Aid Effectiveness Revisited : The Trade-Off Between Needs and Governance

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1 Introduction

The new approach to development aid heralded by the Paris Declaration (March 2005) and the Accra Agenda for Action (September 2008) has been recently called into question. The idea that aid effectiveness can be significantly enhanced through new aid modalities that emphasize aid ownership (giving more policy space to recipient governments) , reduce the role of conditionalities, and avoid reform overload has been put to the hard test of on-the-ground implementation. In particular, manifestations of ill-governance have come increasingly to the fore, so much so that there is talk in various groups about a "Paris Agenda fatigue" (Oden and Wohlgemuth, 2011). Several aid agencies known for the quality of their work (such as the Scandinavian official aid agencies, and DFID in the United Kingdom) have begun to retreat from budget support programmes owing to serious misuses of aid resources (see the evaluation reports by SADEV, 2010, and DFID, 2011). Thus, in a review the OCDE notes that "weak systems to align with and a high risk of corruption have influenced Swedish readiness to provide general budget support" (OECD DAC, 2009, p. 47).

Revealingly, the European Union has re-introduced the concept of result-based disbursements into its budget support programmes (part of the aid is variable, being released in successive tranches conditioned on the performances of the country), and the World Bank is launching a new results-based lending instrument, the so-called Program-for-Results. Ex post governance-related conditionalities are thus replacing ex ante conditionalities.

New international aid organizations and foundations also discover to their dismay that some optimistic assumptions behind their approach to development cooperation were unwarranted. Thus, the Global Fund against Aids, Tuberculosis and Malaria, one of the world's biggest aid outfit which hands over all its money to national governments, and considered as a model for a new approach to development, is confronted with the claim that up to two-thirds of some grants went astray, and that corruption using faked invoices, phoney training events and other abuses involved health ministries in some African countries on an "astonishing" scale. (The Economist, February 19th, 2011). In the same manner, decentralized approaches to development, aimed at involving local target groups and communities through participatory mechanisms, have failed to show unambiguous results, in part because problems of elite capture were underplayed or squarely ignored (Tendler, 1997; Bardhan, 2002, 2009; Platteau and Abraham, 2002; Mansuri and Rao, 2004; Platteau, 2009).

To the bitter experience reported above, the executive director of the Global Fund reacted by asserting that the Fund has "zero tolerance for corruption" (The Economist, February 19th, 2011), a claim reminiscent of Wolfowitz's stated policy when he was president of the World Bank and in tune with the increasingly popular view that corruption poses a major threat to development. The problem with such a blunt statement is the following: it bypasses the critical fact that the most needy population groups tend to live in countries that are relatively badly governed (Collier, 2007, chap. 5). In other words, it slips under the carpet the trade-off between needs and governance that inevitably confronts a donor agency when it allocates money between potential recipient countries. This is precisely the issue that we want to address in this paper. We look at the choice problem of a donor who has to allocate a given amount of aid money between several countries which are heterogeneous in terms of needs and governance. The donor is nevertheless able to influence the quality of governance in recipient countries. Disciplining instruments are indeed available to mitigate aid misuse by local leaders, who act as intermediaries in charge of channeling aid toward target beneficiaries. The intermediary can be thought of as a national government but also as any type of local elite acting on behalf of a local group, community, or municipality. In our setup, the control variables in the hands of the donor are the monitoring of the program (that reduces the measurement error arising from imperfect observation of the aid outcome), and the penalty or punishment to apply whenever the leader is reckoned to have behaved fraudulently.[1]

The problem at hand is thorny because when deciding how to allocate the aid money the donor must consider the possibility to improve the quality of domestic governance of the most needy but worst-governed countries instead of excluding them, perhaps at the expense of the best-governed but less needy countries. When domestic governance responds to the disciplining effort of the donor, we show that the latter's strategy is influenced not only by the quality of local governance and the extent of needs in recipient countries, but also by the total amount of aid available.

Our effort is therefore an attempt to bring analytical insights into the concrete problem of aid allocation faced by donors when one criterion (needs) runs counter to the other criterion (governance), yet the latter is susceptible of being

[1]A detailed empirical study based on a review of development projects funded by the World Bank has thus concluded that (i) there is a significant causal relationship between past supervision and improvement in project performance (with supervision most effective early in the project and in smaller projects), and (ii) the benefits of supervision greatly outweigh the costs (Kilby, 1995).

modified by the donors' costly actions. It should enable us to critically assess policy proposals made by economists to answer the above question. For example, Collier (2007) has suggested that aid should go in priority to the most needy countries but its delivery ought to be accompanied by rigorous monitoring in order to temper governance problems. Thirlwall (2011) seems to adhere to the same approach: he indeed proposes that aid assistance be distributed on a per capita basis according to some target level of per capita income, a principle "which would operate rather like an international negative income tax" (p. 476). He rapidly glosses over the governance problem by pointing out that "all this would be conditional, of course, on the new guiding principle of 'good governance"'.

In the following analysis, we proceed in several steps. After reviewing the directly relevant literature (in Section 2), we examine the one-donor-one-recipient case in order to analyze the strategic behavior of the donor when he can discipline the leader through the combined use of monitoring and punishment (Section 3). In Section 4, we move to the one-donor-two-recipients case when governance levels are exogenous and the donor does not resort to disciplining instruments. In Section 5, using the same one-donor-two-recipients framework, we probe into the inter-country aid allocation problem of our single donor when monitoring and punishment are allowed to vary. Section 6 concludes.

2 Literature review

There is a narrow yet interesting literature that addresses the issue of aid allocation with a focus on agency problems (for a survey of the literature using a macroeconomic framework, see Azam and Laffont, 2003).[2] When a principal-agent framework is used, it is not surprising to find that zero tolerance does not obtain at equilibrium: provided that some form of conditionality is applied to the recipient countries, the donor(s) can only mitigate the moral hazard problem arising from the presence of an intermediary whose actions are imperfectly observed. Thus, Azam and Laffont (2003) reach the conclusion that, by using the optimal aid contract, "the donor will mitigate, without compensating entirely, the effects of favoritism" (p. 51). The optimal contract specifies that the recipient government will receive an aid amount (which is endogenous) linearly dependent on the level of consumption of the poor that it provides. Such a rule is considered by the authors as describing in a stylized manner the conditionality mechanism: in their words, "the aid schedule captures in a stylized way the idea of 'tranches' (p. 35). However, their answer only raises the issue of the recipient's commitment problem (what if the recipient takes the aid money and does not deliver the agreed-upon consumption to the poor?), and does not elu-

[2] We do not survey here the literature that deals with the case of several donors and one recipient country, such as in Torsvik (2005) and Knack and Rahman (2004), who examine how alignment of incentives is affected by the presence of multiple donors that independently provide aid to a poor country. In particular, they are able to analyze the problem of aid coordination that is an important pillar of the Paris Declaration and the Accra Agenda.

cidate the conditions under which a conditionality mechanism may be effective. In their static model, the problem is assumed to be solved by just noticing that aid must just be disbursed only after observing the consumption of the poor (p. 52).

Another aspect of Azam and Laffont's work is directly relevant to us: assuming that the donor is imperfectly informed about the recipient government's concern for the poor, they ask the question as to how the optimal aid contract must be altered to take into account the strategic behavior of the government about its private information. What they show is that the donor will surmount this adverse selection problem by denying aid to governments of countries which have too low a level of altruism, so as to decrease the information rents accruing to the local rich. To put it in another way, the donor should help countries "which have a high enough quality of governance" (p. 40). In more technical terms, the incentive compatibility constraint requires the donor to give a costly rent to 'good governments' in order to deter them from pretending that they are 'bad'. Such a rent therefore measures the cost to the donor of its ignorance about the recipients' altruism. In the presence of a participation constraint on the side of the donor (the donor country also cares for the consumption of its own citizens), it would be too costly to provide the right incentives to 'good governments' if aid had also to be supplied to 'bad governments' (pp. 30, 43).

Svensson (2000, 2003) is another significant contributor to the subject that is of interest to us since he explicitly looks at conditionality as a way to surmount the moral hazard problem on the level of opportunistic recipients. He analyzes a two-stage game among two recipient countries and the donor. The two recipients are identical yet subject to independently correlated shocks, so that their ex post situation may differ. The key assumption is that the probability of good states increases monotonically with the amount of reform effort applied by the recipient country. In Svensson's model (2000), the aid contract thus specifies the amount of aid disbursed as a function of aggregate state (the configuration of the states of nature obtaining in each country) and reform effort. Since reform effort, the decision variable for the recipient, is non-observable, the second-best contract is a compromise between giving aid to those who most need it and providing optimal incentives. This translates into the following donor's strategy: in order to induce the recipient to exert higher effort, aid flows in bad states must be lowered and aid flows in good states (more likely to occur when reform effort has been higher) raised (p. 70). A noteworthy feature of Svensson's work is that he believes there exists a serious commitment or time-inconsistency problem on the side of the donor: ex post, once the shock is realized, the donor is tempted to increase disbursements to the country most in need. Anticipation that this will happen in turn affects the recipient's incentive to carry out politically costly reform policies ex ante (2000, p. 70). As a consequence, donor's discretion (modeled as a simultaneous game) yields lower reform effort (compared to the second-best) but full consumption smoothing. Hence the author's attempt to look into other mechanisms that may possibly mitigate the donor's commitment problem: tied project aid, delegation to an agency with low poverty aversion (and, therefore, more reliable as a committed donor), and competition between recipient countries for a given amount of aid in a sort of tournament game (Svensson, 2000, 2003).

Collier and Dollar (2002) look explicitly at the problem of a donor's allocation of aid between several recipient countries when they differ in terms of both policy quality and poverty. In their setup where the quality of policies in each recipient country is taken as given by the donor, and where the latter maximizes poverty reduction, the following conclusion is reached: holding the level of poverty constant, aid should increase with quality of policy and, holding policy quality constant, it should increase with poverty.

In a one-donor-one-recipient framework, Gaspart and Platteau (2011) assume that the donor requires a conditionality mechanism which they explicitly model as a dynamic game whereby the donor disburses successive tranches of aid money contitional on past achievements by the elite in charge of receiving and channeling external funds. As expected, the leader's opportunism is mitigated, not completely eliminated. Unlike Azam and Laffont, but like Svensson, they assume that the total amount of aid available is given. However, the abundance or scarcity of aid funds is implicitly introduced through a parameter that measures the cost of access to aid funds for the donor. Another key parameter is the cost of re-allocating aid money if a project fails. In their (one-donor-one-recipient) framework, project's failure is understood as the actual detection of embezzlement by the aid intermediary. They thus use a fraud detection function (the leader's decision is imperfectly observable) and a punishment mechanism (the leader and community are deprived of subsequent aid tranches if the former is caught). Finally, they study the problem of aid effectiveness in a three-agent framework: besides the donor and the recipient (the intermediary), the poor appear as a player in the aid game, and their role is critical to make the conditionality mechanism possible when the aid game is of finite duration. While the donor and the intermediary or the local leader play a non-cooperative game together, the leader and the grassroots play cooperatively according to the logic of a bargaining game. Because the latter game involves a 'social game' of indefinite duration (based on some sort of patron-client relationship), their model better fits decentralized aid programs than aid schemes channeled through central governments. Contrary to what immediate intuition suggests, they conclude that cheaper aid is detrimental to the poor in the sense that the share of aid funds embezzled by the local leader is then higher. This is because, when aid becomes cheaper, the donor's incentive to discipline local elites is weakened.

Our own contribution in this paper differs from Azam/Laffont and from Collier/Dollar, yet not from Gaspart/Platteau, in that we explicitly model the possibility for the donor to monitor the use of aid so as to detect fraud, and to punish the fraudulent recipient country. Our model features a static game and two heterogeneous recipients with different quality of governance. The donor, whose utility function embodies the need-governance trade-off (unlike in Svensson, for example, where it only appears as an equilibrium outcome), must decide how to allocate a given aid fund between the two recipient countries which also differ in terms of needs and population size. The fact that we allow for instruments whereby the donor can affect the quality of governance in the recipient countries changes the setting of the problem radically. We are thus able to show that, when the donor is thus equipped with disciplining instruments, all patterns of aid allocation become theoretically possible so that there is no a priori reason to believe that the poorest, and worst-governed countries will be automatically excluded. Unlike in Azam/Laffont and Collier/Dollar, the best-governed and less needy countries might be actually denied aid from the donor. Key parameters determining the outcome are: whether the donor is able and willing to tailor the disciplining instruments to the characteristics of each recipient country; the comparative inter-country levels of needs and governance quality as reflected in a so-called need-adjusted measure of aid effectiveness; the size of the populations; and the total amount of aid available.

3 The one-donor-one-recipient case

In writing the model, we stick to a well-established tradition whereby the incentive aspects of alignment between the interests of donors and recipient governments are analyzed within the Principal-Agent framework. We also place our analysis in the one-donor-several-recipients framework since our purpose is to probe the problem of aid allocation betwen heterogeneous countries. We nevertheless start the analysis by considering the one-donor-one-recipient case. Given the perspective that we adopt, a central question is how to represent governance. In the following, we consider that a governance mechanism is at work when not only the elite's utility decreases as governance improves, but also the marginal loss of utility caused by such an improvement increases when fraud is larger. The underlying forces may come from within or from without, depending on whether the elite is disciplined internally or externally. Discipline is internally activated if the national community punishes fraudulent behavior in some way or other. Such a punishment can be conceptualized as a 'tax' imposed by the domestic community on the share unduly appropriated by its leader. Alternatively, such a 'tax' can be regarded as being self-imposed in the sense that it reflects a certain measure of altruism/paternalism on the part of the leader vis-à-vis his own people. External disciplining is the second form of pressure limiting the leader's ability to embezzle aid funds. It is exerted by the donor agency which is able to sanction the leader whenever fraud is detected.

Unlike the community which is assumed to perfectly observe the fraud, the donor agency detects it only with a positive probability. This is, of course, a simplified framework which we adopt only for the sake of capturing the fact that citizens are better informed than outside agencies about the behaviour of their elite or authorities. On the other hand, since direct punishment may prove practically difficult to enforce for an external organization, it helps to think of sanctioning as the withdrawal of future benefits (the leader, for example, would be put on a black list that would prevent him from receiving aid funds any time in the future).

Our model is deliberately parsimonious because the issue that we tackle is actually complex, and we need to achieve interpretable results that can be relevant for donor agencies and policy-makers. In this section, we successively describe the objective function of the leader or the elite, the probability function for fraud detection, the leader's optimal behavior given the aid delivery parameters chosen by the donor, and the latter's maximization problem yielding the optimal values of these parameters. Thereafter, we derive comparative-static results. Note that a complete list of the notations used is presented in Appendix A.

3.1 Objective of the leader

For each unit of aid, the leader maximizes the following utility function:

$$V(y) = y - \gamma\pi(by) - \beta y^2 - g \tag{1}$$

Bearing in mind that y is the share of aid appropriated by the leader or the elite of the recipient country (that is, the extent of 'fraud'), so that $y \in [0, 1]$, the first two terms show the expected gain by the leader, assuming he/she will have to pay the whole penalty, γ, which the donor inflicts if a fraud is detected. The probability function, $\pi(y)$, is the probability of the fraud being detected at the monitoring precision, $b = 1$. By increasing the monitoring precision, b, the donor may therefore increase the probability of fraud detection, $\pi(by)$, for any given y. The third term in the above expression is the cost of the fraud for the leader, with β representing the domestic governance parameter of the recipient country ($\beta \in [0, 1]$). As we have pointed out earlier, the cost of fraud may be conceived as the cost imposed by the national community or as a self-inflicted cost, such as when the leader makes voluntary gifts to clients following a patronage logic. In keeping with our understanding of the governance mechanism, the relationship between this cost and the extent of the fraud, y, is assumed to be increasing and convex. In this way, we ensure that not only the leader's utility, V, decreases as β is raised, but also that the marginal loss of utility caused by an increase in β, that is $V_{y\beta} = \frac{\delta(\delta V/\delta y)}{\delta\beta}$, is greater when the fraud is more important. As will become clear when the probability of fraud detection is specified, the same property applies to externally imposed governance: in this case, it is the marginal loss of leader's utility caused by an increase in either b or γ that grows when the leader appropriates a larger share of the aid transfer.

