Supplementary Material: "With or Without the European Union: the Convention for the Protection of the Black Sea Against Pollution"

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A Derivations and Proofs

A1 The negotiated transfers in the *no-block* scenario

The first-order condition with respect to t_i is:

$$\frac{U - U^{SQ}}{U_i - U_i^{SQ}} = \frac{1-\gamma_i}{\gamma_i(1-\lambda_i)} \tag{A1.1}$$

The first-order condition with respect to t_j is:

$$\frac{U - U^{SQ}}{U_j - U_j^{SQ}} = \frac{1-\gamma_j}{\gamma_j(1-\lambda_j)} \tag{A1.2}$$

In the no-block scenario, the resulting payoffs are: $U_i^{NB}(p)$, $U_j^{NB}(p)$ and $U^{NB}(p)$. Denote $u_i^{NB}(p) = \alpha_i B(\bar{A}^{NB}) - C(\bar{a}_i^{NB}) - pF(\bar{a}_i^{NB} - a_i^{NB})$, $u_j^{NB}(p) = \alpha_j B(\bar{A}^{NB}) - C(\bar{a}_j^{NB}) - pF(\bar{a}_j^{NB} - a_j^{NB})$ and $u^{NB}(p) = B(\bar{A}^{NB}) + p\left[F(\bar{a}_i^{NB} - a_i^{NB}) + F(\bar{a}_j^{NB} - a_j^{NB})\right]$. With these notations, the transfers are determined from (A1.1) and (A1.2) as:

$$t_i(p) = \gamma_i(u^{NB} - t_j - U^{SQ}) - \frac{1-\gamma_i}{1-\lambda_i}\left(u_i^{NB} - U_i^{SQ}\right) \tag{A1.3}$$

$$t_j(p) = \gamma_j(u^{NB} - t_i - U^{SQ}) - \frac{1-\gamma_j}{1-\lambda_j}\left(u_j^{NB} - U_j^{SQ}\right) \tag{A1.4}$$

Solving these two equations with two unknowns, t_i and t_j, gives us:

$$t_i^{NB}(p) = \frac{\gamma_i(1-\gamma_j)}{(1-\gamma_i\gamma_j)}(u^{NB}(p) - U^{SQ}) - \frac{(1-\gamma_i)}{(1-\lambda_i)(1-\gamma_i\gamma_j)}\left(u_i^{NB}(p) - U_i^{SQ}\right) + \frac{\gamma_i(1-\gamma_j)}{(1-\lambda_j)(1-\gamma_i\gamma_j)}\left(u_j^{NB}(p) - U_j^{SQ}\right) \tag{A1.5}$$

$$t_j^{NB}(p) = \frac{\gamma_j(1-\gamma_i)}{(1-\gamma_i\gamma_j)}(u^{NB}(p) - U^{SQ}) - \frac{(1-\gamma_j)}{(1-\lambda_j)(1-\gamma_i\gamma_j)}\left(u_j^{NB}(p) - U_j^{SQ}\right) + \frac{\gamma_j(1-\gamma_i)}{(1-\lambda_i)(1-\gamma_i\gamma_j)}\left(u_i^{NB}(p) - U_i^{SQ}\right) \tag{A1.6}$$

A2 Additional results in the *no-block* scenario

A2.1 Reaction function of the abatement level

The abatement level of player i is a (weakly) decreasing function of the abatement level of player j. The relationship for player i is defined by:

$$\frac{da_i^{NB}}{da_j^{NB}} = \frac{-\alpha_i B''(A^{NB})}{\alpha_i B''(A^{NB}) - C''(a_i^{NB})} \leq 0.$$

Proof. The expression obtains using the total differential of condition (11) given $d\bar{a}_i^{NB} = 0$ and $dp = 0$. The sign of $\frac{da_i^{NB}}{da_j^{NB}}$ is determined by taking into account the signs of B'' and C''. □

This result indicates that abatement compliance levels are always substitutes i.e. there is leakage, if we exclude the case $B''(A) = 0$ which corresponds to the dominant strategies in abatement.

A2.2 Reaction function of the negotiated abatement level

The negotiated level of abatement of player i is a (weakly) decreasing function of the negotiated level of abatement of player j. For player i, this relationship is defined by:

$$\frac{d\bar{a}_i^{NB}}{d\bar{a}_j^{NB}} = \frac{(\alpha_i + (1-\lambda_i))\, B''(\bar{a}_i^{NB} + \bar{a}_j^{NB})}{C''(\bar{a}_i^{NB}) - (\alpha_i + (1-\lambda_i))\, B''(\bar{a}_i^{NB} + \bar{a}_j^{NB})} \leq 0.$$

Proof. The expression is found using the total differentials of equations (13). □

This result indicates that similar to the abatement compliance levels, the negotiated levels of abatement are always substitutes ("leakage") if we exclude the case $B''(A) = 0$ in which situation the reaction functions are orthogonal.

A2.3 Comparison of the negotiated abatement with the status quo

If the fraud in monetary transfers is small, i.e. $\lambda_i \to 0$ and $\lambda_j \to 0$, then the negotiated abatement level is higher than the actual abatement in the status-quo: $\bar{a}_k^{NB} > a_k^{SQ}$, $k = i, j$.

