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A note on poor-institution traps in international fiscal policy games

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Abstract

This note explores the link between the effort level to strengthen institutional quality and the nature of the fiscal policy game among interdependent economies plagued by corruption. Every country has a lower incentive to improve public governance when the effort made abroad to remedy institutional deficiencies becomes weaker. More importantly, the model highlights a possible trade-off between fighting corruption in interrelated developing countries and promoting fiscal policy coordination among them: cooperation goes together with the acceptance of more corruption. It follows that poor-institution traps can be Pareto-improving.

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1 Introduction

Weak governance structures and corruption are regarded as an issue of concern in many economies, particularly developing and transition ones, and have come to the fore in international policy fora during the past decade. Some recent studies, however, suggest that corruption might turn out to be less damaging than feared, or even beneficial, in countries stuck in very inefficient political systems (Aidt, Dutta and Sena, 2008; Méon and Weill, 2010). The main argument in favor of corruption in the academic literature stems from the "grease the wheels" assumption: corruption constitutes a distortion that partly corrects some other pre-existing distortions in the economic decision-making process, hence a positive effect on welfare.

The present work is in line with these findings and provides a rationale for corruption in a game-theoretic model that combines two strands of research. This note explicitly links the effort aimed at promoting better governance to fiscal policy strategic interactions among interdependent countries plagued by corruption and deficient law enforcement. As in Hefeker (2010), low institutional quality is modeled as a revenue leakage in the budget constraint of the government, and fiscal policy consists in choosing the level of distortionary taxes on output. The game takes place in two stages: each government must first determine its effort to improve institutional quality, then sets fiscal policy, either cooperatively or not.

Three points emerge from this analysis. First, a nation's incentive to carry out governance reforms directly depends on anti-corruption efforts undertaken abroad: domestic authorities struggle less with corruption if foreign countries postpone their efforts on the matter. Second, a trade-off appears between fiscal cooperation and institutional quality improvement initiatives, in the sense that the existing degree of corruption turns out to be higher if fiscal policies are coordinated internationally. Given that such a coordination is rather difficult to implement in practice, especially for authorities whose commitment ability is limited, a second-best solution could be to allow countries to have larger governance failures, contrary to the conventional view in policy circles. Third, joint efforts to curb corruption, such as those promoted by agencies like the World Bank and the International Monetary Fund, appear to be counterproductive. In this model, cooperation at the first stage of the game leads every policy-maker to tackle the corruption problem still less strongly, and the first best is indeed achieved when making the smallest efforts to strengthen institutional quality. The study thus suggests that some developing nations might eventually do little to escape from their poor-institution trap.

The rest of the note is organized as follows. Section 2 presents the two-stage set-up. Section 3 compares the Nash and cooperative solutions for the second stage under the assumption that authorities unilaterally fix their effort level regarding institutional quality. This assumption is then relaxed in Section 4 for considering the benchmark scenario in terms of welfare with full cooperation at both stages. Section 5 concludes.

2 The model

I use a reduced-form model describing strategic interactions between two countries, A and B, supposed to be identical and interrelated through fiscal spillovers. Deviations of output (y) from its natural level (normalized to zero for simplicity) depend on both domestic and foreign corporate tax rates (τ):

$$y_i = -\alpha\tau_i + \beta\tau_j \qquad (1)$$

with $\alpha > \beta \geqq 0$; $i, j = A, B$ and $i \neq j$. A rise in the domestic tax burden leads to a fall in home output because of distortions in economic behavior and activity in the absence of lump-sum taxation, as in the class of models *à la* Alesina and Tabellini (1987). Moreover, the hypothesis of unproductive government expenditure in such models seems more applicable to economies suffering from endemic corruption. On the other hand, an increase in the foreign tax rate exerts a positive effect on domestic activity: the positive sign of the foreign fiscal multiplier (β) can be explained by the move of firms towards the most attractive fiscal environment and by the better national price competitiveness due to the tax rate differential. It follows that A and B are engaged in a tax competition game leading them to inefficiently set a too low tax rate in the absence of international cooperation. In a Nash game, each government will indeed seek to encourage the inflow of productive resources through foreign investment by further reducing the fiscal burden on the firms located within its national boundary.