The last component of the leader's utility function, g, is the cost of handling one unit of aid, which is assumed to be constant (it is, therefore, independent of the amount of the fraud). Such a cost includes all the expenses or effort that the leader must incur in order to get hold of the aid amount by applying to the donor agency, organizing meetings with the intended beneficiaries, receiving foreign experts, submitting follow-up reports, and the like. Note that $V(y) \in [-g, 1 - \beta - g]$[3], from which it also follows that $g \leq 1$.[4]

[3] Indeed, the minimum value of $V(y)$ is $-g$ (when $y = 0$), and its maximum value is $1 - \beta - g$ (when $y = 1$, and the leader is lucky enough to have his or her fraud undetected).

[4] If β is close to zero, indeed, the maximum value of the leader's utility is $1 - g$. If this were negative, the leader would be better off refusing the aid money.

The above leader's utility function is unconventional in the sense that it does not follow the literature on the subject (see Section 2). In this literature, the utility function chosen for the recipient government does not include an expected punishment component and is typically a simple altruistic function which is sometimes supposed to describe what Foster and Rosenzweig (2002) have called a "traditional aristocratic governance structure". The coefficient of the leader's (government's) altruism can be interpreted as a governance parameter, since it reflects the weight given by the leader to the welfare of the community. The reason why we depart from this practice is that, when the leader's behaviour is depicted as altruism, his (her) utility may increase when governance improves (the coefficient of altruism is higher). In our setting, since the participation constraint of the leader may thus be relaxed, it follows that the donor may respond to an improvement in domestic governance by tightening the discipline imposed (raising γ and/or b). In other words, the internal and external controls exerted on the leader may turn out to be complements rather than substitutes. We want to avoid this odd result and use a specification that necessarily yields substitutability between the two types of discipline. Such a purpose is precisely achieved by our specification which, unlike the altruistic function, represents governance as an unambiguous cost for the leader. The trade-off between needs and governance is then certain to emerge in the meaningful sense which we have described in Section 1: poorest countries which are also worst-governed need to be more tightly monitored if their needs are to be catered for by the donor. We will return to this important issue at a later stage when the reader will have a more complete view of our modelling approach.

3.2 Specifying $\pi(y)$

The outcome of the aid program observed by the donor is :

$$x = (1 - y) + u$$

where u is a random component. Let the cdf of u be $F_u()$. In what follows, we assume that $F_u()$ has the ususal S-shape form over some support interval $[-d, +d]$, being convex in a first part of the interval and concave over the rest of the interval. As the probability function $\pi()$ is initially convex, it can be seen that the utility function of the leader in (1) is concave for low enough values of y.

What follows relies on the following simple specification : $\pi(y) = y^2/a^2$, where a may be interpreted as the natural variance of the outcome of the aid program.

Taking into account the precision monitoring factor b leads to:

$$\pi(by) = \frac{(by)^2}{a^2} \tag{2}$$

The above specification can be viewed as a particular case of a more general probability function written as:

$$\pi(y) = 0 \ for \ y \leq h \ \ ; \ \pi(y) = \ \frac{(y-h)^2}{a^2} \ \ for \ h \leq y$$

where h is a threshold below which fraud remains undetected. Allowing for monitoring precision yields:

$$\pi(by) = 0 \ for \ y \leq h/b \ \ ; \ \pi(by) = \ \frac{(by-h)^2}{a^2} \ \ for \ h/b \leq y \leq 1/b$$

From the last expression, it is evident that monitoring precision enables the donor to scale up or down its level of tolerance regarding the proportion of aid that the leader can embezzle with no probability of being detected. In Appendix B, we elaborate on the assumptions underlying our specification of a probability of fraud detection with a threshold. To avoid a cumbersome presentation, we use the simple specification of a continuous probability function (h is assumed to be nil) to derive our central results. For the sake of completeness, however, we will discuss thereafter the implications of the more general specification.

3.3 The leader's behavior

The interior solution of the leader's program, (1), is given by $dV/dy = 1-2\beta y - b\gamma\pi'(by) = 0$. When $\pi = (by)^2/a^2$, this yields the optimal level of embezzlement, $\widetilde{y}(b,\gamma)$:

$$\widetilde{y}(b,\gamma) = \frac{1}{2(\beta + b^2\gamma/a^2)} \tag{3}$$

It will be convenient in what follows to use the following function of the aid delivery variables (b,γ):

$$\varphi = \frac{b^2\gamma}{a^2} \tag{4}$$

The composite variable φ is thus a measure of the degree of severity of the donor in the use of the disciplining, aid delivery instruments.

The optimal fraud can then be written thus:

$$\widetilde{y}(b,\gamma) = \frac{1}{2(\beta + \varphi)} \tag{5}$$

The comparative static results are according to intuition: the share embezzled by the leader increases with the noise in the measurement of the aid outcome, and decreases when either the domestic governance in the recipient country improves or the donor tightens his disciplining instruments (the monitoring precision and/or the amount of the punishment). When the combined domestic and external discipline exerted upon the leader exceeds unity ($\beta + \varphi > 1$), the leader embezzles less than half of the aid money.

To avoid situations where the leader embezzles the totality of the aid money, the donor must set his aid delivery parameters or disciplining instruments, b and

γ, at a sufficiently high level so that dV/dy is non-positive at the point $y = 1$. This follows that $\beta + \varphi \geq 1/2$ or:

$$\varphi = \frac{b^2\gamma}{a^2} \geqslant \frac{1}{2} - \beta \tag{6}$$

On the other hand, the leader will never choose to refrain from cheating altogether because dV/dy is necessarily positive at the point $y = 0$. Note finally that the leader's indirect utility is equal to $V^I = \frac{1}{4(\beta+\varphi)} - g$. Combined with the above condition ($\beta + \varphi \geq 1/2$), the non-negativity of V^I implies that $g \leqq 1/2$.

3.4 Optimal punishment/monitoring by the donor

Let $C(b)$ be the cost of monitoring the use of aid, $C()$ being increasing and convex. $C(b)$ is thus the cost incurred by the donor to achieve a certain level of precision in detecting fraud. The higher the precision b desired by the donor the higher the cost to be incurred and also the higher the marginal cost of enhancing precision. Likewise, $D(\gamma)$, with $D()$ increasing and convex, is the cost for the donor of imposing a level of punishment γ on the leader. $D(\gamma)$ includes the cost involved in the participation in an information-sharing network designed to ensure publicity about fraudulent acts committed by unscrupulous leaders. Whereas the monitoring cost, $C(b)$, is incurred ex ante, since it is aimed at detecting fraudulent behavior, the cost of punishment for the donor, $D(\gamma)$, is incurred ex post, that is, only after the actual detection of a fraud which occurs with probability $\pi()$.

Assuming a logarithmic function for the welfare of the community in the recipient country, the objective of the donor may be specified as:

$$Max_{\gamma,b}\ Log\left[w + t(1 - \widetilde{y}(\gamma, b))\right] - C(b) - \pi(b\widetilde{y}).D(\gamma) \tag{7}$$

where w is the per capita income of the community without aid and t the total amount of aid per capita, which is exogenous. In this specification, w and t appear as perfect substitutes, a feature that will take on its full meaning when we consider the two-country model. It will indeed allow the emergence of a trade-off between needs and governance behind the donor's decision to allocate aid money between two (or several) countries.

Maximization as described by (7) must take place under the participation constraint of the leader. Assuming that the leader's utility function is linearly homogeneous in t (it is equal to the utility derived from one aid unit times the number of aid units available), and that the cost of handling t units of aid is t times the unit cost ($= g.t$), we may continue to express the participation constraint as before:

$$\widetilde{y}(\gamma, b) - \beta\widetilde{y}^2(\gamma, b) - \gamma\pi\left[b\widetilde{y}(\gamma, b)\right] - g \geq V^0 \tag{8}$$

where V^0 is the reservation utility of the leader per unit of aid. Without loss of generality, we assume that $V^0 = 0$: the donor must make sure that the leader can at least cover the cost of handling aid.

A priori, the utility the donor obtains by granting aid could be smaller than the utility received by abstaining from providing aid. We will abstract from this possibility, however, considering that the parameters of the model are such that:

$$Log\left[w+t(1-\ \widetilde{y}(\gamma,b))\right]-C(b)-\pi(b\widetilde{y}).D(\gamma)>Log(w) \tag{9}$$

In other words, we assume that the income per head in the recipient country is sufficiently low and/or the parameters of the cost functions are sufficiently small to make the donor's participation constraint automatically satisfied. The Lagrangian of the donor's maximization problem can then be written:

$$\begin{aligned}\Lambda &= Log\left[w+t(1-\widetilde{y}(\gamma,b))\right]-C(b)-\pi(b\widetilde{y})D(\gamma)\\ &\quad +\mu\left\{\widetilde{y}(\gamma,b)-\beta\widetilde{y}^2(\gamma,b)-\gamma\pi\left[b\widetilde{y}(\gamma,b)\right]-g\right\}\end{aligned} \tag{10}$$

where μ is the Lagrangian coefficient associated with the leader's participation constraint. Two situations can then arise depending upon whether this constraint is binding at equilibrium or not. The case where it is binding reflects conditions under which the monitoring and punishment technology is cheap enough to allow the donor to prevent the leader from obtaining any surplus.

3.4.1 The leader's participation constraint is binding

This case is easy to handle because the equilibrium values of b and γ can be sequentially determined. To see this, let us substitute the value of $\widetilde{y}(\gamma,b)$ as given by (5) in the participation constraint (which is equivalent to setting $V^I=0$). We then find that:

$$\frac{1}{4(\beta+\varphi)}=g\Longrightarrow\widetilde{y}=2g \tag{11}$$

This is a very convenient expression since the equilibrium amount of embezzlement by the leader is set by the donor regardless of the values of the aid delivery parameters. It is simply equal to twice the value of the unit cost of handling aid, from which we infer the condition that $g\leqq 1/2$. It must be noted that this result does not hinge on the quadratic specification of the probability function used for fraud detection, but would obtain with any power function. From (11), it is evident that φ is a substitute for β: the donor tightens his discipline when domestic governance is weaker, and vice-versa.

Once $\widetilde{y}$ is thus determined, and bearing in mind that t and w are exogenous, the optimum values of b and γ can be easily derived from the programme that minimizes the sum of the costs borne by the donor, $C(b)+\pi(b\widetilde{y}).D(\gamma)$. Since we know from the definition of φ that $\gamma=a^2\varphi/b^2$, and since φ is given and determined by the parameters g and β from $\varphi=1/4g-\beta$, itself derived from (11), the donor's costs can be minimized with respect to b only. The donor's optimization problem is thus:

$$Min\ C(b)+\pi(b\widetilde{y}).D(\gamma)=C(b)+\left(\frac{b^2\widetilde{y}^2}{a^2}\right)D\left(\frac{a^2\varphi}{b^2}\right)$$

$$= C(b) + \frac{4b^2g^2}{a^2} D \left[\frac{a^2}{b^2} \left(\frac{1}{4g} - \beta \right) \right]$$

From this programme, the two equilibrium conditions for the values of b and γ can be sequentially determined:

$$b = B(a, \beta, g); \ \gamma = G(a, \beta, g)$$

The comparative static effects obtained from these two equilibrium conditions are derived in Appendix C. We find that the three effects on monitoring precision, b, are determined (once we use Taylor's approximation up to the second-degree derivative), and their direction is in the expected direction. In particular, monitoring precision acts as a substitute when the level of domestic governance changes.

$$\frac{\delta b}{\delta \beta} < 0; \frac{\delta b}{\delta g} < 0; \frac{\delta b}{\delta a} > 0$$

The effects of parametric changes on γ, however, cannot be signed, which indicates that the two disciplining instruments available to the donor may be complements or substitutes. This directly follows from the specification of $\gamma = \varphi \frac{a^2}{b^2} = \left(\frac{1}{4g} - \beta \right) \frac{a^2}{b^2}$, which generates both a direct and an indirect effect (through b). The role of the latter is particularly evident for $\delta\gamma/\delta a = \frac{2a\varphi}{b^2} (1 - \varepsilon_{ba})$, where ε_{ba} is the elasticity of b with respect to a.

$$\frac{\delta \gamma}{\delta \beta} \lesseqgtr 0; \frac{\delta \gamma}{\delta g} \lesseqgtr 0; \frac{\delta \gamma}{\delta a} \lesseqgtr 0$$

If the effects of parametric changes on γ cannot be determined, the effects on the expected punishment for the leader, $\gamma.\pi$, are clear and similar to the effects on b: for a given level of fraud, $\gamma.\pi$ varies inversely with β and g.[5]

The results are summarized in Proposition 1:

Proposition 1. *In situations where the donor is able to put the local leader at his reservation utility, (a) the optimal response of the donor to an improvement in the domestic governance of the host country consists of relaxing the monitoring discipline (reducing monitoring precision) in such a way as to maintain total discipline, and therefore the leader's level of fraud, at the previous level.*

(b) The donor also reduces his disciplining effort when the cost of handling aid or the reservation utility increases for the local leader. The fraud level increases.

Variation of the amount of punishment chosen by the donor when all these changes occur is indeterminate.

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[5]This is evident from: $E = \gamma\pi = \varphi \frac{a^2}{b^2}\pi = \left(\frac{1}{4g} - \beta \right) \frac{a^2}{b^2} \left(\frac{b^2 \widetilde{y}^2}{a^2} \right) = \left(\frac{1}{4g} - \beta \right) \widetilde{y}^2$. When the fraud level is adjusted by the leader, since $\widetilde{y} = 2g$, we have that $\delta E/\delta\beta < 0$, and $\delta E/\delta g \lesseqgtr 0 \Rightarrow 8\beta g \gtreqless 1$.

We may now consider a more specific, power form of the cost functions: $C(b) = ctb^q$ and $D(\gamma) = dt\gamma^m$. The donor's problem becomes:

$$Min_b\ ctb^q + 4dt\frac{b^2}{a^2}g^2\frac{a^{2m}}{b^{2m}}\left(\frac{1}{4g} - \beta\right)^m = ctb^q + 4dtb^{2(1-m)}a^{2(m-1)}g^2\left(\frac{1}{4g} - \beta\right)^m$$

The optimal value of b is given by:

$$b^{q+2(m-1)} = 8(m-1)\frac{d}{qc}a^{2(m-1)}g^2\left(\frac{1}{4g} - \beta\right)^m \tag{12}$$

It is easily verified that [6] :

$$\frac{\delta b}{\delta\beta} < 0; \frac{\delta b}{\delta g} < 0; \frac{\delta b}{\delta a} > 0; \frac{\delta b}{\delta c} < 0; \frac{\delta b}{\delta d} > 0$$

The optimal value of γ follows from the definition $\gamma = a^2\varphi/b^2$, where $\varphi = (1/4g - \beta)$and b is given by (12):

$$\gamma = \frac{\left(\frac{1}{4g} - \beta\right)^{\frac{q-2}{q+2(m-1)}} a^{\frac{2(q+2m-4)}{q+2(m-1)}}}{\left(\frac{8(m-1)d}{cq}\right)^{\frac{2}{q+2(m-1)}} g^{\frac{4}{q+2(m-1)}}} \tag{13}$$

From this expression, bearing in mind that all exponents have a positive value (since m and $q > 2$), the following comparative-static effects are obtained:

$$\frac{\delta\gamma}{\delta\beta} < 0; \frac{\delta\gamma}{\delta g} < 0; \frac{\delta\gamma}{\delta a} > 0; \frac{\delta\gamma}{\delta c} > 0; \frac{\delta\gamma}{\delta d} < 0$$

Finally, after some algebraic work, we derive the following minimum cost function:

$$Co(c, d, g, \beta) =$$

$$H\left[(dt)^{1-p}(ct)^p a^{2(m-1)(1-p)} g^{2(1-p)}\left(\frac{1}{4g} - \beta\right)^{m(1-p)}\right]$$

$$where\ H = 2^{-3p-2}(m-1)^{-p}q^{p-1}\left[2^{-5}(m-1) + q\right]$$

$$and\ p = \frac{-2(1-m)}{q+2(m-1)} \tag{14}$$

All the comparative-static effects derivable from this expression are again according to intuition[7]:

[6] Note that the result $\delta b/\delta g < 0$ hinges on the condition $(\frac{1}{2} - \frac{m}{4}) - 2\beta g < 0$, which is necessarily true when $m > 2$.