Proof. The result obtains by comparing (9) with (13), accounting for the monotonicity of the functions involved, and using the continuity argument of the function $\bar{a}_k^{NB}(\lambda_k), k = i, j$ at the optimum. □

This result shows that the negotiated abatement is higher than the status-quo abatement when the fraud in monetary transfers is small, in the neighborhood of 0.

A3 Proof of Proposition 1

For a linear penalty function i.e. $F'' = 0$ implying $\frac{da_i^{NB}}{d\bar{a}_i} = \frac{da_j^{NB}}{d\bar{a}_j} = \frac{da_j^{NB}}{d\bar{a}_i} = \frac{da_i^{NB}}{d\bar{a}_j} = 0$, the total differential of (13) for $k = j$ assuming $d\lambda_j = 0$ is given by:

$$(d\bar{a}_i + d\bar{a}_j)B''(\bar{a}_i + \bar{a}_j)\left(\alpha_j + (1 - \lambda_j)\right) = d\bar{a}_j C''(\bar{a}_j) \Longleftrightarrow$$
$$d\bar{a}_j = d\bar{a}_i \frac{\left(\alpha_j + (1 - \lambda_j)\right) B''(\bar{a}_i + \bar{a}_j)}{C''(\bar{a}_j) - \left(\alpha_j + (1 - \lambda_j)\right) B''(\bar{a}_i + \bar{a}_j)} \tag{A3.7}$$

Similarly, the total differential of equation (13) is given by:

$$d\bar{a}_i \left[B''(\bar{a}_i + \bar{a}_j)\left(\alpha_i + (1 - \lambda_i)\right) - C''(\bar{a}_i)\right] + d\bar{a}_j \left[B''(\bar{a}_i + \bar{a}_j)\left(\alpha_i + (1 - \lambda_i)\right)\right] = d\lambda_i \left[B'(\bar{a}_i + \bar{a}_j) + pF'\left(\bar{a}_i - a_i^{NB}\right)\right] \tag{A3.8}$$

Solving this system of two equations gives the expression of $\frac{d\bar{a}_i}{d\lambda_i}$.

A4 Proof of Proposition 2

The first-order conditions on compliance levels (11) imply

$$\frac{C'(a_i) - pF'(\bar{a}_i - a_i)}{\alpha_i} = \frac{C'(a_j) - pF'(\bar{a}_j - a_j)}{\alpha_j}.$$

As $\alpha_j < \alpha_i \leq 1$, we have:

$$C'(a_i) - pF'(\bar{a}_i - a_i) > C'(a_j) - pF'(\bar{a}_j - a_j) \tag{A4.9}$$

Assuming the same degree of misuse of transfer receipts by players i and j, $\lambda_i = \lambda_j = \lambda$, the first-order conditions on the negotiated abatement levels (13) imply $\frac{C'(\bar{a}_i) + p\lambda F'\left(\bar{a}_i - a_i^{NB}\right)}{\alpha_i + (1 - \lambda)} = \frac{C'(\bar{a}_j) + p\lambda F'\left(\bar{a}_j - a_j^{NB}\right)}{\alpha_j + (1 - \lambda)}$. As $\alpha_j < \alpha_i \leq 1$, we have:

$$C'(\bar{a}_i) + p\lambda F'\left(\bar{a}_i - a_i^{NB}\right) > C'(\bar{a}_j) + p\lambda F'\left(\bar{a}_j - a_j^{NB}\right) \tag{A4.10}$$

If $(\bar{a}_i^{NB} - a_i^{NB}) > (\bar{a}_j^{NB} - a_j^{NB})$, then we have $a_i^{NB} > a_j^{NB}$ from equation (A4.9).

If $(\bar{a}_i^{NB} - a_i^{NB}) < (\bar{a}_j^{NB} - a_j^{NB})$, then we have $\bar{a}_i^{NB} > \bar{a}_j^{NB}$ from equation (A4.10). This result together with equation (A4.9) implies $a_i^{NB} > a_j^{NB}$.

Hence, under the assumption $\lambda_i = \lambda_j = \lambda$, we always have $a_i^{NB} > a_j^{NB}$.

Given $a_i^{NB} > a_j^{NB}$, we have $\bar{a}_i^{NB} > \bar{a}_j^{NB}$ from equation (A4.10).

A5 Proof of Proposition 3

For a linear penalty function, i.e. $F'' = 0$, the total differential of equation (13) for $k = i$ is given by:

$$(d\bar{a}_i + d\bar{a}_j)B''(\bar{a}_i + \bar{a}_j)\left(\alpha_i + (1-\lambda_i)\right) = d\bar{a}_i C''(\bar{a}_i) + dp\lambda_i F'\left(\bar{a}_i - a_i^{NB}\right)$$

Similarly, the total differential of equation (13) for $k = j$ is given by:

$$(d\bar{a}_i + d\bar{a}_j)B''(\bar{a}_i + \bar{a}_j)\left(\alpha_j + (1-\lambda_j)\right) = d\bar{a}_j C''(\bar{a}_j) + dp\lambda_j F'\left(\bar{a}_j - a_j^{NB}\right)$$

Solving this system of two equations gives the expression of $\frac{d\bar{a}_i}{dp}$.