There is no public debt and seigniorage transferred to the government is also omitted since monetary policy is not considered here.[1] Accordingly, public spending (g) can be financed solely by corporate taxes. The important point is that each government is supposed to suffer from a revenue leakage because of corruption and other various failures, such as bad governance or outdated and inefficient tax legislation and collection system. Revenue shortages are simply modeled by a variable (c) that enters the budget constraint:

$$g_i = \tau_i - c_i \qquad (2)$$

The larger the value taken by c_i, the greater will be the revenue leakage for country i ($i = A, B$). This variable can thus be interpreted as an inverse measure of the efforts undertaken by authorities to stamp out corruption and to promote better governance.

Government i ($i = A, B$) minimizes the following quadratic function:

$$L_i = s_y y_i^2 + s_g \left(g_i - \overline{g}\right)^2 + s_c \left(c_i - \overline{c}\right)^2 \qquad (3)$$

[1] Seigniorage remains a relatively significant source of revenue for some developing nations. This simplification, however, seems acceptable if one admits that every country's central bank in the model is independent and pursues a strict inflation-targeting rule in order to establish its credibility. It can moreover explain the absence of time-inconsistency problems in eq. (1). Anyway, this assumption does not qualitatively alter the conclusions of the study because spillovers concern fiscal policy only.

Each policy-maker is concerned with stabilizing output around its natural level and avoiding public spending deviations from a target $\overline{g}$ ($\overline{g} > 0$). A positive target value reflects the need to provide a minimum amount of public goods for citizens as well as partisan political business cycle considerations, like opportunistic reelection motives. The third argument in the above loss function is borrowed from Hefeker (2010) and represents the political cost of fighting corruption. The parameter $\overline{c}$ can be interpreted as the initial degree of corruption ($\overline{c} > 0$). A positive deviation involves a loss because more corruption may imply a decrease in foreign investments or less support from international organizations. But a corruption level less than $\overline{c}$ turns out to be costly as well, on account of the loss of support from interest groups having benefited from corruption, or because of the loss of economic rents for some bureaucrats. s_y, s_g and s_c denote the weights placed on these various objectives ($s_y, s_g, s_c \geqq 0; s_y + s_g + s_c = 1$).

I consider a two-stage decision-making process. Each of these stages can be played cooperatively or non-cooperatively. The initial stage can be described as an institutional design stage during which both countries have to select their effort level to improve governance, which formally corresponds to the calculation of the optimal value of the control variable c_i ($i = A, B$). The choice of c_i is made on the basis of a trade-off between the need to curtail corruption for increasing the overall available resources and the cost of governance reforms. Subsequently, at the fiscal policy implementation stage, authorities select their tax rate τ_i ($i = A, B$) according to a trade-off between the supply of public goods and output stabilization, given the observed level of corruption.

3 The cooperation-corruption trade-off

It is supposed in this section that there is no cooperation between A and B at the institutional design stage. The Nash (N) and cooperative (C) equilibria for the second stage will be examined successively.

3.1 The case of uncoordinated fiscal policies

Let us start with the presumably most realistic configuration (*i.e.* a Nash behavior at every stage of the game). Each player simultaneously sets its control variable without considering the other player's choice nor the impact of its own strategy on the other's payoff. The game is solved by backward induction from the second stage. The best-response function of government i to country j's fiscal policy for a given degree of corruption c_i ($i, j = A, B; i \neq j$) is (see appendix A for all calculation details):

$$\tau_i = \frac{s_g \left(\overline{g} + c_i\right) + \alpha\beta s_y \tau_j}{s_g + \alpha^2 s_y} \tag{4}$$

A rise in the desired public spending amount or in corruption leads player i to set a higher tax rate for minimizing the deviation from $\overline{g}$ ($(\partial\tau_i)/(\partial\overline{g}) > 0$ and

$(\partial\tau_i)/(\partial c_i) > 0)$. The same holds true in the case of a rise in country j's tax rate $((\partial\tau_i)/(\partial\tau_j) > 0)$: as fiscal spillovers are positive, an increase in taxes in country A stimulates economic activity in B, thereby providing government B with some additional scope for getting closer to its target $\overline{g}$, hence an increase in τ_B. Taxes thus are strategic complements in the present model.