[7] Note that the result $\delta Co/\delta g < 0$ hinges on the condition $m > 2 - 8\beta g$, which is automatically satisfied when $m > 2$.

$$\frac{\delta Co}{\delta \beta} < 0; \frac{\delta Co}{\delta g} < 0; \frac{\delta Co}{\delta c} > 0; \frac{\delta Co}{\delta d} > 0; \frac{\delta Co}{\delta t} > 0; \frac{\delta Co}{\delta a} > 0$$

If the quality of internal governance is considered to be measured not only by β but also by g, we thus obtain similar effects on b and Co. When either β or g rises, -when either the internal 'taxation' of the aid transfer appropriated by the local elite increases, or when the outside option of the elite improves-, the donor chooses to reduce the values of his two instruments, b and γ, and the optimal cost incurred by him unambiguously decreases. On the other hand, an increase in the unit cost of either instrument raises the total cost, and it gives rise to a standard substitution effect (the donor uses more of the instrument that has become relatively cheaper). An increase in the natural variance of the outcome of the aid transfer, a, induces the donor to use his two instruments more intensively and, as a result, his total cost is higher.

Note that when $C(b)$ and $D(\gamma)$ are quadratic functions ($m = q = 2$), the expressions for b and c become quite simple:

$$b^2 = 2ag\sqrt{\frac{d}{c}}\left(\frac{1}{4g} - \beta\right);\ \gamma = \frac{a}{2g\sqrt{d/c}}$$

All the above effects stand confirmed except the fact that γ does not depend any more on β.[8] This suggets that the quadratic specification is a special case, an observation that is elucidated in the next subsection.

3.4.2 The leader's participation constraint is not binding

The donor may actually be unable to put the local leader at his reservation utility (so that $\varphi < 1/4g - \beta$), because the costs of monitoring and punishing for the donor are too high, or the cost of handling aid for the leader is too small. In this case, the Lagrangean coefficient $\mu$is nil, and the maximization problem is simply that given by (7). The two FOCs obtained from the above optimization problem are to be solved simultaneously.

When this setup is used, an odd feature of the quadratic specification for the cost functions emerges. To see this, let us write the donor's objective function as follows after replacing the probability π by its value in terms of the donor's instruments, and isolating the constant terms w and t:

$$W = Log(A - \frac{1}{\beta + \varphi}) - C(b) - D(\gamma).\frac{1}{4}\frac{b^2}{a^2}.\frac{1}{(\beta+\varphi)^2} + Log\left(\frac{t}{2}\right) \tag{15}$$

where $A = 2(w/t{+}1),\ \varphi = \gamma.b^2/a^2,\ C(b) = cb^q/q,\ D(\gamma) = d\gamma^m/m,\ \ q \geq 1,\ m \geq 1$

To simplify the calculations, we replace the variable γ by the variable F defined as twice the amount of the fraud, $F = (\beta + \varphi)^{-1}$. The equilibrium value

[8] Note that, when $D(\gamma) = k\gamma + d\gamma^2$, γ becomes dependent on φ, and therefore on β.

of γ can then be inferred from those of b and F through $\varphi = b^2\gamma/a^2 = \frac{1}{F} - \beta = \frac{1-\beta F}{F}$. Ignoring the constant term, $Log\,(t/2)$, and replacing φ by the above expression, we easily get:

$$\Gamma = Log(A - F) - cb^q/q - \frac{d}{4m}\frac{a^{2m-2}}{b^{2m-2}}.F^{2-m}(1 - \beta F)^m \tag{16}$$

An interior solution in F is given by (see Appendix D for the proof):

$$\frac{F^{\frac{(q+2)(m-1)}{2(m-1)+q}}}{A - F} = H(1 - \beta F)^{\frac{(m-1)(q-2)}{2(m-1)+q}}\,[m - 2(1 - \beta F)] \tag{17}$$

$$where\ H = 2^{p-2}d^{1-p}c^p m^{p-1}(m-1)^{-p}a^{(1-p)(2m-2)}$$

The first comparative static result does not require special comments. According to intuition, when the cost of either monitoring or punishment rises, which translates into a higher value of H, the equilibrium level of fraud, $\tilde{y} = F/2$, increases. This implies that either b or γ, or both, are decreased when c or d become higher. The relaxing of the donor's discipline induces the country's leader to steal more.

The second result is more unexpected. Indeed, when the quality of internal governance increases (β is higher), the extent of the leader's fraud may increase or decrease depending upon the shape of the cost functions. More precisely, these functions need to be sufficiently convex for an improvement in internal governance to lead to reduced embezzlement of aid funds ($\delta F/\delta\beta < 0$), the expected effect. When this is not the case, the donor responds to the improvement in domestic governance by reducing his external discipline to an even larger extent (the donor "overshoots"). Since total discipline, internal and external, is thereby diminished, the leader appropriates a larger share of the aid amount ($\delta F/\delta\beta > 0$). We show (see Appendix D) that a sufficient condition for a nontrivial interior solution to occur and for $\delta F/\delta\beta \leq 0$ is m and $q > 2$. When $m = q = 2$, that is, when both cost functions are quadratic, the above equation (17) essentially degenerates, and it is always the case that $\delta F/\delta\beta \geq 0$.

The intuition behind this result is the following. Think of the donor's utility as made of two components: the benefit, $Log(A - F)$, and the more complex cost element in (16). The marginal benefit is then measured by $1/A - F$, and it must equal the marginal cost at equilibrium. Let β increase. For a given value of φ, F diminishes which has the effect of causing a fall in the donor's marginal benefit. To restore equality between marginal benefit and marginal cost, the donor wants to reduce the latter by reducing the size of the punishment or monitoring precision. If the cost functions are strongly convex, a small change in b and γ will be sufficient to re-establish the equality between marginal benefit and marginal cost. As a result, the initial negative impact of the increase in domestic governance on the level of fraud is maintained. On the contrary, if the cost functions are little convex, big changes in b and γ are needed to re-establish te marginal cost/marginal benefit equilibrium. Doing so, the donor "overshoots" (the rise in β is outweighed by the fall of φ, as a consequence of which $\beta + \varphi$ diminishes) and, in effect, induces an increase in the size of the fraud.

Note that the setting of the convexity threshold at $m = q = 2$ directly follows from our assumption that the probability of detection is itself quadratic. It can, indeed, be seen that 2 is the magic number in all what precedes because of the critical role of $(2 - m)$ as exponent in various terms of (16). The above-stated result is thus relatively general.

Finally, we cannot establish how a rise in the quality of domestic governance affects the value of each disciplining instrument. It is not even possible to establish that external discipline exerted by the donor will be necessarily relaxed when domestic governance improves.

Let us consider the effect of a rise in β on b, in particular. A necessary but not sufficient condition to obtain the immediately intuitive effect that $\delta b/\delta\beta < 0$ is that the elasticity of F with respect to β, $\eta_{F\beta}$, is smaller than one in absolute value. Interestingly, this condition is close to requiring that the donor's participation constraint is satisfied (see Appendix D). It can be shown that $\delta b/\delta\beta < 0$ when at equilibrium the value of F is such that:

$$-\eta_{F\beta} < \frac{\beta}{\beta + \left(\frac{m-2}{m}\right) F^{-1} \left(1 - \beta F\right)^{\frac{q-2(1-m)}{q+2(1-m)}}} < 1$$

To understand why this indeterminacy arises, it must be borne in mind that b is not the only instrument at the donor's disposal. What matters in the end is the expected punishment meted out to the recipient country's elite. When that country's domestic governance improves, the expected punishment must obviously decrease, yet this can happen with a rise in b if it is accompanied by a sufficient fall in the value of γ. When β increases, the marginal impact of monitoring effort decreases since the convex function that relates the detection probability $\pi(by)$ to the intensity of monitoring effort, b, is shifted downward as a result of the consequent fall in the fraud level: for a given value of b, not only $\pi(-)$ but also $d\pi/db$ diminish. The donor may therefore choose to increase b in order to mitigate that effect (bearing in mind that the marginal cost of monitoring, c, is constant), and rely on a reduced punishment level to decrease his external discipline. He is tempted to opt for that policy when the extent of fraud is not much reduced in response to an improvement of domestic governance.

Note that when β increases, a reduction in the leader's expected punishment, $\pi(-)\gamma$ is compatible with an increase in φ, the measure of aggregate external discipline imposed by the donor.[9] This explains why the effect of a change in β on φ is indeterminate.

We can summarise the above findings in the following proposition.

Proposition 2. *In situations where the donor is unable to put the local leader at his reservation utility, (a) the optimal response of the donor to an improvement*

[9] The expected punishment can, indeed, be written thus: $\pi(-)\gamma = \left(b^2F^2/4a^2\right)\left(a^2\varphi/b^2\right) = F^2\varphi/4$. It is thus evident that, when F falls as a result of an increase in β, $\pi(-)\gamma$ can decrease even though φ increases.

in the domestic governance of the host country consists of relaxing the extent of external discipline, φ. However, if the cost functions are not convex enough (if their elasticities are smaller than or equal to 2), external discipline may be so much relaxed by the donor that total discipline, measured by $(\beta + \varphi)$, falls. In this instance, the extent of fraud by the recipient country's elite increases. When both the detection probability and the two cost functions are quadratic, the paradox occurs.

(b) When the cost functions are convex enough to prevent the above paradox from occurring, improved domestic governance will cause a fall in monitoring intensity only if the elasticity of fraud with respect to the domestic governance parameter is low enough (in any event, smaller than one).

(c) When the cost of using monitoring or punishment increases, the less intensive use of the disciplining instruments by the donor induces the leader to appropriate a larger share of the aid transfer. The usual substitution effect obtains when the relative unit cost of the instruments is modified.

3.5 Remark: the case of an altruistic/paternalistic leader

Let us consider the case of an altruistic or paternalistic leader who attaches a weight α to his own income and a weight $(1-\alpha)$ to the income accruing to his constituency. Our specification is reminiscent of the so-called "paternalistic altruism" whereby Azam and Laffont (2003) describe the behavior of local elites in poor countries. In effect, the weight $(1-\alpha)$ needs not be interpreted strictly as a coefficient of altruism, but may be alternatively viewed as the bargaining power wielded by the leader's constituency (people are able to compel the leader to take their interests into account). Whichever the interpretation, the leader's utility function is written as follows:

$$V(y) = \alpha y + (1-\alpha)(1-y) - \alpha\gamma\pi(by) - g = y(2\alpha - 1) + (1-\alpha) - \alpha\gamma\pi(by) - g$$

Equivalently, we may write a function adjusted from Azam and Laffont (2000):

$$V(y) = y + \theta(1-y) - \gamma\pi(by) - g$$

We may then derive the leader's optimum fraud, assuming that the punishment is strong enough and the monitoring precise enough, so that dV/dy cannot be positive when $y = 1$ (and bearing in mind that α must exceed 1/2 for the problem to be non-trivial in the case of the first specification). The properties derived from (3) are easily verified. With the second specification, we thus have $\widetilde{y} = (1-\theta)/2\varphi$.

There is yet a particular problem that arises when an altruistic function is used to depict the leader's behavior. The problem is that we cannot be certain that the indirect utility of the leader decreases when the domestic governance improves (the altruism coefficient increases). Sticking to the Azam and Laffont's specification, we find that $V^I(y) = \frac{1}{2\varphi}\left(1 - \frac{(1-\theta)^2}{2}\right) - g$, from which it immediately follows that $\frac{dV^I}{d\theta} = \frac{1}{2}\left(\frac{1-\theta}{\varphi}\right) = \frac{\widetilde{y}}{2} > 0$. In other words, the leader's utility always increases as the weight given to the citizenry is raised while the aid delivery parameters are kept constant. This is not a peculiarity of simple altruistic functions such as those mentioned above. For example, let us posit a quite general utility function of the type: $V(x) = u(x,e) + \theta U(z,e)$, where x is the wage the leader receives from the donor, z is the amount of aid money, and e is the choice variable of the leader and measures the quality of the leader's input into the project funded by the donor. According to one interpretation, e is the level of theft of project funds, so that lower values of e are associated with higher levels of theft. The function $u(-)$ represents the 'direct utility' of the leader, and $U(-)$ the welfare of the community. It can then be shown that, under reasonable assumptions, given an optimal choice of a, the leader's utility increases in θ (see Wahhaj, 2008).

A consequence of the above result is that, in order to maintain the leader at his reservation utility, the donor may respond to an increase in θ by paradoxically increasing monitoring precision and/or the punishment level, and vice-versa if θ has fallen. When we compute the comparative-static effects from the donor's problem, we thus find that at least one of the effects, $\delta b/\delta\theta$ or $\delta\gamma/\delta\theta$, remains indeterminate while the other has the unexpected positive sign.[10]

Clearly, altruism as reflected in a positive weight given to the utility of the other is not a convenient manner to represent domestic governance. We can nevertheless interpret our own specification as a kind of genuinely paternalistic altruism, in the sense that the leader has his own conception of the way he may harm the community by embezzling funds (the coefficient β then represents a self-inflicted cost incurred by the leader when he deprives the community of a part of the aid fund).

3.6 The case of a probability function with a threshold

If we assume that the fraud detection probability function has a threshold ($h > 0$) below which fraud cannot be detected, the problem becomes more complex owing to the possibility of a corner solution for the leader. This happens when the leader chooses the level of embezzlement in such a way as to avoid the risk of detection altogether. Formally, the solution of the leader's programme cannot lie inside the interval $[0, h/b]$, yet it can be at the corner point $\hat{y} = h/b$. Indeed, the first derivative of the leader's utility function at that point when $\pi(by) = \frac{(by-h)^2}{a^2}$ is $dV/dy = 1 - 2\beta(h/b)$. It follows that the condition for the

[10] Note, incidentally, that the same oddity characterizes Azam-Laffont's model in which the optimal amount of aid granted (which is a variable) is shown to depend linearly on the consumption of the poor as decided by the leader (the government). The authors show that, when θ increases, the coefficient of the variable component of the aid contract decreases, pointing to a relaxation of the donor's discipline, the expected effect. When we complete the exercise and compute the effect of the same parametric change on the contract's fixed component, we nevertheless find that the value of this component may decrease under feasible conditions (proof available from the authors of the present paper), implying a counter-intuitive tightening of the donor's discipline.

corner solution is:

$$\frac{h}{b} > \frac{1}{2\beta} \tag{18}$$

The interpretation of the above is straightforward: the leader chooses the zero-detection level of fraud if domestic governance is sufficiently strong relative to that level. For a given degree of monitoring precision, indeed, a large β means that it is costly for the leader to embezzle too much aid money.

When the condition (18) is violated and the interior solution prevails, we have:

$$\check{y} = \frac{1}{2\left[\beta + \varphi\left(1 - \frac{h}{b}\right)\right]} \tag{19}$$

From the comparaison between (5) and (19), it comes that $\check{y} > \tilde{y}$: as expected, for given values of the disciplining instruments, the leader embezzles more when there is a zero-detection zone in the monitoring process.