A6 The negotiation stage in the *block* scenario

The first-order condition of (19) with respect to $\bar{a}_j$ is

$$\left[\alpha_j B'(a_i^B(\bar{a}_j) + \bar{a}_j)\left(\frac{da_i^B}{d\bar{a}_j} + 1\right) - C'(\bar{a}_j) - p\left(1 - \frac{da_j^B}{d\bar{a}_j}\right)F'\left(\bar{a}_j - a_j^B(\bar{a}_j)\right)\right]\frac{\gamma_j}{U_j - U_j^{SQ}} + \left[(1+\alpha_i)\left(\frac{da_i^B}{d\bar{a}_j} + 1\right)B'(a_i^B(\bar{a}_j) + \bar{a}_j) - C'(a_i^B)\frac{da_i^B}{d\bar{a}_j} + p\left(1 - \frac{da_j^B}{d\bar{a}_j}\right)F'\left(\bar{a}_j - a_j^B(\bar{a}_j)\right)\right]\frac{(1-\gamma_j)}{U_L - U^{SQ}} = 0 \quad \text{(A6.11)}$$

and with respect to t_j is:

$$\frac{U_L - U^{SQ}}{U_j - U_j^{SQ}} = \frac{1-\gamma_j}{\gamma_j(1-\lambda_j)}. \quad \text{(A6.12)}$$

Substituting (A6.12) in (A6.11), we obtain the negotiated abatement level for player j, $\bar{a}_j$, defined implicitly by the following condition:

$$B'(a_i^B(\bar{a}_j, p) + \bar{a}_j) = \frac{C'(\bar{a}_j) + p\lambda_j\left(1 - \frac{da_j^B}{d\bar{a}_j}\right)F'\left(\bar{a}_j - a_j^B(\bar{a}_j, p)\right) + (1-\lambda_j)C'(a_i^B)\frac{da_i^B}{d\bar{a}_j}}{\left[\alpha_j + (1-\lambda_j)(1+\alpha_i)\right]\left(\frac{da_i^B}{d\bar{a}_j} + 1\right)}. \quad \text{(A6.13)}$$

A7 Additional results in the *block* scenario

A7.1 Reaction function of the abatement level

The abatement level of player i is a (weakly) decreasing function of the abatement level of player j. The relationship for player i is defined by:

$$\frac{da_i^B}{da_j^B} = \frac{-(1+\alpha_i)B''(A^B)}{(1+\alpha_i)B''(A^B) - C''(a_i^B)} \leq 0.$$

Proof. The expression obtains using the total differential of condition (17) given $d\bar{a}_i = 0$ and $dp = 0$. The sign of $\frac{da_i^B}{da_j^B}$ is determined by taking into account the signs of B'' and C''. □

As in the no-block case, abatement compliance levels are strategic substitutes in the block case. This means that there is leakage, if we exclude the case $B''(A) = 0$ which corresponds to the dominant strategies in abatement.

A7.2 Comparison of the compliance with the status-quo

The random inspection induces a higher level of total abatement compared to the status quo in the block case., i.e. $a_i^B + a_j^B > a_i^{SQ} + a_j^{SQ}$. In contrast to the no-block case, we cannot compare analytically the individual abatement levels between the institutional arrangements.

Proof. We consider the three equations that define the abatement levels at the status quo and the block case respectively: (9), (17) and (18). For the presentation □ of the proof, we write them here again:

$$B'\left(a_i^{SQ} + a_j^{SQ}\right) = \frac{C'(a_i^{SQ})}{\alpha_i} = \frac{C'(a_j^{SQ})}{\alpha_j}. \tag{A7.14}$$

which implies that $a_j^{SQ} < a_i^{SQ}$ as $\alpha_j < \alpha_i \leq 1$.

$$B'\left(a_i^B + a_j^B\right) = \frac{C'(a_i^B)}{1+\alpha_i}. \tag{A7.15}$$

$$B'\left(a_i^B + a_j^B\right) = \frac{C'(a_j^B) - pF'(\bar{a}_j^B - a_j^B)}{\alpha_j} \tag{A7.16}$$

Here, we will use the method of proof by contradiction to compare the levels of the variables.

First, let us set two assumptions. Assumption 1: $a_i^B + a_j^B < a_i^{SQ} + a_j^{SQ}$, and Assumption 2: $a_j^B > a_i^B$.

Assumption 2 implies: $a_j^B + a_i^B > a_i^B + a_i^B = 2a_i^B$. The result $a_j^{SQ} < a_i^{SQ}$ implies $a_j^{SQ} + a_i^{SQ} < a_i^{SQ} + a_i^{SQ} = 2a_i^{SQ}$. The two inequalities together with Assumption 1 imply $a_i^{SQ} > a_i^B$, and implying in turn $\frac{C'(a_i^{SQ})}{\alpha_i} > \frac{C'(a_i^B)}{1+\alpha_i} \Leftrightarrow B'(a_i^{SQ} + a_j^{SQ}) > B'(a_i^B + a_j^B)$, that is $a_i^{SQ} + a_j^{SQ} < a_i^B + a_j^B$, which is in contradiction with Assumption 1.

Second, let us set two assumptions. Assumption 1: $a_i^B + a_j^B < a_i^{SQ} + a_j^{SQ}$, and Assumption 3: $a_j^B < a_i^B$.