Substituting (4) for τ_i and its counterpart for τ_j into (3) gives a two-variable function for the first stage that has to be minimized with respect to c_i and c_j. The ensuing first-order conditions for A and B yield a level of institutional effort in each economy that depends on the effort made abroad and thus correspond to A's and B's reaction functions associated with anti-corruption policies. It is shown in Appendix A that i's best response at the first stage can be written as:

$$c_i = \frac{\Gamma_0\overline{c} - \Gamma_2\left[(\alpha-\beta)\left[s_g + \alpha(\alpha+\beta)s_y\right]\overline{g} - \beta s_g c_j\right]}{\Gamma_0 + \Gamma_1} \tag{5}$$

where $\Gamma_0, \Gamma_1, \Gamma_2 > 0$ (see Appendix A for the definition of these terms).

The higher is the starting degree of corruption, the lower is the effort aimed at alleviating the problem because of political costs (*i.e.* $(\partial c_i)/(\partial\overline{c}) > 0$). Conversely, corruption is decreasing with the targeted amount of public spending in order to limit the revenue leakage (*i.e.* $(\partial c_i)/(\partial\overline{g}) < 0$). The main point in eq. (5) is the positive sign of $(\partial c_i)/(\partial c_j)$, hence the proposition below:

Proposition 1 *A country makes smaller efforts for fighting corruption within its borders and for improving the quality of its institutions if governance and corruption issues receive less attention abroad.*

The degree of corruption in one country affects the other country's policy decisions through its impact on taxes. Governance and anti-corruption reforms (*i.e.* the choice of c_A and c_B at the first stage) appear here to be strategic complements at the international level since fiscal policies that depend on these measures are strategic complements too at the second stage. If A makes less effort for strengthening institutional quality, and so tolerates a rise in c_A, the tax rate τ_A needed to provide a given amount of public goods will be higher, which will allow government B to fix a greater tax rate in turn given its public spending objective, as seen above. In that case there will be less need for B to struggle with corruption. This multi-country framework thus shows that the existing corruption level partly depends on the extent of the problem abroad, and especially that there is little strategic incentive to deal with poor-institution traps within an environment where neighboring countries do not care much about such an issue.

Solving the system constituted by eq. (5) and its counterpart for country j yields the level of corruption for the fully non-cooperative game:[2]

$$c^{NN} = \frac{\Delta_0\overline{c} - \Delta_1\overline{g}}{\Delta_0 + \Delta_1} \tag{6}$$

[2] Given the symmetry of the model, the country index is omitted in the equilibrium expressions. The first and second superscript letters denote the cooperative (C) or non-cooperative (N) nature of the decision-making process of the first and second stages, respectively.

where $\Delta_0, \Delta_1 > 0$ (see Appendix A for the definition of these terms).

The equilibrium tax rate for the second stage is found by substituting (6) for c_i and c_j back into the reaction function (4):

$$\tau^{NN} = \frac{\Delta_0 s_g \left(\bar{c} + \bar{g}\right)}{\left[s_g + \alpha \left(\alpha - \beta\right) s_y\right] \left(\Delta_0 + \Delta_1\right)} \tag{7}$$

Substituting (7) for τ_A and τ_B into (1) and (2) gives the values of output and public spending that will be used to compute the welfare loss under the fully non-cooperative scenario:

$$L^{NN} = \frac{\left[\frac{(\alpha-\beta)^2\left(s_g+\alpha^2 s_y\right)\Delta_0^2 s_g s_y}{\left[s_g+\alpha(\alpha-\beta)s_y\right]^2} + \Delta_1^2 s_c\right]\left(\bar{c}+\bar{g}\right)^2}{\left(\Delta_0+\Delta_1\right)^2} \tag{8}$$

3.2 The case of coordinated fiscal policies

Let us now suppose that fiscal policies are run in a cooperative fashion during the second stage, which formally amounts to minimizing the sum of national losses with respect to τ_A and τ_B when both players' objective functions are weighted equally. Remember that the anti-corruption effort is still determined unilaterally by authorities at the first stage. It is shown in Appendix B that the equilibrium values of c_i and τ_i $(i = A, B)$ become:

$$c^{NC} = \frac{\Omega_0 \bar{c} - \Omega_1 \bar{g}}{\Omega_0 + \Omega_1} \tag{9}$$

$$\tau^{NC} = \frac{\Omega_0 s_g \left(\bar{c} + \bar{g}\right)}{\left[s_g + \left(\alpha - \beta\right)^2 s_y\right] \left(\Omega_0 + \Omega_1\right)} \tag{10}$$

where $\Omega_0, \Omega_1 > 0$ (see Appendix B for the definition of these terms).