The leader will be at the corner or at the interior solution depending on the outcome of the donor's optimization: the donor will induce the leader to be at the corner if his own indirect utility is higher than it would be with the interior solution. As it is evident from (18), the donor uses b but not γ towards such a purpose. In the case of the corner solution, b^* is set at a level low enough to cause h/b^* to exceed $1/2\beta$, yet at the same time, b should not be too small since $\hat{y}$ varies inversely with b at the corner. As for γ, its value is indeterminate, a direct consequence of the fact that the cost $D(\gamma)$ is incurred only in the event of fraud detection (see Appendix E for the full proof).[11]

When the interior solution prevails, so that the equilibrium fraud level is given by (19), the donor's optimization programme may not be solved sequentially, even when the leader is put at his reservation utility.[12] Like in the case where $h = 0$, some comparative-static effects are impossible to sign unambiguously, and there exists the possibility that b and γ are used as substitutes by the donor.

4 Allocating aid between two heterogeneous recipients with a given aid delivery system

4.1 The aid allocation rule and its properties

Let us consider the case of two beneficiaries with initial income per capita w_1 and w_2, and population n_1 and n_2. The donor is willing to transfer a total amount T. In this section, we assume that the aid delivery system (b, γ), which applies equally to both countries, is fixed. As a consequence, the donor knows the shares that are going to be embezzled by the elites ruling in these two countries, y_1

[11] It can also be shown (see Appendix C) that $\delta b^*/\delta h > 0$: the donor responds to an increase in the tolerance margin by enhancing monitoring precision. Moreover, $\delta b^*/\delta\beta > 0$.

[12] The participation constraint of the leader is written: $\tilde{y}\,(1 + 2\varphi h/b) - \tilde{y}^2\,(\beta + \varphi) - \gamma h^2/a^2 - g = 0$, from which it is evident that $\tilde{y}$ does not depend only on the parameters, including h, but also on b and γ.

and y_2. His problem is to allocate total aid so as to maximize social welfare as given by (we ignore monitoring and punishing costs at this stage):

$$W = n_1 Log\left[w_1 + s_1 T(1 - y_1)/n_1\right] + n_2 Log\left[w_2 + s_2 T(1 - y_2)/n_2\right]$$

where s_1 and s_2 are the shares of total aid going to the two beneficiaries. The main argument in the donor's welfare function, $[w_i + s_i T(1 - y_i)/n_i]$, is the level of income per capita achieved in the grassroot community of country i once the effect of aid transfer is taken into account. The weight ascribed to a country is proportional to the size of its population. What bears emphasis is that in this setup the quality of internal governance prevailing in each country matters: it actually operates through the share that accrues to the target population in country i, which is denoted by $(1 - y_i)$. Since the donor is sensitive to poverty, other things being equal, he prefers to help poorer communities. However, other things are not equal precisely because the quality of governance varies from country to country, determining different levels of aid effectiveness.

Assuming that the donor's participation constraint is satisfied, implying that $W \geq n_1 Log(w_1) + n_2 Log(w_2)$, maximization of the social welfare function under the constraint $s_1 + s_2 = 1$ leads to the following solution:

$$s_1 = Inf\left\{1, Sup\left[0, \frac{n_1}{n_1 + n_2} + \frac{1}{T}\left(\frac{w_2}{1 - y_2} - \frac{w_1}{1 - y_1}\right)\frac{n_1 n_2}{n_1 + n_2}\right]\right\} \quad (20)$$

$$= Inf\left\{1, Sup\left[0, \frac{n_1}{n_1 + n_2} + \frac{1}{T}\left(\omega_2 - \omega_1\right)\frac{n_1 n_2}{n_1 + n_2}\right]\right\} \quad (21)$$

Comparative statics for the interior solution shows that the share of beneficiary 1 increases with population, but decreases with initial income and the opportunism of the leader. On the other hand, the share of beneficiary 1 increases with the initial income of the other beneficiary and the opportunism of its leader while it decreases with its population. Formally:

$$\frac{\delta s_1}{\delta w_1} < 0; \frac{\delta s_1}{\delta y_1} < 0; \frac{\delta s_1}{\delta n_1} > 0; \frac{\delta s_1}{\delta w_2} > 0; \frac{\delta s_1}{\delta y_2} > 0; \frac{\delta s_1}{\delta n_2} < 0$$

All these effects are in accordance to expectation. They also match the so-called 'algorithm for the poverty-efficient allocation of aid' proposed by Collier and Dollar (2002). For a given level of poverty, a country should receive more aid if the quality of its policies is comparatively high and, analogously, for a given quality of policy, it should receive more aid if it is comparatively poor.

Leaving population size aside, the key factor featuring in the above equilibrium relationship is $\omega_i = w_i/(1 - y_i)$. This composite variable encapsulates the needs versus governance dilemma which lies at the core of our analytical endeavour. In a particular sense, it provides a need-adjusted measure of aid ineffectiveness, aid being ineffective when it goes either to a country that barely needs it (w_i is high), or to a country that cannot properly direct it towards the needy ($\hat{y}_i$ is high). Therefore, the higher ω_i the less induced is the donor to allocate aid to country i. In the particular case where $n_1 = n_2$, relative country shares in total aid are equal to 1/2 plus an expression that is positive or negative depending on whether the country considered is comparatively aid effective in the need-adjusted sense. When the role of population size is also taken into account, an additional trade-off emerges between aid effectiveness and the number of people involved. This is apparent from a comparison of the shares of aid money accruing to both countries:

$$s_1 > s_2 \Longleftrightarrow \left(\frac{n_1 n_2}{n_1 + n_2}\right)(\omega_2 - \omega_1)\,\frac{2}{T} + \frac{n_1 - n_2}{n_1 + n_2} > 0$$

The first term of the condition reflects the comparative advantage of country 1 from the viewpoint of need-adjusted aid effectiveness and the second term its advantage from the viewpoint of population size. Clearly, the two terms need not be both positive for s_1 to exceed s_2.

The critical role of relative inter-country need-adjusted aid effectiveness is also seen in the following, apparently odd comparative-static result:

$$\frac{\delta s_1}{\delta T} \gtreqless 0 \Longleftrightarrow \omega_1 \gtreqless \omega_2$$

The share of aid money allocated to a given country will rise with total aid available if and only if need-adjusted aid ineffectiveness is greater in that country than in the other. The underlying logic becomes clear once we understand that in the initial equilibrium the share of the more ineffective country is the lowest whereas both countries receive the same absolute amount out of an additional aid fund.[13]

We can now turn to the conditions determining the two possible corner solutions to the donor's problem: $\hat{s}_1 = 1$; $\hat{s}_2 = 0$, and $\hat{s}_1 = 0; \hat{s}_2 = 1$. The first solution obtains when $dW/ds_1 > 0$ at $s_1 = 1$ (or, equivalently, when $s_2 \leqq 0$), and the second one when $dW/ds_2 > 0$ at $s_2 = 1$ (or when $s_1 \leqq 0$). The following expressions describe the corresponding conditions:

$$\hat{s}_1 = 1; \hat{s}_2 = 0 \Longleftrightarrow \omega_2 > \omega_1 + \frac{T}{n_1} \tag{22}$$

$$\hat{s}_1 = 0; \hat{s}_2 = 1 \Longleftrightarrow \omega_1 > \omega_2 + \frac{T}{n_2} \tag{23}$$

[13] Assume that (i) country 1 is less attractive than country 2 on account of need-adjusted aid effectiveness ($\omega_1 > \omega_2$) either because its level of living is comparatively high or because its governance is comparatively bad, or both, and (ii) populations have the same size in the two countries ($n_1 = n_2$). It is then easy to show that, as a consequence of assumption (ii), $d(s_1 T)/dT = d(s_2 T)/dT$: aid will increase by the same absolute amount in the two countries if the total fund available is marginally higher. This simply reflects the fact that the optimal aid allocation is such that the marginal utility for the donor to give aid to country 1 is the same as that of giving aid to country 2. On the other hand, under the above two conditions, the share accruing to country 1 is smaller at equilibrium than the share going to country 2 :

$$\hat{s}_1 < \hat{s}_2 \Longleftrightarrow \omega_1 - \omega_2 > 0$$

Since country 1 receives the same absolute amount of money as country 2 out of the additional available fund while its relative share is lower in the initial situation, it follows that its share will increase and the share of country 2 will fall when the aid amount becomes higher.

In words, the donor allocates the whole aid fund to one country if the need-adjusted measure of aid ineffectiveness for the excluded country exceeds that obtaining for the favoured country by a sufficiently wide margin. This margin is equal to the amount of aid that the favoured country would receive on a per capita basis. The total amount of aid available matters: the larger this amount the less likely is the donor to exclude the less aid-efficient country (when aid delivery parameters are exogenous). We shall see later that this result can be generalized to n countries.

4.2 Comparing theory with practice

It is interesting to relate this theoretical allocation rule with the rules used by international donors when indeed they are using explicit allocation formulas. This is the case of both the International Development Association (IDA), the arm of the World Bank that specializes in managing multilateral aid to low income countries, or the African Development Bank (AfDB). These rules are known generically as 'Performance Based Allocation' or PBA rules. For instance, the allocation corresponding to the PBA rule used by the AfDB is:

$$A_i = CPA_i^4.(GNI_i/P_i)^{-.125}P_i$$

where A_i is proportional to the allocation for country i, CPA_i is the country performance assessment as judged by AfDB local representatives, GNI_i/P_i is gross national income per capita (excluding aid), and P_i the population. CPA_i is itself an index that is defined as:

$$CPA_i = .26.CPIA + .58.GR + .16.PPA$$

where the $CPIA$ is a Country Policy and Institutional Assessment index that takes into account various aspects of policies and institutions, GR the Governance rating component of the $CPIA$ index, and PPA is an assessment of the performances of the 'portfolio', i.e. previous aid given to that country.[14]

In terms of the model analyzed in this paper, the PBA rule obviously combines the three key characteristics of recipient countries: their level of income, w_i, their governance, β_i or, equivalently, $1 - y_i$, and their population n_i. Rigorously, in the present two-country framework, this PBA formula would lead to the following shares:

$$S_1 = \frac{[k(1-y_1)]^4 .w_1^{-125}.n_1}{[k(1-y_1)]^4 .w_1^{-125}.n_1 + [k(1-y_2)]^4 .w_2^{-125}.n_2},$$

and symmetrically for S_2. In that expression, $k()$ is some transform of the governance variable since it is not clear in the PBA framework how CPA_i translates into higher or lower shares of aid embezzled by country i's leaders. It can be seen that the same 'ingredients' are found in the PBA rules and in our

[14]This formula is taken from a presentation made by B. Chervalier, head of of the 'Resource Mobilization and Allocation Unit' of AfDB.

own aid allocation formula, but they are not combined in the same way. Yet, the above allocation rule satisfies the comparative-static properties obtained in the preceding sub-section. It is still the case that the share going to country i declines with its initial level of income, and increases with both its population size and the quality of its governance. However, it is not the case that it depends upon the total amount of aid available. The same observation can be made regarding the allocation formula arrived at by Collier and Dollar (2002).[15]

Part of the theoretical allocation rule that we have derived from our model and some of its properties are obviously influenced by the logarithmic functional form which has been selected. Yet other features of that rule are robust to the social welfare function chosen. In particular, the measure of need-adjusted aid ineffectiveness, ω_i, seems a rather rigorous way to combine poverty and governance. It is certainly more intuitively appealing than $[k(1-y_1)]^4 .w_1^{-125}$ used in the PBA formula. Of course, the problem is that y_i is not observed and $k()$ is not known. Equivalently, what is not known is the way in which CPA_i transforms into y_i. Yet something of this sort is needed to put the PBA formula on more solid welfare grounds. As it stands, the rule is almost fully arbitrary, especially when allocating aid among countries with similar income per capita, w.

Clearly, the implicit theory behind the AfDB yardstick is much more oriented towards forcing recipient countries to improve on governance in a kind of independent manner. In our framework, progress in governance can be obtained through the use of aid delivery instruments, b and γ.[16] It follows that the aid allocation rule depends explicitly on these instruments. If they are country-specific, bearing in mind that $1-\tilde{y} = 1-\left[2\left(\beta + b^2\gamma/a^2\right)\right]^{-1}$, it comes easily that:

$$\frac{\partial s_1}{\partial b_1} \geq 0$$

If the instruments are the same in the two countries, however, it comes after

[15]In Collier and Dollar's paper, the donor has a fixed amount of aid and he wants to allocate it between the recipient countries so as to maximize poverty reduction measured as: $\sum_i G^i \alpha^i h^i N^i$, where G^i is the rate of growth of country i, α^i is the elasticity of poverty reduction with respect to income, h^i is a measure of poverty (say, the headcount index), and N^i is the size of its population. The rate of growth is influenced by the amount of aid received (assuming diminishing returns), the quality of policies, p^i, and the interaction between these two variables (plus a number of exogenous conditions). Using their estimate of the growth equation, Collier and Dollar arrive at the following allocation formula:

$$A^i = 13.5 + 7.8p^i - \frac{\lambda}{0.04\alpha^i}\left(\frac{h^i}{y^i}\right)^{-1},$$

where A^i is the aid received by country i, y^i is its level of income per capita, and λ is the shadow value of aid.

[16] Of course, the real issue lies more in the nature of the aid delivery instruments actually available to the donors than in the two simple parameters that we have used for the sake of modeling simplicity.

some calculations that

$$\frac{\partial s_1}{\partial b_1} \geq 0 \iff w_1 \frac{y_1^2}{(1-y_1)^2} \geq w_2 \frac{y_2^2}{(1-y_2)^2}$$

which is less intuitive.

Referring to the PBA rule used by multilateral aid agencies, this result suggests an important practical lesson: the allocation rule should logically be modified whenever the donor decides to change its aid delivery system. Unfortunately, there is very little transparency or debate about the nature of the monitoring and the punishment used in donor agencies.

4.3 Generalizing to n recipient countries

The two-recipient-country allocation generalizes easily to the case of any number of recipients. In what follows it is still assumed that the aid delivery instruments, b and γ, are fixed. The objective function of the donor is:

$$Max \sum_{i=1}^{n} n_i Log\left[w_i + s_i T(1-y_i)/n_i\right] \quad s.t. \;\; s_i \in [0,1] \;\; \forall i, \;\; \sum_{i=1}^{n} s_i \leq 1$$

Straight resolution of the preceding program leads to the following allocation rule:

Proposition 3. *Assuming that recipient countries are ranked by ascending ω_i, the first i^* countries receive an individual share given by:*

$$s_i = \frac{n_i}{T}\left[\frac{\sum_{j=1}^{i^*} n_j.\omega_j}{\sum_{j=1}^{i^*} n_j} - \omega_i\right] + \frac{n_i}{\sum_{j=1}^{i^*} n_j}$$

whereas the $n-i^*$ remaining countries receive nothing. The threshold i^* is given by the following condition:

$$\omega_{i^*+1} \geq \frac{\sum_{j=1}^{i^*} n_j.\omega_j}{\sum_{j=1}^{i^*} n_j} + \frac{T}{\sum_{j=1}^{i^*} n_j}$$

Interestingly enough, the critical role played by the size of total aid clearly comes out of the above expressions. When T increases, the number of beneficiaries (i^*) increases, whereas the share of those countries where aid is relatively ineffective in comparison with the mean aid ineffectiveness among initial beneficiaries increases and the share of the relatively aid efffective beneficiaries decreases. In other words, small donors should cater to fewer countries and they should allocate a higher share to the most aid effective countries among them.

5 The optimal aid delivery system with two recipient countries

We now complete the model by identifying the optimal aid delivery parameters, or disciplining instruments, b and γ, when there are two recipient countries, thus generalizing the argument in section 2 for a single recipient country. To simplify, it will be assumed that the two leaders in the recipient countries have the same aid management cost, g. We will nevertheless relax this assumption at some stage of our argument.