Assumption 1, and equations (A7.14) and (A7.16) imply $a_j^{SQ} < a_j^B$. The latter inequality with Assumption 1 imply $a_i^B < a_i^{SQ}$. This latter inequality and equations (A7.14) - (A7.15) imply $\frac{C'(a_i^B)}{1+\alpha_i} < \frac{C'(a_i^{SQ})}{\alpha_i} \Leftrightarrow B'(a_i^B + a_j^B) < B'(a_i^{SQ} + a_j^{SQ})$, that is, $a_i^{SQ} + a_j^{SQ} < a_i^B + a_j^B$, which is in contradiction with Assumption 1.

To summarize: Assumptions 1 and 2 are not compatible, and Assumptions 1 and 3 are not compatible. This shows that Assumption 1 does not hold. We thus have: $a_i^B + a_j^B > a_i^{SQ} + a_j^{SQ}$.

A7.3 Comparison of the negotiated abatement with the status quo

If the fraud in monetary transfers for player j is small, i.e. $\lambda_j \to 0$, then the negotiated abatement level for that player is higher than the actual abatement in the status-quo: $\bar{a}_j^{NB} > a_j^{SQ}$.

Proof. The result obtains by comparing (9) with (20), accounting for the monotonicity of the functions involved, and using the continuity argument of the function $\bar{a}_j^B(\lambda_j)$ at the optimum. □

This result, which is identical to that obtained in the no-block case, shows that the negotiated abatement is higher than the status-quo abatement when the fraud in monetary transfers is small, in the neighborhood of 0.

A7.4 Negotiated abatement and the level of fraud

The negotiated abatement level for player j , $\bar{a}_j^B$ is a decreasing function of the loss in transfer receipts λ_j . The relationship is defined by:

$$\frac{d\bar{a}_j^B}{d\lambda_j} = \frac{B'(a_i^B + \bar{a}_j^B)(1 + \alpha_i) + pF'(\bar{a}_j^B - a_j^B)}{B''(a_i^B + \bar{a}_j^B) - C''(\bar{a}_j^B)} < 0.$$

Proof. For a linear penalty function i.e. $F'' = 0$ implying $\frac{da_j^B}{d\bar{a}_j} = 0$, the total differential of (20) assuming $d\bar{a}_i^B = da_i^B = 0$ and $dp = 0$ provides the relationship above. The sign of $\frac{d\bar{a}_j^B}{d\lambda_j}$ is determined by taking into account the signs of B' , B'', F' and C''. □

This result, which is identical to that obtained in the no-block case, shows that the higher the level of fraud in transfers, the lower the negotiated abatement level for player j.

A7.5 Substitute vs. complementary policy variables

The negotiated abatement level for player j, $\bar{a}_j^B$ is a (weakly) decreasing function of the inspection probabability. The relationship is defined by:

$$\frac{d\bar{a}_j^B}{dp} = \frac{-\lambda_j F'(\bar{a}_j^B - a_j^B)}{(\alpha_j + (1-\lambda_j)(1+\alpha_i))\, B''(a_i^B + \bar{a}_j^B) - C''(\bar{a}_j^B)} \leq 0.$$

Proof. For a linear penalty function i.e. $F'' = 0$ implying $\frac{da_j^B}{d\bar{a}_j} = 0$,, the total differential of (20) assuming $d\bar{a}_i^B = da_i^B = 0$ provides the relationship above. The sign of $\frac{d\bar{a}_j^B}{dp}$ is determined by taking into account the signs of B'' , F' and C''. □

As for the no-block case, in the case of unilateral fraud by player j (as there is no fraud by player i by definition), the negotiated abatement level for player j decreases with the inspection probability in the block case. In this case, the inspection frequency and the negotiated standard are strategic susbstitutes from the large player's point of view, as inspection and transfer payments in negotiations are both costly. If fraud in transfers is missing in both groups of countries i.e. $\lambda_i = \lambda_j = 0$, then the negotiated abatement level is independent of the probability of inspection, $\frac{d\bar{a}_j^B}{dp} = 0$.

B Quadratic Model

B1 Full Cooperative Solution

Conditions (4) give the equilibrium abatement levels for the full cooperative (FC) solution:

$$a_i^{FC} = a_j^{FC} = \frac{(\alpha_i + \alpha_j + 1)b_1}{2b_2(\alpha_i + \alpha_j + 1) + c}, \tag{B1.17}$$

with the resulting social welfare function W.

B2 Status Quo: Nash Equilibrium

Conditions (9) give the status-quo (SQ) equilibrium abatement levels:

$$a_i^{SQ} = \frac{\alpha_i b_1}{b_2(\alpha_i + \alpha_j) + c} \tag{B2.18}$$

$$a_j^{SQ} = \frac{\alpha_j b_1}{b_2(\alpha_i + \alpha_j) + c}, \tag{B2.19}$$

with the resulting payoffs denoted by U_i^{SQ}, U_j^{SQ} and U^{SQ}, for the two players and the large player, respectively.