A straightforward algebraic computation gives the following welfare loss:

$$L^{NC} = \frac{\left[\frac{(\alpha-\beta)^2\Omega_0^2 s_g s_y}{s_g+(\alpha-\beta)^2 s_y} + \Omega_1^2 s_c\right]\left(\bar{c}+\bar{g}\right)^2}{\left(\Omega_0+\Omega_1\right)^2} \tag{11}$$

The comparison of results permits a second proposition to be established:

Proposition 2 *There is a trade-off between fiscal policy coordination and the incentive to improve institutional quality: the degree of corruption in every country is always more important if fiscal policies are coordinated internationally.*

The equilibrium tax rate is greater under cooperation at the implementation stage ($\tau^{NC} > \tau^{NN}$) because governments internalize the positive externality generated by fiscal policy on foreign output. The increase in taxes is taken into account *ex ante*, at the institutional design stage, when selecting the optimal effort level: for a targeted level of public expenditure, authorities, knowing that taxes will be raised, are less prone to tackle the governance issue because of the political cost associated with institutional reforms, hence a lower effort and so more corruption ($c^{NC} > c^{NN}$). The rise in corruption is however not harmful since fiscal policies are coordinated: the lower output level due to higher taxes is more than offset by larger public expenditure and by a smaller gap between the final corruption level and the initial one, so both countries are eventually better off ($L^{NN} > L^{NC}$).

International fiscal policy coordination, however, is very rare in practice, despite the welfare gain.[3] Indeed, there is every reason to believe that the problem is even more acute in developing or transition nations facing weak commitment ability and law enforcement. Consequently, an alternative to be considered for improving welfare could be to tolerate more corruption in order to stop or at least to curb tax competition among countries. More generally, even if there is no cooperation at the second stage, any increase in the corruption level can be shown to be welfare-enhancing in this model. This is a corollary of Proposition 2:

Corollary 3 *A rise in corruption exerts a positive effect on welfare by leading countries to set higher tax rates. Corruption can thus be seen as a second-best mechanism for internalizing spillovers among interdependent economies and for limiting tax competition.*

The argument can be presented graphically in a Hamada diagram by making use of eq. (4), *i.e.* the best-response function of player i to any strategy of player j ($i, j = A, B; i \neq j$) in the Nash game (see fig. 1 in Appendix 3). A's and B's reaction functions are upward-sloping in the (τ_A, τ_B) space. According to (4), a rise in c_i meaning more corruption does not alter the slope of i's reaction function and results in its translation towards larger values of τ_i (dashed straight lines), thereby shifting the Nash equilibrium to the upper right on the 45-degree line, as if fiscal policies were coordinated.

4 Accepting corruption: a vice or a virtue?

I finally examine the first-best solution associated with cooperation at both stages. The equilibrium values for the effort level, taxes and welfare losses then are (see Appendix D for all calculation details):

$$c^{CC} = \frac{\left[s_g + (\alpha - \beta)^2 s_y\right] s_c \overline{c} - (\alpha - \beta)^2 s_g s_y \overline{g}}{s_c s_g + (\alpha - \beta)^2 (s_c + s_g) s_y} \tag{12}$$

$$\tau^{CC} = \frac{s_c s_g (\overline{c} + \overline{g})}{s_c s_g + (\alpha - \beta)^2 (s_c + s_g) s_y} \tag{13}$$

[3] Besides the temptation to renege on commitments, the problem has mainly to do with the rigidity inherent in the fiscal decision-making process, and with political business cycle considerations that prompt short-termist governments to give preference to their own interests at the expense of the economic situation abroad.

$$L^{CC} = \frac{(\alpha-\beta)^2 s_c s_g s_y (\bar{c}+\bar{g})^2}{s_c s_g + (\alpha-\beta)^2 (s_c+s_g) s_y} \tag{14}$$