There are two situations that need to be distinguished, one in which the disciplining instruments are tailored to each country's internal governance, and the other in which the instruments are uniformly applied to the two countries. Which situation is empirically more relevant or theoretically more justifiable is hard to say a priori. If a donor adjusts its disciplining effort to the local governance of the target countries, he is better able to tame corruption in each and every country. Compared to such a differentiated strategy, a uniform (b, γ) appears as a blunt instrument. It may nevertheless prove preferable if it allows the donor to economize on significant transaction costs or to reap substantial scale economies. Moreover, equity considerations may prevent him from applying different treatments to countries on account of perceptible variations in internal governance.

Note that, for each situation, we have to consider the possibilities that the leaders' participation constraints are binding or not.

5.1 The case of individualized disciplining treatment with binding leaders' participation constraints

Assuming that monitoring and punishing expenditures are proportional to the size of the aid transfer, the donor's objective function can be written:

$$Max_{b_1, b_2, \gamma_1, \gamma_2, s_1, s_2} \Omega = n_1 Log \left[w_1 + \frac{s_1 T}{n_1} (1 - \tilde{y}_1) \right] - s_1 T\, C(b_1) - s_1 T\, D(\gamma) \pi_1 (b_1 \tilde{y}_1)$$

$$+ n_2 Log \left[w_2 + \frac{s_2 T}{n_2} (1 - \tilde{y}_2) \right] - s_2 T\, C(b_2) - s_2 T\, D(\gamma) \pi_2 (b_2 \tilde{y}_2)$$

Bearing in mind that, when participation constraints are binding, $\tilde{y}_i = 2g$, and is therefore identical across the two countries, we first optimize with respect to the disciplining instruments:

$$Max_{b_1, b_2, \gamma_1, \gamma_2}\, \Omega = n_1 Log \left[w_1 + \frac{s_1 T}{n_1} (1 - 2g) \right] - Co^1 (cs_1 T, ds_1 T, g, \beta_1)$$

$$+ n_2 Log \left[w_2 + \frac{s_2 T}{n_2} (1 - 2g) \right] - Co^2 (cs_2 T, ds_2 T, g, \beta_2)$$

where Co^1 and Co^2 correspond to the minimum cost functions obtained after the donor has chosen the optimal values of b and γ for each recipient country. Remembering (14), we now write:

$$Co^i = H\, a^{2(m-1)(1-p)}(ds_iT)^{1-p}(cs_iT)^p g^{2(1-p)} \left(\frac{1}{4g} - \beta\right)^{m(1-p)}$$

$$= H\, a^{2(m-1)(1-p)} d^{1-p} c^p g^{2(1-p)} \left(\frac{1}{4g} - \beta\right)^{m(1-p)} s_iT$$

$$where\ p = \frac{-2(1-m)}{q+2(m-1)};\ H = constant$$

Let us call Co_1^1 and Co_2^2 the first derivatives of the two cost functions with respect to s_1 and s_2, respectively. Since the cost functions are linear in s_1T and s_2T, respectively, s_1 does not appear in the function $Co_1^1$and s_2 does not appear in Co_2^2. The first-order conditions with respect to s_1 and s_2 then yield the following equilibrium allocation condition:

$$\frac{T(1-2g)}{w_1 + \frac{s_1T}{n_1}(1-2g)} - Co_1^1 = \frac{T(1-2g)}{w_2 + \frac{s_2T}{n_2}(1-2g)} - Co_2^2$$

We can rewrite this condition after positing that $\omega_i' = w_i/T(1-2g)$, which mesure the need-adjusted aid ineffectiveness of each country:

$$\frac{1}{\omega_1' + s_1/n_1} - Co_1^1 = \frac{1}{\omega_2' + s_2/n_2} - Co_2^2 \tag{24}$$

In the simple case where $\beta_1 = \beta_2$, we have that $Co_1^1 = Co_2^2$, so that the above expression can be further simplified and is easily interpretable. The poorer (and/more populated) country receives a larger share of the aid amount. Let us now relax this assumption and look at how the shares s_1 and s_2 are determined when domestic governance differs across the two countries. We assume that $\beta_2 > \beta_1$, with the consequence that $Co^2 < Co^1$, and $Co_2^2 < Co_1^1$. Let us define $\Delta = Co_1^1 - Co_2^2$, which is positive, so that (24) now writes:

$$\frac{1}{\omega_1' + s_1/n_1} = \frac{1}{\omega_2' + s_2/n_2} + \Delta$$

From this equality, we can easily derive an expression of s_1/n_1 as a function of s_2/n_2:

$$\frac{s_1}{n_1} = \frac{\omega_2' + s_2/n_2}{1 + \Delta\omega_2' + \Delta s_2/n_2} - \omega_1' \tag{25}$$

Taking into account the constraint $s_1 + s_2 = 1$, we can write the above condition as the following implicit function:

$$\frac{1-s_2}{n_1} - \frac{\omega_2' - \omega_1' - \Delta\omega_1'\omega_2' + s_2/n_2(1 - \Delta\omega_1')}{1 + \Delta\omega_2' + \Delta s_2/n_2} = f(s_2) = 0$$

From this expression, by applying the implicit-function theorem, we obtain the comparative-static results that we look for.

$$\frac{\delta s_2}{\delta \omega_2'} \leq 0;\ \frac{\delta s_2}{\delta \omega_1'} \geq 0;\ \frac{\delta s_2}{\delta n_2} \geq 0;\ \frac{\delta s_2}{\delta n_1} \leq 0;\ \frac{\delta s_2}{\delta \Delta} \geq 0$$

$$\frac{\delta s_2}{\delta T} \gtreqless 0 \Longleftrightarrow w_2 \gtreqless w_1(1 + \Delta\omega_2' + \Delta\frac{s_2}{n_2})^2$$

$$\frac{\delta s_2}{\delta g} \gtreqless 0 \Longleftrightarrow w_1 \gtreqless \frac{w_2}{(1 + \Delta\omega_2' + \Delta\frac{s_2}{n_2})^2}$$

The results concerned with the effect of own or the other country's need-adjusted aid ineffectiveness and population size all confirm what we know from the case of exogenous domestic governance parameters. On the other hand, and as expected, the direct effect of an increase in the cost advantage of the better governed country, Δ, is to increase its share in total aid. The critical role of Δ also emerges from the comparative-static effect of a variation in g. When g increases, indeed, the better governed country will get a higher share if its cost advantage is sufficiently large to compensate the effect of its higher income level. The effect of an increase in the total amount of aid available again confirms the role of Δ: the relative share of the better governed country will be raised only if its level of living, w_2, exceeds the other country's level, w_1, by a sufficiently wide margin. And the higher its cost advantage, Δ, the higher this margin.

To understand the latter result, we must notice that the same margin, $(1 + \Delta\omega_2' + \Delta\frac{s_2}{n_2})$, plays a key role in determining which country, the better or the worse governed, gets the major part of the aid available. More precisely, the worse governed country will obtain more than half the aid amount is the following condition is satisfied:

$$s_1 > 1/2 \Longleftrightarrow w_1 + \frac{1}{2n_1}T(1-2g) < \frac{w_2 + (s_2/n_2)\,T(1-2g)}{1 + \Delta\omega_2 + \Delta s_2/n_2}$$

Since s_2 would then be smaller than $1/2$, we can rewrite the above condition as:

$$s_1 > 1/2 \Longleftrightarrow w_1 + \frac{1}{2n_1}T(1-2g) < \frac{w_2 + \left(\frac{1}{2n_2} - \varepsilon\right)T(1-2g)}{1 + \Delta\frac{w_2}{T(1-g)} + \Delta\left(\frac{1}{2n_2} - \varepsilon\right)}$$

The poorer and worse governed country is thus more likely to get the largest portion of the aid but only provided that its cost disadvantage resulting from lower domestic governance is not too high. As we have learned from our treatment of the case of exogenous governance, the country with the initially higher (smaller) share will see this share diminish (increase) as the total amount of aid available increases.

In the same line of reasoning, we can highlight he conditions under which the two corner solutions arise. The poorer and worse governed country, country 1, will be deprived of any aid if:

$$s_1 = 0;\ s_2 = 1 \Longleftrightarrow \Delta > \frac{1}{\omega_1'} - \frac{1}{\omega_2' + 1/n_2}$$

Thus, the lower the level of need-adjusted aid effectiveness (that is, the higher the income) of country 1 compared to country 2, or the greater its cost disadvantage, the more likely it will be denied aid.

The opposite case in which the richer and better governed country is excluded occurs when:[17]

$$s_2 = 0;\ s_1 = 1 \Longleftrightarrow \frac{\omega_2'}{1+\Delta\omega_2'} \geq 1 + \omega_1'$$

As expected, the possibility of exclusion of country 2 is greater if its need-adjusted aid ineffectiveness is higher, or its cost advantage smaller.

It is useful to compare the conditions for inclusion of the poorer and worse governed country when domestic governance is given and when it is improvable by the donor's actions. Bearing (23) in mind, and adjusting for the fact that $\omega_i' = \omega_i/T$, we write the conditions under which country 1 will receive a positive share of aid:

$$\frac{1}{\omega_1} > \frac{1}{\omega_2 + T/n_2}\ \textit{with exogenous governance}$$

$$\frac{1}{\omega_1} > \frac{\Delta}{T} + \frac{1}{\omega_2 + T/n_2}\ \textit{with endogenous governance}$$

The implication is straightforward: the external governability of country 1 leads to an increase in its need-adjusted aid effectiveness, $(1/\omega_1)$, and this improvement (compared to $1/\omega_2$) raises its chance to receive aid provided that the differential cost resulting from the donor's actions is not too high. In other words, the disciplining actions of the donor have the effect of raising the term on the left-hand side of the inequality condition (which is favourable to country 1), and of causing the appearance of a new term on the right-hand side (which is potentially unfavourable). Moreover, the impact of a larger amount of aid is always to raise the prospect that the internally less well governed country will receive a portion of it.

An interesting result arises when we relax the assumption that the elite's outside option is identical across the two countries, thereby re-introducing the possibility of different governance levels. We would like to know whether the country with the higher g would be favoured by the donor.

First note that we now have $\omega_i' = w_i/(1-2g_i)T$. We then assume that, starting from a situation in which $g_1 = g_2$, we raise g_1. As is evident from (25),

[17] The condition $1 < \frac{\omega_2' - \omega_1' - \Delta\omega_1'\omega_2'}{1+\Delta\omega_2'}$ can, indeed, be rewritten: $1 < \frac{\omega_2'}{1+\Delta\omega_2'} - \omega_1'$.

the resulting increase in ω_1 has the effect of lowering s_1. Yet, a second effect needs to be taken into account, which occurs on the cost side of the donor's problem. When $g_1$increases, the minimum aggregate cost incurred for country 1, Co^1, falls -see (14). This is a consequence of the fact that the donor must relax his disciplining effort so as to enable country 1's elite to get a larger share of the transfer. Since Co^1decreases, Δ is reduced and s_1 rises. There are thus two effects running into opposite directions. In other words, we cannot rule out the possibility that the donor will choose to raise the share of aid accruing to the country whose governance has worsened (in the sense of an improved outside option for the elite).

The main lesson from the above analysis is summarized in the following proposition.

Proposition 4. *(a) When governance is endogenous to the donor's effort and the donor is able to put the elite of each recipient country at their identical reservation utility, the levels of fraud are equalized. The shares of aid accruing to each country then depend upon the relative income levels, the relative population sizes, and the cost differentials. The poorer country will not receive a large share if the cost of disciplining it is high compared to the richer country.*

(b) A greater availability of aid enhances the chance that the poorer and worse governed country is included in the aid programme.

(c) When the elite's reservation utility of a country increases relative to the other country, thereby reducing its need-adjusted aid effectiveness, its share in total aid may increase.

5.2 The case of individualized disciplining treatment with non-binding leaders' participation constraints

To be written.

5.3 The case of uniform disciplining treatment

When the aid delivery parameters are uniformly applied to the two countries, two cases can arise depending on whose leader the participation constraint is binding. They are defined by the following property.

Proposition 5. *If the best governed country receives aid, its participation constraint must be binding.*

The proof is straightforward. The participation constraint for country i writes: y

$$\frac{1}{4(\beta_i + \varphi)} \geq g$$

Assuming without loss of generality that $\beta_2 \geq \beta_1$, it follows that:

$$\frac{1}{\beta_1 + \varphi} \geq \frac{1}{\beta_2 + \varphi}$$

By assumption, the participation condition must be binding for at least one of the two countries. Otherwise the donor could improve its objective. The proposition follows.

Two situations are thus possible: (i) Leader 2's participation constraint is binding which allows leader 1 to participate at a utility level greater than his reservation; (ii) Leader 2 does not participate, in which case leader 1's participation constraint is binding. The optimal aid delivery instruments must be determined by comparing the objective of the donor in those two cases.

The detailed analysis, which is somewhat cumbersome, is presented in Appendix F. Let us denote by W_1 the value of the donor's objective function when aid goes entirely to country 1, by W_2 its value when aid goes entirely to country 2, and by W_{12} its value when aid goes to both countries. Country 2 is assumed to be better governed than country 1, and Δ is the differential in need-adjusted aid ineffectiveness, so that $\Delta = \omega_2 - \omega_1$. The results can then be summarized in Proposition 4.

Proposition 6. *Case "1+2". If* $W_{12} > W_1$, *and if* $T/n_1 \geq \Delta \geq 0$ *and* $T/n_2 \geq -\Delta \geq 0$, *both countries participate in the aid programme and the best governed country's participation condition is binding. There is then more embezzlement in the worst governed country.*

Case "2". If $W_2 > W_1$, *and if* $-\Delta \geq T/n_2$, *the best governed country's participation condition is binding, both countries would like to participate but the donor excludes the worst governed country.*

Case "1". In all other cases, the worst governed country is the only one to receive aid.

Case 2 is especially interesting to look at since it corresponds to the exclusion of the worst governed country ($\beta_1 < \beta_2$) which is also assumed to be the poorest ($w_1 < w_2$). Bearing in mind that $\Delta \leq 0$ obtains when $\omega_1 \geq \omega_2$, what the condition shows is the following: the worst governed country is excluded from the aid programme if its comparative disadvantage in terms of need-adjusted aid ineffectiveness, $(\omega_1 - \omega_2)$, exceeds the amount of aid per capita were it entirely given to the better governed country. Therefore, the larger the amount of aid available the harder it is to satisfy this condition. In other words, when aid is plentiful, it is unlikely that the badly governed countries will be deprived of aid assistance. This confirms the result mentioned in Subsection 4.3.

The analytical expressions of the conditions defining the three preceding cases are quite intricate. In effect, it is impossible to solve any condition of the type $W_{12} > W_1$ or $W_2 > W_1$ with respect to any parameter of the model because of the presence of the log function. Moreover, every case is defined by multiple inequalities. That these inequalities are not redundant is seen from the fact that the $W_{12} > W_1$ or $W_2 > W_1$ conditions do involve the cost function parameters whereas the inequalities in Δ do not.

Numerical simulations allow us to get some idea of the practical implications of the preceding proposition. Figure 1 shows the various aid regimes ("12", "1" and "2") in the (β_1, w_1) space for given values of β_2 and w_2. According to expectations, regime "2" where aid concentrates on the best governed country holds when the worst governed country is rich enough (in relative terms), with the threshold increasing with the quality of that country's governance. When crossing the upper threshold curve, the aid regime switches to "12" where both countries receive aid. Although not depicted in Figure 1, the share of aid going to country 1 increases with the quality of its governance within regime "12".