B3 No-Block Scenario

Conditions (11) give the equilibrium abatement levels in the last stage of the game:[1]

$$a_i^{NB} = \frac{p^{NB} f(b_2(\alpha_j - \alpha_i) + c) + \alpha_i b_1 c}{c\,(b_2(\alpha_i + \alpha_j) + c)} \tag{B3.20a}$$

$$a_j^{NB} = \frac{p^{NB} f(b_2(\alpha_i - \alpha_j) + c) + \alpha_j b_1 c}{c\,(b_2(\alpha_i + \alpha_j) + c)}, \tag{B3.20b}$$

where NB denotes *no-block.*

Note that $a_j^{NB} > 0$ as $\alpha_i > \alpha_j$. The compliance level a_i^{NB} is positive if the numerator is positive: $p^{NB} f b_2\ (\alpha_j - \alpha_i) + p^{NB} f c + \alpha_i b_1 c > 0$. This condition can be written as:

$$\frac{c}{b_2} > \frac{(\alpha_i - \alpha_j) p^{NB} f}{p^{NB} f + \alpha_i b_1}. \tag{B.3.21}$$

In the second stage, the large player negotiates with each of the small players individually to determine the abatement targets $\bar{a}_i^{NB}$ and $\bar{a}_j^{NB}$, anticipating the compliance levels in the third stage and taking into account the inspection probability in the first stage. The first-order conditions given by equations (13) give the equilibrium negotiated levels:

$$\bar{a}_i^{NB} = \frac{p^{NB} f b_2(\lambda_j(1 + \alpha_i) - \lambda_i(1 + \alpha_j)) - c p^{NB} f \lambda_i + c b_1(\alpha_i + 1 - \lambda_i)}{c\,(b_2(\alpha_i + \alpha_j - \lambda_i - \lambda_j + 2) + c)} \tag{B3.22a}$$

$$\bar{a}_j^{NB} = \frac{p^{NB} f b_2(\lambda_i(1 + \alpha_j) - \lambda_j(1 + \alpha_i)) - c p^{NB} f \lambda_j + c b_1(\alpha_j + 1 - \lambda_j)}{c\,(b_2(\alpha_i + \alpha_j - \lambda_i - \lambda_j + 2) + c)} \tag{B3.22b}$$

[1]The second-order conditions are fulfilled.

The transfer levels are given by equations (A1.3) and (A1.4), which together with the compliance levels (B3.20) and the negotiated levels (B3.22) give the respective payoffs U_i^{NB}, U_j^{NB} and U^{NB}.

In the last stage of the game, the large player determines the inspection probability p^{NB} based on the first-order condition given by (14).

B4 Block Scenario

Conditions (17) and (18) give the equilibrium abatement levels in the block case:

$$a_i^B = \frac{(1+\alpha_i)\left(cb_1 - b_2 p^B f\right)}{c\left(b_2\left(1+\alpha_i+\alpha_j\right)+c\right)} \qquad \text{(B.4.23a)}$$

$$a_j^B = \frac{cb_1\alpha_j + p^B f\left(b_2(1+\alpha_i)+c\right)}{c\left(b_2\left(1+\alpha_i+\alpha_j\right)+c\right)}, \qquad \text{(B4.23b)}$$

where B denotes *block*.

Note that $a_j^B > 0$. The compliance level a_i^B is positive if the numerator is positive, i.e.:

$$\frac{c}{b_2} > \frac{p^B f}{b_1}. \qquad \text{(B4.24)}$$

In the second stage, the large player negotiates with j. Recall that for player i there is no negotiation and there is no compliance problem for this player.

$$\bar{a}_j^B = \frac{\left[-\lambda_j c(c+b_2\left(1+\alpha_i+\alpha_j\right)) + b_2^2\left(1+\alpha_i\right)\left(\alpha_j+\left(1-\lambda_j\right)\left(1+\alpha_i\right)\right)\right] p^B f}{c\left[b_2\left(1+\alpha_i+\alpha_j\right)+c\right]\left[b_2\left(\alpha_j+\left(1-\lambda_j\right)\left(1+\alpha_i\right)\right)+c\right]} + \frac{b_1\left(\alpha_j+\left(1-\lambda_j\right)\left(1+\alpha_i\right)\right)\left(c+b_2\alpha_j\right)}{\left[b_2\left(1+\alpha_i+\alpha_j\right)+c\right]\left[b_2\left(\alpha_j+\left(1-\lambda_j\right)\left(1+\alpha_i\right)\right)+c\right]} \qquad \text{(B4.25)}$$

B5 Comparison of *block* and *no-block* scenarios: Proposition 4

For the quadratic case, at the absence of fraud in transfers and for a given inspection probabability, the difference of the total abatement between the block and no-bloc cases is written as:

$$A^B - A^{NB} = \frac{p^B fc + b_1 c(1+\alpha_i+\alpha_j)}{cb_2(1+\alpha_i+\alpha_j)+c^2} - \frac{2p^{NB} fc + b_1 c(\alpha_i+\alpha_j)}{cb_2(\alpha_i+\alpha_j)+c^2}$$

The sign of this difference depends on the sign of the following expression:

$$GapA = fc^2b_2(\alpha_i + \alpha_j)\left(p^B - 2p^{NB}\right) + fc^3\left(p^B - 2p^{NB}\right) + c^2\left(b_1c - fb_2 2p^{NB}\right)$$

We note that $GapA > 0$ when the following sufficient conditions are met: $p^B > 2p^{NB}$ and $(b_1c - fb_2) > 0$, because $p^{NB} < 1$ by definition.