$c^{CC} > c^{NC} > c^{NN}$ and $\tau^{CC} > \tau^{NC} > \tau^{NN}$ always hold. Unlike the previous case, player i now internalizes at the first stage the impact of a change in c_i on y_j and g_j $(i, j = A, B; i \neq j)$. From an *ex ante* perspective, more domestic corruption is associated with greater public expenditure abroad (see the second line of eq. (B3) in Appendix B: $(\partial g_j)/(\partial c_i) > 0$): as already seen, a rise in c_i allows government j to increase taxes. The impact of a change in the domestic corruption level on foreign output is unclear (see the first line of (B3): $(\partial y_j)/(\partial c_i) \gtrless 0$): on the one hand, an increase in c_i exerts a positive spillover on y_j because of the subsequent rise in τ_i; on the other hand, it also leads to a rise in τ_j that is damaging for output y_j. However, the net effect of domestic corruption on foreign welfare turns out to be positive (*i.e.* $(\partial V_j)/(\partial c_i) < 0$ from (B3)). Therefore, the best strategy is indeed to pay even less attention to institutional quality, hence an additional rise in the equilibrium tax rate, so $y^{NN} > y^{NC} > y^{CC}$. However, as $g^{NC} > g^{CC} > g^{NN}$, the positive effects of cooperation on public spending outweigh the deterioration of output. The first best is achieved because all spillovers are internalized, so $L^{NN} > L^{CN} > L^{CC}$.

According to the model, any attempt to work out joint anti-corruption measures in interrelated countries, maybe under the patronage of international agencies,[4] should be doomed to failure. But if corruption can be a virtue from a purely academic viewpoint, it is still regarded in international policy fora as a vice that must be combated, hence the second corollary from Proposition 2:

Corollary 4 *Reaching the first-best outcome seems, at the very least, highly unlikely since it would involve lower anti-corruption efforts, which is the exact opposite of what is required by international organizations.*

5 Conclusion

This paper has highlighted three points. First, the domestic corruption level has an impact on foreign welfare, with the result that the development of a poor-institution trap in one country is likely to lead to the same phenomenon in neighboring economies. Second, a rise in corruption can in theory make countries better off by involving a change in national policies that stops or at least weakens tax competition. Third, as a consequence of the previous result, and given the prevailing view of politics on the matter, the first best appears to be unrealistic here, as it would lead authorities to deliberately reduce their effort to combat corruption.

[4] The United Nations Convention against Corruption (UNCAC), adopted in October 2003 and entered into force in December 2005, clearly constitutes the best illustration of this type of initiative, as it obliges every member state to implement a wide range of anti-corruption measures.

References

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A The fully non-cooperative equilibrium

The model is solved backwards from the second stage, at which each policy-maker chooses the corporate tax rate in a non-cooperative fashion, taking as given the corruption level. Substituting (1) and (2) into (3) and then minimizing it with respect to τ_i yields (4) in the main text (with $i, j = A, B; i \neq j$):

$$\tau_i = \frac{s_g\left(\overline{g} + c_i\right) + \alpha\beta s_y \tau_j}{s_g + \alpha^2 s_y} \tag{A1}$$

Solving the system made of eq. (A1) and its counterpart for j gives:

$$\tau_i = \frac{s_g}{2}\left[\frac{2\overline{g} + c_i + c_j}{s_g + \alpha\left(\alpha - \beta\right)s_y} + \frac{c_i - c_j}{s_g + \alpha\left(\alpha + \beta\right)s_y}\right] \tag{A2}$$

Now substitute the above equation and its counterpart for country j into (3) for obtaining a two-variable function at the first stage of the game:

$$\begin{aligned} V_i\left(c_i, c_j\right) = \; & s_y\left[\frac{s_g}{2}\left(-\frac{\left(\alpha-\beta\right)\left(2\overline{g}+c_i+c_j\right)}{s_g+\alpha\left(\alpha-\beta\right)s_y} - \frac{\left(\alpha+\beta\right)\left(c_i-c_j\right)}{s_g+\alpha\left(\alpha+\beta\right)s_y}\right)\right]^2 \\ & + s_g\left[\frac{1}{2}\left(-2\overline{g} - 2c_i + \frac{\left(2\overline{g}+c_i+c_j\right)s_g}{s_g+\alpha\left(\alpha-\beta\right)s_y} + \frac{\left(c_i-c_j\right)s_g}{s_g+\alpha\left(\alpha+\beta\right)s_y}\right)\right]^2 \\ & + s_c\left(c_i - \overline{c}\right)^2 \end{aligned} \tag{A3}$$