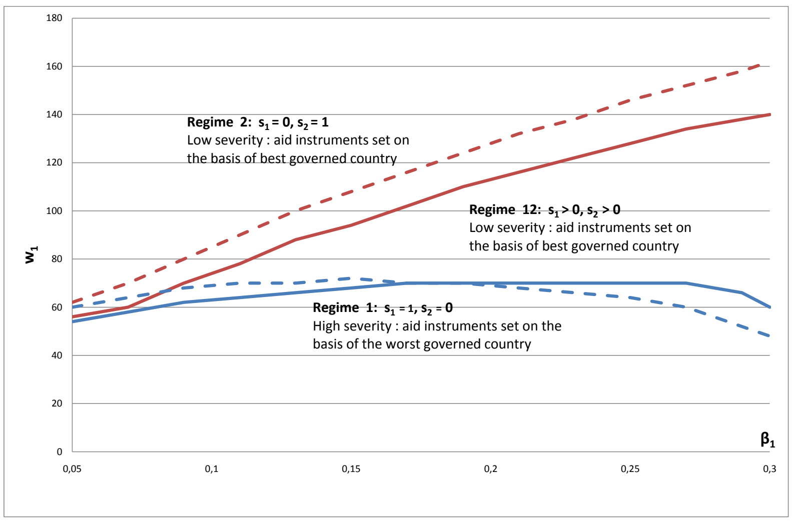
The lower threshold curve is the frontier between regime "1" where only country 1 receives aid, and the other two regimes: regime "2" for low governance quality and regime "12" for higher quality. As could be expected, regime "1" holds for lower income levels in country 1. Interestingly enough, however, the threshold is not a monotonic function of the quality of governance. It is thus not the case that the better governed the poor country the higher the income threshold below which it will receive the entire aid fund. This is true up to some governance quality, but then the the threshold stays constant for a while and then declines.

The same discontinuities come out of Figure 2 in which the share of country 1 in total aid is measured along the vertical axis and its level of income along the horizontal axis. Each curve is drawn for a given quality of governance with the upper curves corresponding to higher levels of governance. It is striking that the relationship between s_1 and w_1 is smooth only for the highest levels of governance. For most governance levels, the line is broken pointing to a sudden jump to the maximum share ($s_1 = 1$) when the income w_1 falls below a certain point. When the quality of governance is extremely low, the jump is from a zero to a unitary share once poverty reaches a critical point.

Understanding this non-monotonicity is somewhat subtle, as it requires that we distinguish between the cost effects and the effects on the true utility of the donor. This is done in Appendix G.

We may now examine the effects of increasing the size of aid, which are represented by the dotted lines in Figure 1. As was already stressed, an interesting implication of the present analysis is that both the allocation of aid and the optimal aid delivery instruments strongly depend on how much is to be distributed. The dotted lines in Figure 1 suggest that increasing the size of aid also increases the area in the (β_1, w_1) space where regime "12" holds, that is where both countries 1 and 2 receive aid. Note, however, that this is unambiguously the case only for governance levels not too far apart in the two countries. When the governance is much worse in country 1 than in country 2, it is still the case that the optimal policy is close to the bang-bang type, i.e. either the donor is very severe and excludes the best governed country or it is lax and excludes the worst governed country.

A last comment is in order in relation to the numerical simulations which have just been discussed: the bang-bang nature of the optimal policy lies very much in the specification which was selected. With the original specification in this paper, it was necessary to put the size of aid, T, at around 50% of the total income of the two countries for the solution of the optimal aid delivery problem to yield smooth results. With T closer to what it actually is in the real world - a few percentage points of GDP at best -, the solution would be essentially of the bang-bang type shown on the left hand side of Figure 1. Moving from a unit inequality aversion as implied by the logarithmic specification to less or more aversion did not change that result very much. Since in the real world we do not actually observe that donors concentrate only on 1 or 2 countries, one should admit either that donors tend to magnify the impact of their aid on recipient countries or that they pursue other objectives than standard welfare. The numerical simulations reported in Figures 1 and 2 rely on the assumption that donors tend to magnify the impact of their aid by a factor of 5.



Dotted curves show the effect of increasing total aid by 50% from baseline

Figure 1: The various aid regimes in the (β_1, w_1) space ($\beta_2 = .3$, $w_2 = 100$)

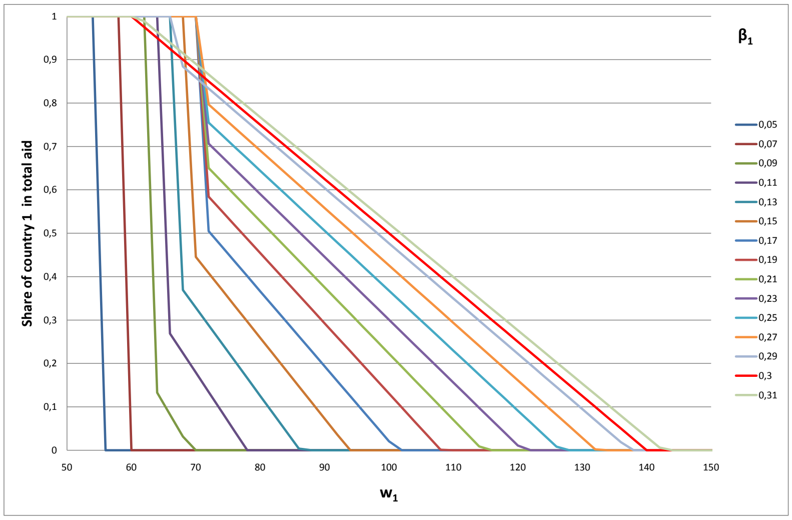


Figure 2: Share of country 1 as a function of its income (w_1) and its governance parameter (β_1), with optimal uniform aid delivery instruments ($w_2 = 100, \beta_2 = 0.3$)

6 Conclusion and discussion

The economic literature that seriously addresses the issue of governance and aid effectiveness concludes that badly governed countries ought to be denied development assistance until they put some 'order in their house'. As a general policy prescription, this is a problematic statement because the poorest people tend precisely to live in badly governed countries (in particular, those where the state has failed). What the present paper argues is that the contradiction between the objective of poverty alleviation, as reflected in the Millenium Development Goals (MDGs), for example, and that of aid effectiveness, as enshrined in the Paris Declaration and the Accra Agenda for Action, is not inescapable.

There are two main problems with most of the existing literature. First, it assumes that governance quality as given and considers the various incentive problems (moral hazard and adverse selection) that arise when badly governed (and poor) countries receive aid. Second, it ignores the role of total aid supply. When local governance is out of the control of the donor and the latter's objective function embodies a trade-off between needs and governance, poor and badly governed countries are likely to be excluded from development assistance. We nevertheless show that this conclusion critically depends on the total amount of aif available. Just think of the donor as a whole community of donors acting in a coordinated fashion like the UN assembly for the MDGs. If the total amount of aid that they put in the common pool is large enough, all countries regardless of their governance quality will receive aid. This is because the marginal utility of the donor with respect to the income level of a given country is decreasing and this effect becomes strong when the total amount of aid is large.

Once the assumption of exogenous governance is relaxed and the donor is able to use aid delivery parameters with a view to improving governance quality, so that external discipline can substitute for locally deficient governance, all sorts of aid distribution patterns become possible. In particular, it is quite conceivable that the worst governed countries are prioritized and the best governed ones perhaps even removed from the list of beneficiaries.

When the donor is able (and willing) to tailor the values of these instruments to the specific governance conditions that prevail in each recipient country, the poorest countries can never be excluded from the aid programme. By contrast, the richest countries can be excluded if they are relatively too rich and total aid resources are too limited. To put it in another way, when aid resources are sufficiently plentiful, and the donor's disciplining instruments are country-specific, both the richer and the poorer countries will receive aid.

When the donor can influence domestic governance yet only by applying a uniform disciplining treatment to the recipient countries, all scenarios become feasible. In a two-country setup, only the poorer country is eligible for aid (if it is not too badly governed and the other country is too rich in relative terms), or only the richer country is eligible (if it is not too rich and the other country is too badly governed), or the poorer and the richer countries receive aid (in the other cases). Again, the quantity of aid resources available plays a critical role. As it increases, the likelihood of an inclusive aid programme tends to be higher, yet only provided that the governance levels in the two countries are not too far apart.

What does this mean for the debate about aid effectiveness and poverty reduction? When the donor applies the same discipline to all the countries, an increase in aid availability may trigger a shift from the regime where only the richer and better-governed country is granted aid to a regime where the poorer and more badly governed country also receives aid support (case i). In this case, aid effectiveness understood as quality of governance (or, more exactly, the outcome of governance) decreases marginally as a consequence of the increase in the total aid fund. Average effectiveness also decreases. Alternatively, the shift caused by the higher amount of aid may be from a regime in which both countries participate to a regime where only the poorer and more badly governed country has access to the donor's support (case ii). In this case, again, the marginal (and average) effectiveness of aid fall. Still another possibility arises when the greater availability of aid has the effect of making the richer and better governed country eligible while it was excluded in the initial situation characterized by the concentration of the whole aid effort on the poorer country (case iii). Here, the outcome of the increase in total aid supply is to raise the average effectiveness of aid but the marginal effectiveness remains constant.

If the donor applies country-specific disciplining treatment, a possible effect of greater aid availability is to trigger a move from a regime where only the poorer country has access to aid to a regime where both the poorer and the richer countries do (case iv). This scenario is similar to the previous one (iii) . Note that if outside opportunities vary between recipient countries, say the richer and better governed country has the more attractive outside option, its participation in the aid programme would cause marginal aid effectiveness to decline (since the donor has to show less severity to be able to include it).

In the end, when the donor's utility function balances needs against governance considerations, it is not meaningful to be exclusively concerned with aid effectiveness understood as the outcome of domestic governance. What matters is how many among the poorest can be reached cost-effectively by the donor, and this is precisely the objective pursued by the donor possessing such a utility function.

If we adopt the Rawls criterion as the appropriate yardstick to assess the outreach (rather than effectiveness) of the aid programme, we again see that the conclusion varies depending on the scenario considered. Thus, in the first two scenarios described above, (i) and (ii), the outreach improves while in case (iii) the outcome is ambiguous because the poorer people get a lower share (less than 100 percent) of a larger total aid fund. The same ambiguity obtains in case (iv).

To conclude, the way we look at the problem of aid effectiveness hinges crucially upon whether the quality of local governance is considered as given or as liable to improve under the donor's pressure. Moreover, total aid available appears to exert a major influence on both the pattern of inter-country allocation of aid and the extent of poverty reduction in the most needy countries. The policy implications of our analysis are as follows. If the aid delivery parameters can be adjusted to the governance situation in each recipient country, the interests of the poorest will be best taken into account. If, on the other hand, these parameters must have uniform values, an abundant aid supply is the safest way to reach the poorest and worst governed countries.

A final remark is in order. It can be argued that the punishment imposed by the donor does not only harm the elites but also their communities, say because future aid tranches will not be disbursed. We need to bear in mind, however, that the alternative is even worse since the absence of punishment is likely to cause the exclusion of the poorest and most badly governed countries from initial consideration by the donor.

Appendix A: Notations

The basic notations used in the paper are thus:

t = the size of the aid program;

y = the share of aid appropriated by the leader or the elite of the recipient country (that is, the extent of 'fraud'): $y \in [0,1]$

β = the internal governance parameter of the recipient country, or the cost inflicted by the national community on a leader who behaves fraudulently: $\beta \in [0,1]$;

b = the degree of precision achieved in the monitoring of the country leader's behavior ($\in [0,\infty[$);

$\pi(by)$ = the probability of fraud detection;

h = the threshold below which fraud remains undetected;

γ = the amount of the penalty if the fraud is detected;

g = the cost of handling one unit of aid for the leader;

V° = the reservation utility of the leader;

$C(b)$ = the cost of monitoring;

$D(\gamma)$ = the cost of imposing the penalty level γ.

Appendix B: Probability Function with a Detection Threshold

The donor infers the probability of fraud, say $y > Y$, where Y is an arbitrary threshold, from observing x knowing $F()$.

$$\Pr\{y > Y\} = \Pr\{(1-x) + u > Y\} = 1 - F_u\left[Y - (1-x)\right]$$

Punishing will occur if this probability is above some threshold $1-\theta$, that is:

$$F\left[Y - (1-x)\right] \leq \theta \iff x \leq 1 - Y + F_u^{-1}(\theta) = \xi \tag{26}$$

In other words, the donor senses fraud when the observed output is below some threshold, ξ, that depends on Y and θ.

Given such behavior by the donor, the probability $\pi(y)$ for the fraud to be detected as a function of the fraud y is given by :

$$\pi(y) = \Pr\{x = 1 - y + u \leq \xi\} = F_u\left[y - (1-\xi)\right] \tag{27}$$

Assume now that the donor is able to modify the distribution of the outcome random component, u, through monitoring. A convenient assumption is that the donor can scale the random component up or down by a factor $b \geq 0$. The cdf of the noise in the outcome observation, $v = u/b$, is now given by:

$$F_v(v) = F_u(v/b)$$

Finally, it makes sense to require that the probability of fraud detection be zero when there is no fraud. This implies that $F_u\left[-(1-\xi)\right] = 0$, which permits identifying ξ once the original distribution of the noise, $F_u()$, is known. A less stringent constraint would be to allow the probability of fraud detection to be zero for a fraud below some small threshold, h. In other words:

$$F_u\left[y-(1-\xi)\right]=0 \quad for \quad y\leq h$$

Clearly, the leader can then embezzle a proportion h of aid with no probability of being detected.

Appendix C: Comparative-static effects on b and γ when the leader's PC is binding

The donor minimizes the function $C(b)+\left(\frac{b^2\widetilde{y}^2}{a^2}\right)D\left(\frac{a^2\varphi}{b^2}\right)$, where $\varphi=\frac{1}{4g}-\beta$, and $\widetilde{y}=2g$. Differentiating this expression with respect to b yields:

$$\psi(b;g,\beta,a)=C'(b)+D\left(\frac{a^2\varphi}{b^2}\right).\frac{8bg^2}{a^2}+\frac{4b^2g^2}{a^2}.D'\left(\frac{a^2\varphi}{b^2}\right).a^2\varphi\left(-\frac{2}{b^3}\right)=0,$$

which can be rewritten as follows:

$$\psi(b;g,\beta,a)=bC'(b)+D\left(\frac{a^2\varphi}{b^2}\right).\frac{8b^2g^2}{a^2}-8\varphi g^2.D'\left(\frac{a^2\varphi}{b^2}\right)=0$$

Signing $\delta b/\delta g$ Differentiating $\psi(b;g,\beta,a)$ with respect to b again yields:

$$\psi_b=bC"(b)+C'(b)+D(-).\frac{16bg^2}{a^2}+D'(-).\frac{8b^2g^2}{a^2}.a^2\varphi\left(\frac{-2}{b^3}\right)$$

$$-8D"(-)g^2\varphi a^2\varphi\left(\frac{-2}{b^3}\right),$$

which can be simplified as:

$$\psi_b=bC"(b)+C'(b)+D(-).\frac{16bg^2}{a^2}+16\frac{g^2\varphi}{b}\left[D"(-)\frac{a^2\varphi}{b^2}-D'(-)\right]$$

The sign of the above expression is positive by virtue of the second-order condition of the donor's optimization problem, bearing in mind that the donor minimizes costs. We therefore have:$\psi_b>0$.