For the quadratic case, at the absence of fraud in transfers and for a given inspection probabability, the difference of the total negotiated abatement between the block and no-bloc cases is written as:

$$\bar{A}^B - \bar{A}^{NB} = \frac{b_2b_1(1+\alpha_i+\alpha_j)^2 - b_2p^Bf(1+\alpha_i) + b_1c(2+2\alpha_i+\alpha_j)}{(b_2(1+\alpha_i+\alpha_j)+c)^2} - \frac{b_1(2+\alpha_i+\alpha_j)}{(b_2(2+\alpha_i+\alpha_j)+c)}$$

The sign of this difference depends on the sign of the following expression:

$$Gap\bar{A} = [b_2(2+\alpha_i+\alpha_j)+c]\left[-b_2p^Bf(1+\alpha_i) + \alpha_ib_1c\right] + cb_1b_2$$

We note that $Gap\bar{A} > 0$ when the following sufficient condition is met: $\left(b_1c - fb_2\frac{\alpha_i+1}{\alpha_i}\right) > 0$, because $p^B < 1$ by definition.

B.6 Characterization of the over-compliance cases

Note that although f is a model parameter, whether the fine is applied or not, i.e. $f > 0$ or $f = 0$, is decided in the last stage of the game after the inspection. Consequently, in order to adress the question of over-compliance, we have to use backward induction. Thus, in the case of exact compliance or over-compliance we have that $f = 0$ and this has to be anticipated by all the players as early as the negotiation stage. Suppose that for some constellations of parameters we have over-compliance or full compliance i.e., $\bar{a}_k \leq a_k,\ k = i, j$. In this case, at the inspection stage no fine will be applied which means that $f = 0$. This should be anticipated by the players in the second and third stages of the game which means that the compliance and negotiated abatement levels are given by (B.3.20), (B3.22), (B4.23) and (B4.25) respectively for $f = 0$.

No-Block Scenario

The compliance levels are:

$$a_i^{NB}|_{f=0} = \frac{\alpha_ib_1}{b_2(\alpha_i+\alpha_j)+c} \tag{B6.26a}$$

$$a_j^{NB}|_{f=0} = \frac{\alpha_jb_1}{b_2(\alpha_i+\alpha_j)+c}. \tag{B6.26b}$$

The negotiated abatement levels are:

$$\bar{a}_i^{NB}|_{f=0} = \frac{b_1(\alpha_i + 1 - \lambda_i)}{b_2(\alpha_i + \alpha_j - \lambda_i - \lambda_j + 2) + c} \quad \text{(B6.27a)}$$

$$\bar{a}_j^{NB}|_{f=0} = \frac{b_1(\alpha_j + 1 - \lambda_j)}{b_2(\alpha_i + \alpha_j - \lambda_i - \lambda_j + 2) + c} \quad \text{(B6.27b)}$$

Under the condition that $f = 0$, it must be also that there is over-compliance or full compliance i.e. $\bar{a}_i^{NB}|_{f=0} \leq a_i^{NB}|_{f=0}$. This condition is equivalent to:

$$\frac{1-\lambda_i}{1-\lambda_j} \leq \frac{\alpha_i b_2}{\alpha_j b_2 + c}.$$

The analogous condition for player j is:

$$\frac{1-\lambda_j}{1-\lambda_i} \leq \frac{\alpha_j b_2}{\alpha_i b_2 + c}.$$

Note that in the absence of misuse of funds i.e., $\lambda_i = \lambda_j = 0$, the above conditions are reduced to $(\alpha_i - \alpha_j)b_2 \geq c$ and $(\alpha_j - \alpha_i)b_2 \geq c$, for players i and j respectively. Note that since $\alpha_j < \alpha_i$, in the case of no misuse of funds, player j can never over-comply with a negotiated abatement target. For player i, the condition that ensures (weak) over-compliance is: $(\alpha_i - \alpha_j)b_2 \geq c$ that implies roughly that the benefit of abatement must be sufficiently large compared to the abatement cost.

Block Scenario

The reasoning is the same as in the *no-block* case, except that now we investigate over-compliance only for player j. The compliance level for player j is:

$$a_j^B|_{f=0} = \frac{b_1\alpha_j}{b_2\left(1 + \alpha_i + \alpha_j\right) + c} \quad \text{(B6.28)}$$

The negotiated abatement level for player j is:

$$\bar{a}_j^B|_{f=0} = \frac{b_1\left[\alpha_j + \left(1-\lambda_j\right)\left(1+\alpha_i\right)\right]\left(c + b_2\alpha_j\right)}{\left[b_2\left(1+\alpha_i+\alpha_j\right)+c\right]\left[b_2\left(\alpha_j + \left(1-\lambda_j\right)\left(1+\alpha_i\right)\right)+c\right]} \quad \text{(B6.29)}$$

Then, the over- or full-compliance condition $\bar{a}_j^B|_{f=0} \leq a_j^B|_{f=0}$ is equivalent to

$$c(1-\lambda_j)(1+\alpha_i) < 0,$$

which is *false* for any constellation of parameters. This means that in the *block* case there can never be over-compliance of player j. Intuitively, this can be interpreted as the result of the large player's negotiation power over j such that the negotiated abatement level is so high that it cannot be over-complied. Moreover, a high negotiated abatement level comes with higher monetary transfers from the large player such that it pays off to pay the under-compliance fine in the case that inspection occurs.