The game at the first stage is non-cooperative, too. Accordingly, the effort by government i ($i = A, B$) to fight corruption is determined from the first-order condition $\frac{\partial V_i}{\partial c_i} = 0$, which gives (5) in the main text:

$$c_i = \frac{\Gamma_0 \overline{c} - \Gamma_2\left[\left(\alpha-\beta\right)\left[s_g + \alpha\left(\alpha+\beta\right)s_y\right]\overline{g} - \beta s_g c_j\right]}{\Gamma_0 + \Gamma_1} \tag{A4}$$

where:

- $\Gamma_0 \equiv \left[s_g\left(s_g+2\alpha^2 s_y\right)+\alpha^2\left(\alpha^2-\beta^2\right)s_y^2\right]^2 s_c$
- $\Gamma_1 \equiv \alpha^2\left[s_g+\left(\alpha^2-\beta^2\right)s_y\right]^2\left(s_g+\alpha^2 s_y\right)s_g s_y$
- $\Gamma_2 \equiv \alpha\left[s_g+\left(\alpha^2-\beta^2\right)s_y\right]\left(s_g+\alpha^2 s_y\right)s_g s_y$

Solving the system made of the first-order conditions at the institutional design stage for c_i and c_j gives the optimal anti-corruption effort (which is identical in both countries, hence the omission of the country index):

$$c^{NN}=\frac{\Delta_0\bar{c}-\Delta_1\bar{g}}{\Delta_0+\Delta_1} \tag{A5}$$

with the first and second superscript letters denoting the nature of the game at the first and second stages, respectively, and where:

- $\Delta_0 \equiv \left[s_g+\alpha\left(\alpha-\beta\right)s_y\right]^2\left[s_g+\alpha\left(\alpha+\beta\right)s_y\right]s_c$
- $\Delta_1 \equiv \alpha\left(\alpha-\beta\right)\left[s_g+\left(\alpha^2-\beta^2\right)s_y\right]\left(s_g+\alpha^2 s_y\right)s_g s_y$

Substitute (A5) into the first-order conditions calculated for the second stage (eq. (A1) and its counterpart for j) and solve the ensuing system to obtain the equilibrium tax rate:

$$\tau^{NN}=\frac{\Delta_0 s_g\left(\bar{c}+\bar{g}\right)}{\left[s_g+\alpha\left(\alpha-\beta\right)s_y\right]\left(\Delta_0+\Delta_1\right)} \tag{A6}$$

The substitution of (A5) and (A6) into (1) and (2) in the main text results in:

$$y^{NN} = -\frac{\left(\alpha-\beta\right)\Delta_0 s_g\left(\bar{c}+\bar{g}\right)}{\left[s_g+\alpha\left(\alpha-\beta\right)s_y\right]\left(\Delta_0+\Delta_1\right)} \tag{A7}$$

$$g^{NN}-\bar{g} = -\frac{\alpha\left(\alpha-\beta\right)\Delta_0 s_y\left(\bar{c}+\bar{g}\right)}{\left[s_g+\alpha\left(\alpha-\beta\right)s_y\right]\left(\Delta_0+\Delta_1\right)} \tag{A8}$$

Moreover, the difference between the degree of corruption in equilibrium and the initial level $\bar{c}$ is:

$$c^{NN}-\bar{c}=-\frac{\Delta_1\left(\bar{c}+\bar{g}\right)}{\Delta_0+\Delta_1} \tag{A9}$$

The welfare loss in the fully non-cooperative game is finally calculated by substituting (A7), (A8) and (A9) into (3):

$$L^{NN}=\frac{\left[\frac{\left(\alpha-\beta\right)^2\left(s_g+\alpha^2 s_y\right)\Delta_0^2 s_g s_y}{\left[s_g+\alpha\left(\alpha-\beta\right)s_y\right]^2}+\Delta_1^2 s_c\right]\left(\bar{c}+\bar{g}\right)^2}{\left(\Delta_0+\Delta_1\right)^2} \tag{A10}$$

B The case of coordinated fiscal policies

The effort level is still chosen in a non-cooperative fashion at the institutional design stage of the game, but fiscal policies now are internationally coordinated at the second stage. For the sake of simplicity, it is assumed that both countries' losses are weighted equally, so each policy-maker must differentiate the sum $L_A + L_B$ with respect to its tax rate. Policy-maker i's first-order condition under cooperation is (with $i, j = A, B; i \neq j$):

$$\tau_i = \frac{s_g\left(\overline{g} + c_i\right) + 2\alpha\beta s_y \tau_j}{s_g + \left(\alpha^2 + \beta^2\right) s_y} \tag{B1}$$