By differentiating $\psi(b;g,\beta,a)$ with respect to g, we have:

$$\psi_g=D(-)16\frac{b^2g}{a^2}+D'(-)\frac{8b^2g^2}{a^2}\left[\frac{a^2}{b^2}\left(-\frac{1}{4g^2}\right)\right]-16D'(-)g\varphi$$

$$-8D'(-)g^2\left(-\frac{1}{4g^2}\right)-8D"(-)g^2\varphi\left(-\frac{a^2}{4b^2g^2}\right)$$

which can be simplified into:

$$\psi_g=D(-)16\frac{b^2g}{a^2}-16D'(-)g\varphi+2D"(-)\varphi\frac{a^2}{b^2}$$

To be able to sign this expression, we need to proceed in two steps. First, we use Taylor's expansion to write an approximation of the function $D(\gamma)$ up to the second-order derivative:

$$D(\gamma) = D(0) + \gamma D'(0) + \frac{\gamma^2}{2} D"(0) \Rightarrow D(0) = D(\gamma) - \gamma D'(0) - \frac{\gamma^2}{2} D"(0)$$

Applying the same Taylor's theorem recursively, we find:

$$D(0) = D(\gamma) - \gamma\left[D'(\gamma) - \gamma D"(0)\right] - \frac{\gamma^2}{2} D"(0) = D(\gamma) - \gamma D'(\gamma) + \frac{\gamma^2}{2} D"(\gamma)$$

Since $D(0) = 0$ by assumption, we finally have that:

$$D(\gamma) - \gamma D'(\gamma) + \frac{\gamma^2}{2} D"(\gamma) = 0 \tag{28}$$

The second step consists of rewriting ψ_g so as to exploit the above property. Bearing in mind the definition of φ, we have:

$$\psi_g = 16\frac{g\varphi}{\gamma} D(-) - 16g\varphi D'(-) + 2\gamma D"(-),$$

or

$$\psi_g = 16g\varphi D(-) - 16g\varphi\gamma D'(-) + 2\gamma^2 D"(-) = 16g\varphi\left(D - \gamma D'\right) + 2\gamma^2 D".$$

Using (28) , $\psi_g = 16g\varphi\left(-\frac{1}{2}\gamma^2 D"\right) + 2\gamma^2 D" = 2\gamma^2 D"\left(1 - 4g\varphi\right)$. Remembering that $\varphi = \frac{1}{4g} - \beta$, or $g\varphi = \frac{1}{4} - \beta g$, it is evident that $(1 - 4g\varphi) > 0$.

Since $D"(\gamma) > 0$ by assumption, we have shown that $\psi_g > 0$. Combined with the property $\psi_b > 0$, we can conclude that:

$$\frac{\delta b}{\delta g} = -\frac{\psi_g}{\psi_b} < 0$$

Signing $\delta b/\delta\beta$ Differentiating $\psi(b; g, \beta, a)$ with respect to β yields:

$$\psi_\beta = -8g^2 D'(-) + 8g^2 D'(-) + 8g^2\varphi\frac{a^2}{b^2} D"(-) = 8g^2\gamma D"(-) > 0$$

It immediately follows that:

$$\frac{\delta b}{\delta\beta} = -\frac{\psi_\beta}{\psi_b} < 0$$

Signing $\delta b/\delta a$ Differentiating $\psi(b; g, \beta, a)$ with respect to a, we get:

$$\psi_a = D(-)8b^2g^2\left(\frac{-2}{a^3}\right) + 8\frac{b^2g^2}{a^2} D'(-)\frac{2a\varphi}{b^2} - 8D"(-)\frac{g^2\varphi^2}{b^2}2a$$

$$= g^2 \left[D' \frac{\varphi}{a} - D \frac{b^2}{a^3} - D" \frac{a\varphi^2}{b^2} \right] = \frac{g^2}{a} \left[D'\varphi - D \frac{b^2}{a^2} - D" \frac{a^2\varphi^2}{b^2} \right]$$

The sign of ψ_a is therefore the sign of the expression between brackets. This expression can be written:

$$\varphi D' - \frac{\varphi}{\gamma} D - \gamma\varphi D" = \varphi \left(D' - \frac{D}{\gamma} - \gamma D" \right) = -\frac{b^2}{a^2} \left[D(\gamma) - \gamma D'(\gamma) + \gamma^2 D"(\gamma) \right]$$

We know from (28) that $D(\gamma) - \gamma D'(\gamma) + \frac{1}{2}\gamma^2 D"(\gamma) = 0$. The implication is that $D(\gamma) - \gamma D'(\gamma) + \gamma^2 D"(\gamma) > 0$, as a consequence of which $\psi_a < 0$. Therefore, we have that:

$$\frac{\delta b}{\delta a} = -\frac{\psi_a}{\psi_b} > 0$$

Signing $\delta\gamma/\delta g$, $\delta\gamma/\delta\beta$, $\delta\gamma/\delta a$ To compute the comparative-static effects of parametric changes on γ, we write γ as follows:

$$\gamma = \varphi \frac{a^2}{b^2} = \left(\frac{1}{4g} - \beta \right) \frac{a^2}{b^2}$$

The effect of a change in g is:

$$\frac{\delta\gamma}{\delta g} = -\frac{a^2}{4b^2 g^2} - \frac{2a^2}{b^3} \varphi . \frac{db}{dg} = \frac{a^2}{b^2} \left[\frac{2}{b} \varphi \left(-\frac{db}{dg} \right) - \frac{1}{4g^2} \right],$$

where $db/dg < 0$. We have, therefore, that:

$$\frac{\delta\gamma}{\delta g} \lesseqgtr 0 \Rightarrow \frac{1}{4g^2} \gtreqless \frac{2}{b} \varphi \left(-\frac{db}{dg} \right)$$

The effect of a change in β is:

$$\frac{\delta\gamma}{\delta\beta} = -\frac{a^2}{b^2} - \left(\frac{1}{4g} - \beta \right) \left(\frac{2a^2}{b^3} \right) . \frac{db}{d\beta}$$

Since $db/d\beta < 0$, we can write the following condition:
or

$$\frac{\delta\gamma}{\delta\beta} \gtreqless \Rightarrow \left(\frac{1}{4g} - \beta \right) \left(\frac{2}{b} \right) \cdot \left(-\frac{db}{d\beta} \right) \lesseqgtr 1$$

The effect of a change in a is:

$$\frac{\delta\gamma}{\delta a} = \frac{2a\varphi}{b^2} + a^2\varphi \left(\frac{-2}{b^3} \right) . \frac{db}{da} = \frac{2a\varphi}{b^2} \left(1 - \varepsilon_{ba} \right)$$

We can thus infer that:

$$\frac{\delta\gamma}{\delta a} \gtreqless 0 \Rightarrow \varepsilon_{ba} \lesseqgtr 1$$

Appendix D: Comparative-static effects when the leader's PC is not binding

Consider the following expression for the donor's utility:

$$\Gamma = Log(A-F) - ctb^q/q - \frac{dt}{4m}\frac{a^{2m-2}}{b^{2m-2}}.F^{2-m}(1-\beta F)^m \tag{29}$$

We now write the FOCs for the maximization of Γ with respect to F and b:

$$\frac{\partial \Gamma}{\partial F} = -\frac{1}{A-F} - \frac{dt}{4m}\frac{a^{2m-2}}{b^{2m-2}}.\frac{(1-\beta F)^{m-1}}{F^{m-1}}(2-m-2\beta F) = 0 \tag{30}$$

$$\frac{\partial \Gamma}{\partial b} = -ctb^{q-1} + \frac{dt}{4m}\frac{a^{2m-2}}{b^{2m-1}}.(2m-2)F^{2-m}(1-\beta F)^m = 0 \tag{31}$$

Note that an interior solution is such that: $2-m-2\beta F \leq 0$ or $\beta F \geq 1-m/2$. This is always satisfied if $m \geq 2$ but may raise some problem if this is not the case.

Solving (31) yields:

$$b^{2m+q-2} = \frac{(m-1)d}{2mc}a^{2m-2}F^{2-m}(1-\beta F)^m \tag{32}$$

which can be rewritten:

$$b^{2m-2} = \left[\frac{(m-1)d}{2mc}\right]^p a^{p(2m-2)}F^{p(2-m)}(1-\beta F)^{pm} \quad \text{with} \quad p = \frac{2m-2}{2m-2+q}$$

Note that we obtain the usual effects of a change in a, c, or d on the level of b. Substituting in (30) leads to:

$$-\frac{1}{A-F} + 2^{p-2}dt^{1-p}c^p m^{p-1}(m-1)^{-p}a^{(1-p)(2m-2)}F^{1-m-p(2-m)}$$

$$(1-\beta F)^{m-1-pm}\left[m-2(1-\beta F)\right] = 0$$

Let H be:

$$H = 2^{p-2}dt^{1-p}c^p m^{p-1}(m-1)^{-p}a^{(1-p)(2m-2)}$$

An interior solution in F is given by:

$$\frac{F^{\frac{(q+2)(m-1)}{2(m-1)+q}}}{A-F} = H(1-\beta F)^{\frac{(m-1)(q-2)}{2(m-1)+q}}\left[m-2(1-\beta F)\right] \tag{33}$$

Bearing in mind that $[m-2(1-\beta F)] > 0$, and that $\beta F \leq 1$ (since the maximum value of $\tilde{y}$ is $1/2\beta$), the comparative statics on that equation are relatively simple. First, as the LHS is an increasing function of F, it is clear that a small increase in H, which stands for the cost of the disciplining instruments, increases F - assuming some concavity or stability property at the solution. It thus must decrease b or γ, or both.

Two cases are to be distinguished for the comparative statics on β. First, if $q \leq 2$, then both the RHS an dthe LHS are increasing in βF. Clearly, an increase in β triggers an increase in F. The donor tends to "overshoot" by reducing the severity of the discipline beyond the point where the fraud would remain constant. On the other hand, if $q \geq 2$, the RHS is not necessarily monotonic anymore. The solution may occur in the portion where it is increasing and we then continue to have $\partial F/\partial \beta \geq 0$. But it may occur in a decreasing portion of the RHS, in which case we have $\partial F/\partial \beta \leq 0$. A particular case obtains when $m \geq 2$ since the RHS is then decreasing everywhere. It is easily shown that, in this case, there always exists a non-trivial interior solution such that $\partial F/\partial \beta \leq 0$.

Proposition. *A sufficient condition for a non-trivial interior solution to occur and for $\partial F/\partial \beta \leq 0$ is m and $q > 2$.*

In summary, the 'normal' case is when both cost functions are convex enough, in effect with an elasticity greater then 2 (see the formal proof below).

Note that the cases m or $q = 2$ are problematic because the basic equation (33) essentially degenerates.

The case where $m = q = 2$:

$$\frac{1}{A-F} = H(2\beta) \quad with \quad H = \frac{1}{4}a(cd)^{1/2}$$

Then, itis always the case that $\partial F/\partial \beta \geq 0$.

Consider now the case $m = 2$ and $q \in [1, \infty]$. The basic equation (33) becomes:

$$\frac{1}{A-F} = 2H\beta(1-\beta F)^{\frac{q-2}{q+2}} \tag{34}$$

Then $\partial F/\partial \beta \geq 0$ if $q \leq 2$. When $q > 2$, the result is ambiguous: when reducing the punishment and the monitoring in response to a better governance, the donor may "overshoot" or not (causing $\beta + \varphi$ to decrease or increase).

Consider finally the case where $q = 2$. Then (33) becomes:

$$\frac{F^{\frac{4(m-1)}{2(m-1)+2}}}{A-F} = H\left[m - 2(1-\beta F)\right]$$

where it is easy to show that $\partial F/\partial \beta \geq 0$ for all m.

Proof of the above proposition.

Let us write (33) as:

$$\phi = H(1-\beta F)^{z}\left[m - 2(1-\beta F)\right] - \frac{F^{s}}{A-F} = 0,$$

$$where\ z = \frac{(m-1)(q-2)}{2(m-1)+q};\ s = \frac{(q+2)(m-1)}{2(m-1)+q}$$

The concavity condition on F requires that $\phi_F = d\phi/dF < 0$. Differentiating ϕ with respect to F yields:

$$-H\beta t\,(1-\beta F)^{z-1}\,[m-2(1-\beta F)] + 2\beta H\,(1-\beta F)^{z} - \frac{(A-F)sF^{s-1}+F^{s}}{(A-F)^2}$$

This expression can be rewritten:

$$-\beta H\,(1-\beta)^{z-1}\,[mz-2\,(1-\beta F)\,(z+1)] - \frac{(A-F)sF^{s-1}+F^{s}}{(A-F)^2} < 0$$

Bearing in mind that $(A-F) > 0$, -since $A \geq 2$ and $F \leq 2$ (which follows from $\beta + \varphi \geq 1/2$)-, a sufficient condition for the concavity condition to hold true is that the expression between square brackets is non-negative: $\theta = [mz - 2\,(1-\beta F)\,(z+1)] \geq 0$. Note carefully that this is possible only if $z > 0$, which implies that $m > 1$ and $q > 2$. The important point is that $\theta \geq 0$ implies that $\phi_\beta < 0$, so that $\delta F/\delta\beta = -\phi_\beta/\phi_F < 0$. Indeed, we have that:

$$\phi_\beta = -HF\,(1-\beta F)^{z-1}\,[mz-2\,(1-\beta F)\,(z+1)] = -HF\,(1-\beta F)^{z-1}\,\theta$$

Substituting the value of z into θ, we easily get that $\theta \geq 0 \Longleftrightarrow \frac{(m-1)(q-2)}{q} \geq 2\,(1-\beta F)$. This condition can be rewritten $F \geq \frac{1}{\beta}\left[1-\left(\frac{m-1}{2}\right)\left(\frac{q-2}{q}\right)\right]$, from which it is immediately obvious that the higher m or q (or β) the more likely is the condition to be satisfied. Moreover, assuming that $m = q = 2+\varepsilon$, where ε is positive, we find that the condition becomes $F \geq \left(\frac{1}{\beta}\right)\sigma$, where $\sigma < 1$, and that the smaller ε the closer σ approaches 1 from below. Since $F \leq 1/\beta$ (see above), it follows that the higher ε the larger the interval within which both conditions can be simultaneously satisfied.

Finally, it must be noted that

$$\phi_H = (1-\beta F)^{z}\,[m-2\,(1-\beta F)]$$

This expression is unambiguously positive because $m > 2(1-\beta F)$ when an interior solution exists. We can therefore conclude that $\delta F/\delta H > 0$.

Having elucidated the effect of a variation in β on F, we can look at its effect on b. Knowing that $m > 2$ and $q > 2$, a simple look at (32) reveals that there are two effects at work. The term F^{2-m} indicates that, when a country improves its domestic governance (β rises and F diminishes), the donor chooses to raise b, the level of monitoring precision. The term $(1-\beta F)^m$ points to an opposite effect only if βF increases as β rises, that is, when the elasticity of F with respect to β ($\eta_{F\beta}$) is smaller than one. To preserve the intuitively appealing possibility that $db/d\beta < 0$, we therefore assume that $\eta_{F\beta} < 1$. Note carefully that even with this assumption we cannot sign $d\varphi/d\beta$: the donor may increase or decrease his measure of aggregate discipline when domestic governance improves in the recipient country. As explained in the text, an increase in φ is compatible with a fall in $\pi(-)\gamma$. The proof of the indeterminacy of the sign of $d\varphi/d\beta$ is straightforward and given below.

Proof. Bear in mind that $\varphi = \frac{1-\beta F}{F}$. It follows that $d\varphi/d\beta = \frac{-dF/d\beta - F^2}{F^2}$. It therefore comes that: $d\varphi/d\beta > 0 \Rightarrow -dF/d\beta > F^2$, or $d\varphi/d\beta > 0 \Rightarrow -\eta_{F\beta} > \beta F$. Since both $-\eta_{F\beta}$ and$\beta F < 1$, this inequality can possibly be satisfied.

Since $\eta_{F\beta}$ plays a key role in the comparative statics, it is useful to write it down explicitly. Knowing ϕ_F and ϕ_β, we derive $\eta_{F\beta} = (-\phi_\beta/\phi_F)\frac{\beta}{F}$, which yields the following expression after some algebraic manipulation:

$$-\eta_{F\beta} = \frac{1}{\left(\frac{1-\beta F}{1-\beta}\right)^{1-z} + (1-\beta F)^{1-z}\left[\frac{F^s}{(A-F)^2 H\beta\theta} + \frac{sF^{s-1}}{(A-F)H\beta\theta}\right]}$$

As the second term in the denominator is positive, a sufficient condition to have $-\eta_{F\beta} < 1$ is that the first term be greater than one. This would hold automatically true if the exponent, $1-z$, is positive, and if $(1-\beta F/1-\beta)$ is higher than unity. Bearing in mind the definition of z, the first condition becomes: $q < 4\left(\frac{m-1}{m-2}\right)$. This is obviously a very plausible situation since it allows for a monitoring cost function that is quite convex (q can easily exceed 4). The second condition requires that the equilibrium value of F does not exceed one, that is, the donor does not allow the elite to appropriate more than half of the aid transfer.