B7 Extension: heterogeneous monitoring costs

Here, we present an extension to the model by allowing the monitoring costs of the MSs (player i) and non-MSs (player j) to differ for the EU. We posit that it is more costly to the EU to inspect the abatement compliance of non-MSs than that of the MSs. This could be the case because the EU has better information about the abatement technology used by its MSs and their compliance behavior given the past or current regulations at the EU level that MSs should abide. The total inspection cost of the EU, as a sum of the cost of inspection of MSs and non-MSs respectively is:

$$I_T(p) = I(p) + \mu I(p) = (1 + \mu)I(p),$$

with $\mu > 1$ reflecting the larger cost of inspection of the non-MSs.

In the quadratic case, this can be written as:

$$I_T(p) = (1 + \mu)\left(\frac{g}{2}p^2\right), \text{ with } \mu > 1.$$

Recall that in the delegation equilibrium, the EU only inspects non-MSs, thus pays $\mu\left(\frac{g}{2}p^2\right)$ as inspection cost.

In order to evaluate the welfare implications of different institutional arrangements in this case, we keep the same parameter constellations as before, except that now, for simplicity, we fix $b_2 = 1$ and $g = 2$, and we let parameter μ take values from 2 to 5 with an increment of 1. This change does not affect any of our qualitative results. Now the EU is better-off in the cooperative scenarios than in the status-quo in a slightly smaller proportion of cases, i.e. for the no-block case, in 0.7% of cases compared to 0.8% of cases in the main analysis, and for the block case, in 29% of cases compared to 33% of cases in the main analysis. This result is explained by the larger inspection costs supported by the EU.

C Tables

C1 Preference of delegation scenario

Table C1: Preference of delegation scenario

In favor of delegation regime	*Share of simulated cases*
EU prefers delegation	27%
Player i prefers delegation	70%
EU and Player i both prefer delegation	1%
Player j prefers delegation	100%

C2 Choice of governance regime

Table C2: Choice of governance regime

Positive gains to cooperation	*No-delegation* (66 590 cases)	*Delegation* (730 cases)
Player i	100% of cases	100% of cases
Player j	99.9% of cases	100% of cases
EU	0.7% of cases	33% of cases

C3 Model outcome with and without EU Party to the Convention

Table C3: Cooperative vs. status-quo equilibria

	No-Delegation game	Delegation game
Number of cases	9	1
Baseline	Players i and j are better off; EU is worse off; Larger total abatement	Players i and j are better off; EU is worse off; Larger total abatement
More corruption	Players i and j are better off; EU is worse off; Larger total abatement	Players i, j and EU are better off; Larger total abatement
Lower benefits from abatement	Players i and j are better off; EU is worse off; Larger total abatement	Players i and j are better off; EU is worse off; Larger total abatement
Lower penalty from non-compliance	Players i and j are better off; EU is worse off; Larger total abatement	Players i and j are better off; EU is worse off; Larger total abatement