Solving the system constituted by (B1) and its counterpart for government j yields:

$$\tau_i = \frac{s_g}{2}\left[\frac{2\overline{g} + c_i + c_j}{s_g + (\alpha - \beta)^2 s_y} + \frac{c_i - c_j}{s_g + (\alpha + \beta)^2 s_y}\right] \tag{B2}$$

Substitute (B2) and its counterpart for j into the objective function (3) in the main text to obtain:

$$\begin{aligned} V_i\left(c_i, c_j\right) &= s_y\left[\frac{s_g}{2}\left(-\frac{(\alpha - \beta)\left(2\overline{g} + c_i + c_j\right)}{s_g + (\alpha - \beta)^2 s_y} - \frac{(\alpha + \beta)\left(c_i - c_j\right)}{s_g + (\alpha + \beta)^2 s_y}\right)\right]^2 \\ &\quad + s_g\left[\frac{1}{2}\left(-2\overline{g} - 2c_i + \frac{\left(2\overline{g} + c_i + c_j\right) s_g}{s_g + (\alpha - \beta)^2 s_y} + \frac{\left(c_i - c_j\right) s_g}{s_g + (\alpha + \beta)^2 s_y}\right)\right]^2 \\ &\quad + s_c\left(c_i - \overline{c}\right)^2 \end{aligned} \tag{B3}$$

The first-order condition $\frac{\partial V_i}{\partial c_i} = 0$ can be written as:

$$\begin{aligned} c_i &= \frac{\left[s_g^2 + \left(2\left(\alpha^2 + \beta^2\right) s_g + \left(\alpha^2 - \beta^2\right)^2 s_y\right) s_y\right] s_c \overline{c}}{s_c s_g^2 + \left[2\left(\alpha^2 + \beta^2\right) s_c + \alpha^2 s_g\right] s_g s_y + \left(\alpha^2 - \beta^2\right)^2 \left(s_c + s_g\right) s_y^2} \\ &\quad - \frac{\left[\alpha s_g + (\alpha - \beta)(\alpha + \beta)^2 s_y\right](\alpha - \beta) s_g s_y \overline{g} - \alpha\beta s_g^2 s_y c_j}{s_c s_g^2 + \left[2\left(\alpha^2 + \beta^2\right) s_c + \alpha^2 s_g\right] s_g s_y + \left(\alpha^2 - \beta^2\right)^2 \left(s_c + s_g\right) s_y^2} \end{aligned} \tag{B4}$$

The optimal effort level at the first stage follows from the resolution of the system made of (B4) and the counterpart for j:

$$c^{NC} = \frac{\Omega_0 \overline{c} - \Omega_1 \overline{g}}{\Omega_0 + \Omega_1} \tag{B5}$$

where:

- $\Omega_0 \equiv \left[s_g^2 + \left(2\left(\alpha^2 + \beta^2\right) s_g + \left(\alpha^2 - \beta^2\right)^2 s_y\right) s_y\right] s_c$

- $\Omega_1 \equiv \left[\alpha s_g + (\alpha-\beta)(\alpha+\beta)^2 s_y\right](\alpha-\beta) s_g s_y$

The equilibrium tax rate under cooperation at the second stage is obtained by substituting (B5) into (B2):

$$\tau^{NC} = \frac{\Omega_0 s_g (\overline{c}+\overline{g})}{\left[s_g + (\alpha-\beta)^2 s_y\right](\Omega_0+\Omega_1)} \tag{B6}$$

By making use of the two above results with (1) and (2) in the main text, one arrives at:

$$y^{NC} = -\frac{(\alpha-\beta)\Omega_0 s_g (\overline{c}+\overline{g})}{\left[s_g + (\alpha-\beta)^2 s_y\right](\Omega_0+\Omega_1)} \tag{B7}$$

$$g^{NC} - \overline{g} = -\frac{(\alpha-\beta)^2 \Omega_0 s_y (\overline{c}+\overline{g})}{\left[s_g + (\alpha-\beta)^2 s_y\right](\Omega_0+\Omega_1)} \tag{B8}$$

Moreover, one has:

$$c^{NC} - \overline{c} = -\frac{\Omega_1 (\overline{c}+\overline{g})}{\Omega_0+\Omega_1} \tag{B9}$$

