \alpha(1-\alpha)$, $e_1^C = (1-\alpha)$, $e_2^C = \alpha$ under the centralized one. Note that the condition for an optimal allocation of permits under the centralized regime requires a specific aggregate cap ($\omega^C = 1$) regardless of its distribution between countries. Therefore, to show the statement a) of the proposition, we assume that $\omega_1^C = \omega_2^C = \frac{1}{2}\omega^C$. Now we can easily show that $W_1^D \leq W_1^C$ whenever $\hat{\beta}_1 \leq \beta$ and $W_2^D \leq W_2^C$ whenever $\beta \leq \hat{\beta}_2$, where $\hat{\beta}_1 = \frac{5\alpha-12\alpha^2+3\alpha^3+6\alpha^4-3\alpha^6+\alpha^7+2}{3\alpha-2\alpha^2-2\alpha^3+\alpha^4+4}$ and $\hat{\beta}_2 = \frac{6\alpha-11\alpha^2+5\alpha^4+3\alpha^5-4\alpha^6+\alpha^7+2}{3\alpha-2\alpha^2-2\alpha^3+\alpha^4+4}$. Since $0 < \hat{\beta}_1 < \hat{\beta}_2 < 1$, for any $0 \leq \alpha \leq 1$, we can easily see that at least one country would prefer the decentralized regime whenever either $0 \leq \beta < \hat{\beta}_1$ or $\hat{\beta}_2 < \beta \leq 1$.

To show the statement b), imagine that the centralized regulator could reallocate permits in order to compensate the losing country and achieve unanimity. Let $\omega_1^C = \gamma\omega^C = \gamma$ and $\omega_2^C = (1-\gamma)\omega^C = (1-\gamma)$, where $\gamma \in [0, 1]$ is the share of the total allowances assigned to country 1 by the centralized regulator.

Assume that $\alpha = .9$. This implies that $\hat{\beta}_1 = 0.442\,84 - 4.998\,9 \times 10^{-2}$ γ. Now assume, for instance, that $\beta = .39$. This implies that the condition required for country 1 to prefer the centralized regime to the decentralized one (i.e. $\hat{\beta}_1 < .39$) is never satisfied for $\gamma \in [0, 1]$.