D Figures

D1 Negotiated transfers

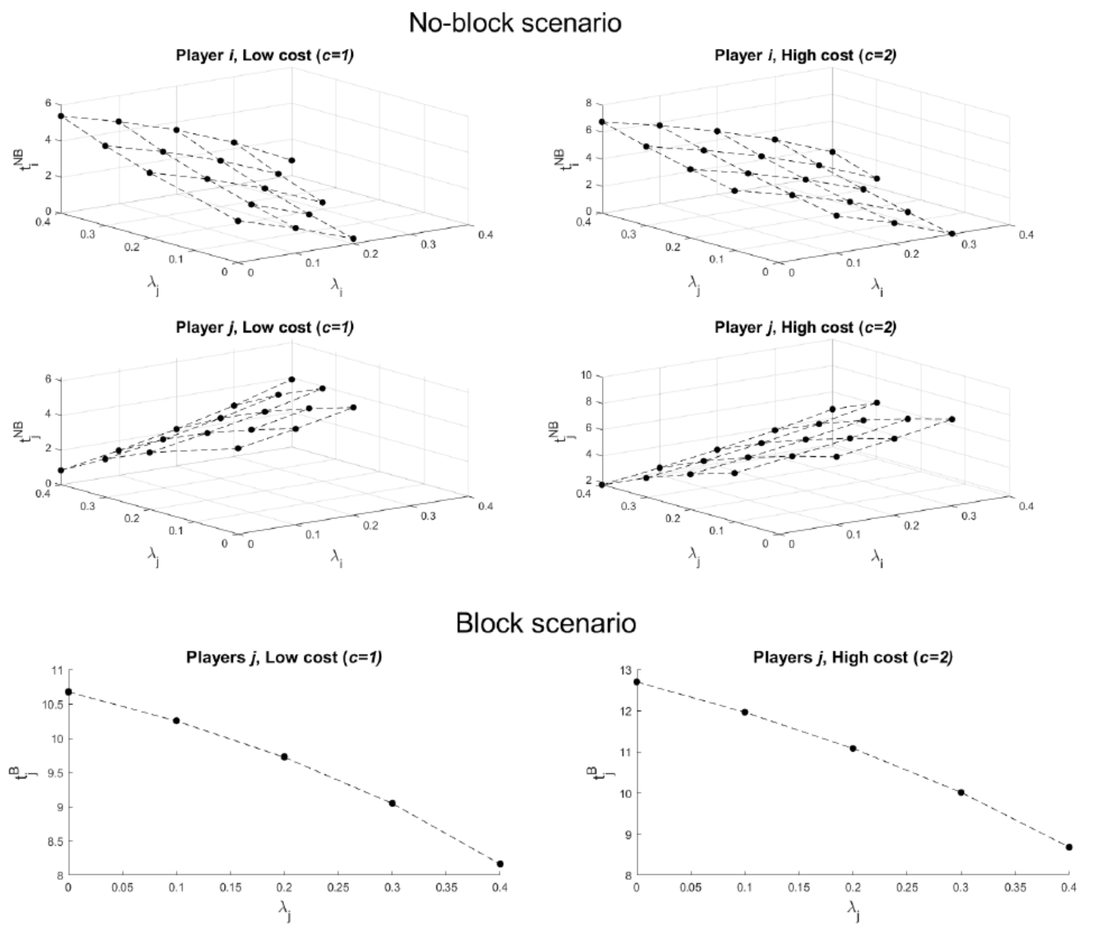

Figure D1: Negotiated transfers as a function of the level of fraud. Parameters used: $b_1 = 10$, $b_2 = 1$, $\alpha_i = 0.5$, $\alpha_j = 0.33$, $f = 1$, $g = 5$, $\gamma_i = 0.4$, $\gamma_j = 0.4$

D2 Inspection probability

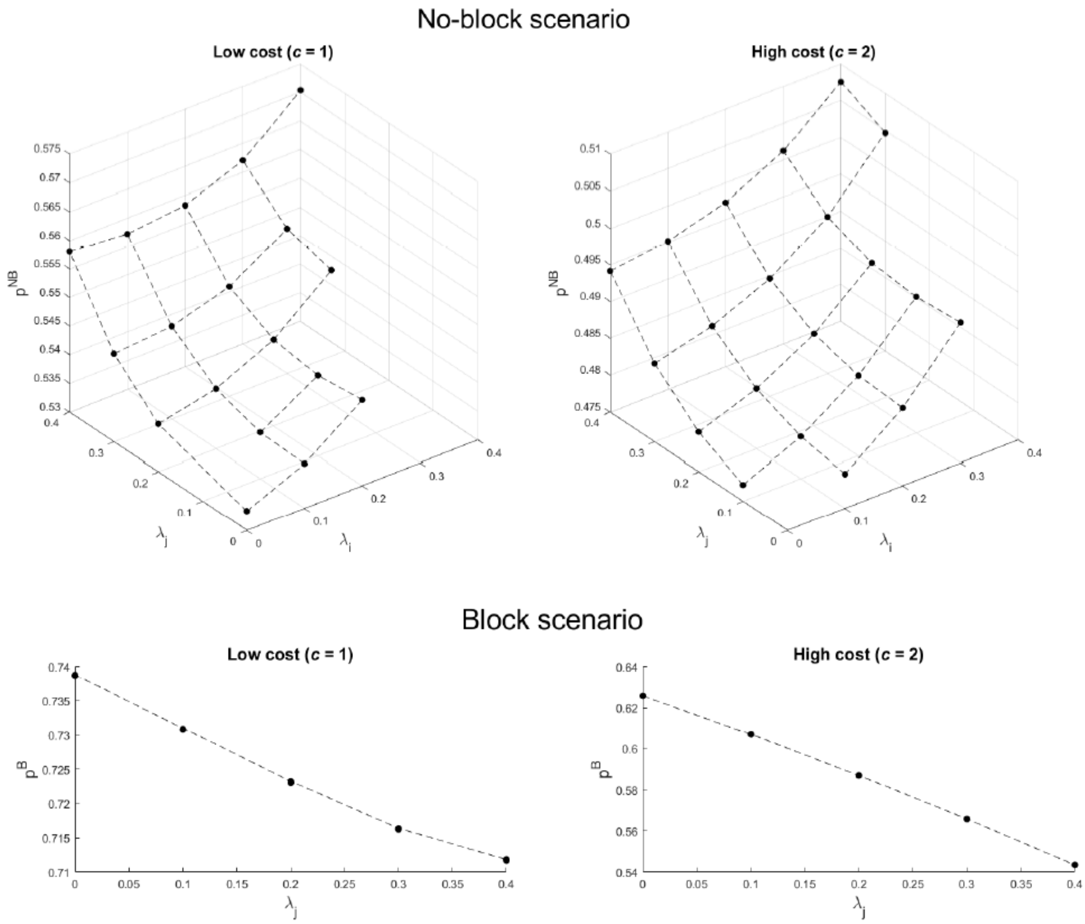

Figure D2: Inspection probability as a function of the level of fraud. Parameters used: $b_1 = 10,\ b_2 = 1,\ \alpha_i = 0.5,\ \alpha_j = 0.33,\ f = 1,\ g = 5,\ \gamma_i = 0.4,\ \gamma_j = 0.4$