The welfare loss when fiscal policies are coordinated is finally calculated with (B7), (B8) and (B9):

$$L^{NC} = \frac{\left[\frac{(\alpha-\beta)^2\Omega_0^2 s_g s_y}{s_g+(\alpha-\beta)^2 s_y} + \Omega_1^2 s_c\right](\overline{c}+\overline{g})^2}{(\Omega_0+\Omega_1)^2} \tag{B10}$$

C The Hamada diagram

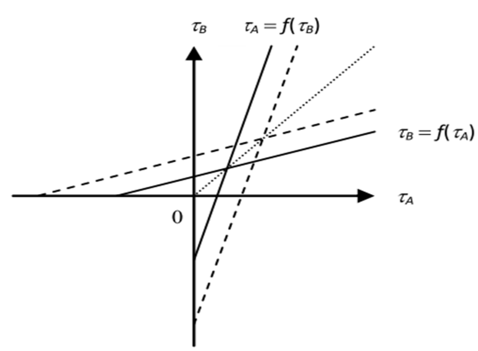

Fig. 1. The effect of corruption on the Nash equilibrium

D The first-best outcome

The benchmark in terms of welfare is associated with a cooperative behavior at both stages. The relevant first-stage objective function is therefore given by eq. (B3) in Appendix B. The first-order condition now is $\frac{\partial V_i}{\partial c_i} + \frac{\partial V_j}{\partial c_i} = 0$ $(i, j = A, B; i \neq j)$, hence:

$$\begin{aligned} c_i \quad = \quad & \frac{\left[s_g^2 + \left(2\left(\alpha^2+\beta^2\right)s_g + \left(\alpha^2-\beta^2\right)^2 s_y\right)s_y\right]s_c\overline{c}}{s_c s_g^2 + \left(\alpha^2+\beta^2\right)\left(2s_c+s_g\right)s_g s_y + \left(\alpha^2-\beta^2\right)^2\left(s_c+s_g\right)s_y^2} \\ & - \frac{\left[s_g + \left(\alpha+\beta\right)^2 s_y\right]\left(\alpha-\beta\right)^2 s_g s_y \overline{g} - 2\alpha\beta s_g^2 s_y c_j}{s_c s_g^2 + \left(\alpha^2+\beta^2\right)\left(2s_c+s_g\right)s_g s_y + \left(\alpha^2-\beta^2\right)^2\left(s_c+s_g\right)s_y^2} \end{aligned} \tag{D1}$$

Solving the system made of eq. (D1) and its counterpart for country j yields the optimal effort under cooperation at the design stage:

$$c^{CC} = \frac{\left[s_g + \left(\alpha-\beta\right)^2 s_y\right]s_c\overline{c} - \left(\alpha-\beta\right)^2 s_g s_y \overline{g}}{s_c s_g + \left(\alpha-\beta\right)^2\left(s_c+s_g\right)s_y} \tag{D2}$$

Substituting back this value into eq. (B2) in Appendix B then gives the equilibrium tax rate:

$$\tau^{CC} = \frac{s_c s_g\left(\overline{c}+\overline{g}\right)}{s_c s_g + \left(\alpha-\beta\right)^2\left(s_c+s_g\right)s_y} \tag{D3}$$

By making use of (1) and (2), one arrives at:

$$y^{CC} = -\frac{\left(\alpha-\beta\right)s_c s_g\left(\overline{c}+\overline{g}\right)}{s_c s_g + \left(\alpha-\beta\right)^2\left(s_c+s_g\right)s_y} \tag{D4}$$

$$g^{CC} - \overline{g} = -\frac{\left(\alpha-\beta\right)^2 s_c s_y\left(\overline{c}+\overline{g}\right)}{s_c s_g + \left(\alpha-\beta\right)^2\left(s_c+s_g\right)s_y} \tag{D5}$$

Moreover, one has:

$$c^{CC} - \overline{c} = -\frac{\left(\alpha-\beta\right)^2 s_g s_y\left(\overline{c}+\overline{g}\right)}{s_c s_g + \left(\alpha-\beta\right)^2\left(s_c+s_g\right)s_y} \tag{D6}$$

The welfare loss of each country is finally given by:

$$L^{CC} = \frac{\left(\alpha-\beta\right)^2 s_c s_g s_y\left(\overline{c}+\overline{g}\right)^2}{s_c s_g + \left(\alpha-\beta\right)^2\left(s_c+s_g\right)s_y} \tag{D7}$$