It is also evident that the smaller the value of A, and therefore the closer A to F, the higher the value of the second term in the denominator and hence the greater the likelihood that $-\eta_{F\beta}$ is smaller than unity (in the event that $F > 1$). A low value of A implies that w is small compared to t, which are precisely the conditions under which the donor's participation constraint is less likely to be violated. In other words, assuming that $-\eta_{F\beta} < 1$ may be interpreted as equivalent to positi,ng values of w and t such that the donor's participation constraint is certain to be satisfied.

To complete our proofs, we derive below the inequality condition that must be satisfied in equilibrium in order to obtain the immediately intuitive, negative effect of a change in β on b. Starting from (32) and differentiating with respect to β, we write:

$$\frac{\delta b}{\delta\beta} = Z\left(\frac{2-m}{q+2(m-1)}\right)F^{\frac{4-3m-q}{q+2(m-1)}}(1-\beta F)^{\frac{m}{q+2(m-1)}}\frac{dF}{d\beta}$$

$$+Z\,F^{\frac{2-m}{q+2(m-1)}}\left(\frac{m}{q+2(m-1)}\right)(1-\beta F)^{\frac{2-m-q}{q+2(m-1)}}\frac{d(1-\beta F)}{d\beta}$$

$$where\ Z = \left[\frac{(m-1)d}{2mc}a^{2(m-1)}\right]^{\frac{1}{q+2(m-1)}}$$

To be negative, this expression requires that:

$$\left(\frac{m}{m-2}\right) F\left(1-\beta F\right)^{\frac{2(1-m)-q}{2(1-m)+q}} \frac{d(1-\beta F)}{d\beta} < \frac{dF}{d\beta}$$

Bearing in mind that $d(1-\beta F)/d\beta = -F - \beta(dF/d\beta)$, we can rewrite the condition as follows:

$$F > -\frac{dF}{d\beta}\left[\beta + \left(1-\beta F\right)^{\frac{q-2(1-m)}{q+2(1-m)}} F^{-1}\left(\frac{m-2}{m}\right)\right]$$

This yields:

$$-\eta_{F\beta} < \frac{\beta}{\beta + \left(1-\beta F\right)^{\frac{q-2(1-m)}{q+2(1-m)}} F^{-1}\left(\frac{m-2}{m}\right)} < 1$$

□

Appendix E: The corner solution when the fraud detection function has a threshold

We differentiate (10) with respect to b and γ, bearing in mind that $\tilde{y} = h/b$ in the case the corner solution obtains. We immediately see that the second first-order condition is always equal to zero (all the terms actually vanish), regardless of the value taken on by γ, which is therefore indeterminate. As for the first equilibrium condition, since not only $\pi(by)$ but also $d\pi/dy$ are zero at the corner point, it takes the simple following form:

$$\frac{h}{b^2} - C'(b)\frac{G}{t} + \mu\frac{h}{b^2}\left(2\beta\frac{h}{b} - 1\right)\frac{G}{t} \leq 0,$$

where $G = w + t\left(1-\tilde{y}\right) = w + t\left(1 - h/b\right)$. At the corner solution, we have that $h/b > 1/2\beta$, implying that $(2\beta h/b) > 1$. In the above condition, there is thus two positive terms and one negative term, so that the optimal value of b is given by:

$$C'(b)\frac{G}{t} = \frac{h}{b^2}\left[1 + \mu\frac{G}{t}\left(2\beta\frac{h}{b} - 1\right)\right]$$

Defining $\phi = \frac{h}{b^2} - C'(b)\frac{G}{t} + \mu\frac{h}{b^2}\left(2\beta\frac{h}{b} - 1\right)\frac{G}{t}$, we can sign the comparative-static effects $\delta b^*/\delta h$ and $\delta b^*/\delta\beta$.

First note that $\phi_b < 0$, by virtue of the second-order condition. We also have that

$$\phi_h = \frac{1}{b^2} + C'(b)\frac{1}{b} + \frac{\mu}{b^2}\frac{G}{t}\left(2\beta\frac{h}{b} - 1\right) + \mu\frac{h}{b^3}\left(2\beta\frac{G}{t} - 1\right)$$

This expression is unambiguously positive because $2\beta h/b$ is greater than one because of (18), and $2\beta G/t$ is a fortiori greater than one because G/t must be higher than $\tilde{y} = h/b$. As a consequence, $\delta b^*/\delta h = -\phi_h/\phi_b > 0$. On the other hand, $\delta b^*/\delta\beta = -\phi_\beta/\phi_b > 0$, because

$$\phi_\beta = 2\mu \frac{h^2}{b^3}\frac{G}{t} > 0.$$

Appendix F: Proof of Proposition 4 (the case of uniform disciplining treatment)

Case (i). The participation constraint of the best governed country 2 is binding and the two countries participate.

In this case, the combination φ of b and γ is given by the participation constraint of country 2. Let us call it φ_2, which is equal to :

$$\varphi_2 = \frac{1}{4g} - \beta_2$$

Given this disciplining mechanism, the optimal behavior of leaders 1 and 2 are given by:

$$y_1 = \frac{1}{1/2g - 2(\beta_2 - \beta_1)} \geq \; y_2 = 2g \tag{35}$$

Yet for leader 1 to be allowed to participate, it is necessary that $y_1 \in [0,1]$.

The assumption above that $\beta \leq 1/4g$ ensures that y_1 is positive.[18] That it is smaller than unity requires:

$$2g \leq \frac{1}{1 + 2(\beta_2 - \beta_1)}$$

This condition also ensures that y_2 is less than unity.

The need-adjusted measures of aid ineffectiveness can then be derived:

$$\omega_1 = \frac{w_1.\left[1 - 4g(\beta_2 - \beta_1)\right]}{1 - 2g - 4g(\beta_2 - \beta_1)}; \quad \omega_2 = \frac{w_2}{1 - 2g}$$

We know the optimal allocation of total aid T among the two countries. Replacing the aid ineffectiveness terms ω_i in (21) by the preceding expressions:

$$s_1 = \frac{n_1}{n_1 + n_2}\left[1 + \frac{n_2\Delta}{T}\right] \qquad s_2 = \frac{n_2}{n_1 + n_2}\left[1 - \frac{n_1\Delta}{T}\right] \tag{36}$$

$$\Delta = \frac{w_2}{1 - 2g} - \frac{w_1.\left[1 - 4g(\beta_2 - \beta_1)\right]}{1 - 2g - 4g(\beta_2 - \beta_1)} = \omega_2 - \omega_1 \tag{37}$$

This solution will hold only if the two shares are strictly positive. In that case, the objective function of the donor will be given by:

$$\begin{gathered} W_{12} = Z_{12} - Co_{12} \qquad\qquad \textit{with} \\ Z_{12} = n_1 Log\left[w_1 + s_1 T(1 - y_1)/n_1\right] + n_2 Log\left[w_2 + s_2 T(1 - y_2)/n_2\right] \\ Co_{12} = Co(a, c, d, \widehat{y}, \varphi_2);\; \widehat{y}^2 = s_1 y_1^2 + s_2 y_2^2;\; \varphi_2 = 1/4g - \beta_2 \end{gathered} \tag{38}$$

[18] First, we have that $\varphi_2 > 0 \Rightarrow \beta_2 < 1/4g$. Second, since$\beta_1 \leq \beta_2$ by assumption, it also follows that $\beta_1 < 1/4g$. As a result, the expression $1/2g - 2(\beta_2 - \beta_1)$ is necessarily positive.

where s_1 and s_2 are given by (36) and y_1 and y_2 by (35). Note that with two countries receiving s_1 and s_2 shares of total aid, the expected size of punishment is given by:

$$s_1\pi(b^*y_1)\gamma^* + s_2\pi(b^*y_2)\gamma^*$$

which, after some transformation, leads to the cost function in (38). With the quadratic cost functions, the corresponding expression is simply: $Co_{12} = \varphi_2(c/d)\left[s_1y_1^2 + s_2y_2^2\right] = \varphi_2(c/d)\widehat{y}^2$. The proof is as follows.

From the definition of φ, we can write$b$ as: $b^2 = (a^2/\gamma)\varphi_2$. Plugging the equilibrium value of γ, as given in (**??**) yields:

$$b^2 = 2\left(\frac{c}{d}\right)^{-1/2} ag\varphi_2$$

Bearing in mind the definition of $\pi(-)$, and substituting the above value of b^2 and the equilibrium value of γ in the expected punishment function leads to the following simple expression:

$$s_1\pi(by_1)\gamma + s_2\pi(by_2)\gamma = s_1\varphi_2\left(\frac{c}{d}\right)y_1^2 + s_2\varphi_2\left(\frac{c}{d}\right)y_2^2,$$

which becomes:

$$\varphi_2\left(\frac{c}{d}\right)\left[s_1y_1^2 + s_2y_2^2\right] = \varphi_2\left(\frac{c}{d}\right)\hat{y}^2$$

We must now envisage the two corner solutions $s_1 = 0$ and $s_2 = 0$.

Case (i.a): The donor excludes the worst governed country (1): $s_1 = 0$

This case will occur if:

$$\Delta \leq 0 \text{ and } \frac{T}{n_2} \leq -\Delta$$

The objective function of the donor is then:

$$\begin{array}{c} W_2 = Z_2 - Co_2 \qquad\qquad\qquad with \\ Z_2 = n_1Log\left[w_1\right] + n_2Log\left[w_2 + T(1-2g)/n_2\right] \\ Co_2 = Co(c,d,2g,\varphi_2);\ \varphi_2 = 1/4g - \beta_2 \end{array} \tag{39}$$

Case (i.b): The donor excludes the best governed country (2): $s_2 = 0$
This case occurs if:

$$\Delta \geq 0 \text{ and } \frac{T}{n_1} \leq \Delta$$

In this case, however, leader 2's participation constraint cannot be binding as initially assumed, which leads us to consider the case where leader 1's participation constraint is binding and the better governed country 2 does not participate. Before we do so, however, we need to evaluate the donor's objective function in the interior solution case.

Case (ii). Only country 1 participates: $s_2 = 0$

In this case, the combination φ of b and γ is given by the participation constraint of country 1. Let us call it φ_1.It is equal to :

$$\varphi_1 = \frac{1}{4g} - \beta_1$$

Given this disciplining mechanism, the optimal behavior of leader 1 is given by:

$$y_1 = 2g$$

whereas leader 2 does not participate. After minimizing the cost of implementing the aid delivery instruments corresponding to φ_1, the objective function of the donor is found to be:

$$\begin{array}{cc} W_1 = Z_1 - Co_1 & with \\ Z_1 = n_1 Log\left[w_1 + T(1-2g)/n_1\right] + n_2 Log\left[w_2\right] & \\ Co_1 = Co(a,c,d,2g,\varphi_1);\ \varphi_1 = 1/4g - \beta_1 & \end{array} \tag{40}$$

We are now able to restate Proposition 4 in a somewhat more precise fashion:

Proposition. *Case "1+2". If $W_{12} > W_1$, where W_{12} and W_1 are given by (38) and (40), respectively, and if $T/n_1 \geq \Delta \geq 0$ and $T/n_2 \geq -\Delta \geq 0$, where Δ is given in (36), then both countries participate in the aid programme and the best governed country's participation condition is binding. The optimal aid delivery instruments are given by minimizing costs under the constraint: $b^2.\gamma/a^2 = 1/4g - \beta_2$.*

Case "2". If $W_2 > W_1$, where W_2 and W_1 are given by (39) and (40), respectively, and if $-\Delta \geq T/n_2$, where Δ is given in (36), then the best governed country's participation condition is binding, both countries would like to participate but the donor excludes the worst governed country. The optimal aid delivery instruments are given by minimizing costs under the constraint: $b^2.\gamma/a^2 = 1/4g - \beta_2$. Total cost is slightly different from the previous case.

Case "1". In all other cases: the worst governed country is the only one to receive aid. The optimal aid delivery instruments are given by minimizing costs under the constraint: $b^2.\gamma/a^2 = 1/2g - \beta_1$.

Appendix G: Understanding the non-monotonicity between threshold level of income and governance quality

To compare the donor's utility in regimes "1" and "12", let us distinguish between the cost part of his objective, Co, and the true utility, Z . For a given β_1, it can be shown that the difference $Z_{12} - Z_1$ is an increasing function of w_1 starting from negative values whereas the difference in costs $Co_{12} - Co_1$ is increasing in w_1 and likely to be negative. The dependency on w_1 is through the term $\widehat{y}^2$ in (38). If w_1 increases, the share of country 1 decreases, which reduces $\widehat{y}^2$ and therefore the cost Co_{12}. On the other hand, Co_1 is likely to be larger than Co_{12} because regime "1" is more severe than regime "12". The two curves are represented in Figure 3. They cross at 1 for some value for w_1, which is the switching threshold from regime "1" to regime "12". Now, consider an increase in β_1. It can be shown that it shifts $Z_{12} - Z_1$ up. Z_{12} increases since fraud y_1 is reduced and, consequently, the share of country 1 goes up. Z_1 is unaffected. As far as the cost curve is concerned, Co_1 unambiguously goes down since less severity is required in regime "1". The change in Co_{12}, essentially due to the change in $\widehat{y}^2$, is ambiguous. However, it is likely to be second order in comparison with the change in Co_1 because it does not directly affect the severity of the aid delivery instruments, which is given by φ_2. As both the $Z_{12} - Z_1$ and the $Co_{12} - Co_1$ shift upwards, the direction in which their intersection varies is undetermined. From the simulation results in figure 1, it would increase when the country's income level, w_1, is low and decrease in the opposite case. In other words, the cost curve would shift more than the utility curve for low income levels, the opposite being true for higher income levels.

Figure 3 also enables us to understand why there is a discontinuity in country 1's aid share when w_1 passes the regime "1"/regime "12" threshold. The upper quadrant in Figure 3 shows the relationship between the income level of country 1 and its share of aid, s_1. The segment BC corresponds to what would imply regime "12" if it were optimal for all values of w_1 for which s_1 is between 0 and 1. The problem is that this is the case only when the utility curve $Z_{12} - Z_1$ is above the cost curve $Co_{12} - Co_1$. In regime "1", on the left hand side of point A, $s_1 = 1$. On the right hand side of A, s_1 is given by the segment BC. Thus, there is a discontinuity in s_1 at A , the threshold between regimes "1" and "12". This discontinuity is readily apparent in Figure 2 which shows the (s_1, w_1) loci for various values of β_1, using the numerical illustration that produced Figure 1.

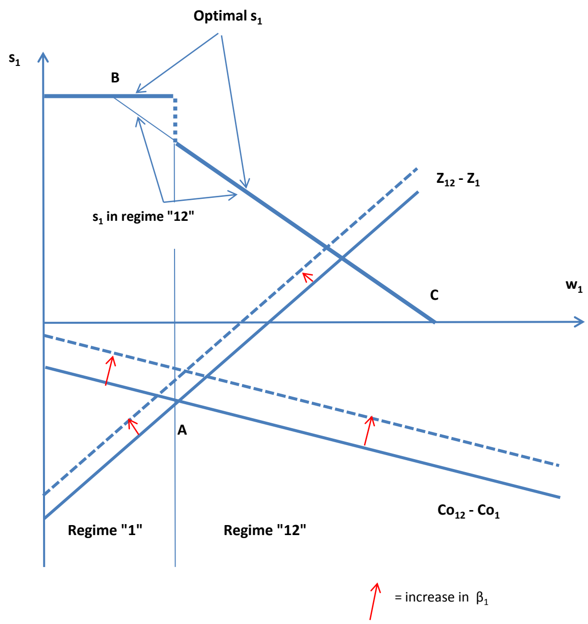


Figure 3: Comparative statics on β_1

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