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# Is Cheap Aid Money for Participatory Development Desirable for the Poor?

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*Abstract: Nowadays, much hope is placed on the prospects of rapid poverty reduction through massive increases of aid resources accompanied by more decentralised or participatory approaches to development. There is a sort of implicit belief that the extent of poverty alleviation can be roughly commensurate to the absolute amount of aid money available. When local-level elite capture is taken seriously, however, things do not appear so simple. With the help of a three-agent game-theoretical model, and assuming that aid agencies act as local monopolists using conditional transfers to discipline local leaders or intermediaries, we show that a lower cost of access to aid money has the effect of diminishing the share accruing to the poor. Moreover, it does not necessarily lead to poverty alleviation understood as reduction of absolute poverty rather than relative deprivation.*

Keywords: participatory or decentralised development, conditional transfers, elite capture, aid effectiveness, poverty alleviation

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## 1. Introduction

Rich countries concerned about the development of the poorer part of the world are today confronted with a serious dilemma. On the one hand, they are eager to step up their efforts to reduce income poverty and human deprivation, as reflected in present efforts aimed at relieving poverty on a vast scale, particularly those conducted under the UN program of the Millennium Development Goals (MDG), the Marshall Plan for Africa recommended by the UK's Commission for Africa, and various earmarked trust funds. On the other hand, there has been growing concern about weak aid effectiveness and low absorption capacity of poor countries (Boone, 1996; Alesina and Dollar, 2000; Burnside and Dollar, 2000; Isham and Kaufmann, 2000; Easterly, 2001; Easterly *et al.*, 2003; Collier and Dollar, 2004). Donors often adopt a lax behaviour because of a 'budget-pressure problem' arising from the high cost of not disbursing the money allocated: in these conditions, money tends to be disbursed irrespective of whether the conditions attached to an aid program have been fulfilled or not (Svensson, 2000, 2003; Kanbur, 2006). When conditionality is taken seriously, low rates of aid disbursement are the expected consequence of the donor's rigorous attitude.<sup>2</sup>

An attempt by the donor community, bilateral and multilateral aid organizations alike, to resolve the above contradiction has consisted of including participatory elements in the design of their large-scale development assistance programs, or to channel substantial amounts of aid money through Non-Governmental Organizations (Stiles, 2002; Brett, 2003). Thus, the move to put participation and empowerment of the poor squarely on the agenda is especially noticeable in the case of the World Bank which has made it one of the cornerstones of its Comprehensive Development Framework. This shift of approach has been duly reflected in the World Development Report 2000/2001 entitled "Attacking Poverty", and in the massive increase in the amount lent by the Bank for Community-Driven Development (henceforth labeled CDD) from \$325 million in 1996 to a conservatively estimated figure of \$2 billion in 2003 (Mansuri and Rao, 2004). Revealingly, the share of the World Bank-financed projects that go through NGOs has risen dramatically from only 6 percent between 1973 and 1988 to over 50 percent in 1994 (Hudock, 1999), and the same can also be said of

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<sup>2</sup> Over the 1990s, ODA commitments of the European Union exceeded gross disbursements by more than US\$1.6 billion each year, peaking at US\$2.2 billion in 1994 (Heller and Gupta, 2002: 137). In particular, in 1996-97, £4.5m of the budget of DFID (Department For International Development, UK) for Africa was unallocated. In 2000-01, that rose to £18m (*The Economist*, November 2<sup>nd</sup>-8<sup>th</sup> 2002, p. 39)!

many official development assistance agencies. The country-led model, which puts aid recipients in control of their development strategy and related development spending, is another component of the move toward a new aid paradigm aimed at overcoming the so-called ‘ownership problem’.

The above shift appears all the more desirable as poverty is increasingly recognized as having many dimensions that go beyond inadequate income or human deprivation to include vulnerability and, more relevant to our concern, a lack of voice, power, and representation (World Bank, 2001: 1-12). The hope is entertained by the international donor community that, if the new approach is followed, (1°) larger aid flows will effectively reach the poor, and (2°) not only income poverty but also human deprivation in many dimensions will be reduced. Implicit in this hope is the widely held belief that poverty reduction can be commensurate with financial development assistance efforts: an increase in aid flows will result in a proportional improvement of the lot of the poor as measured, say, by the headcount or the poverty gap indices.

Upon careful thinking, however, such a proportional relationship cannot be taken for granted. The micro-analytics of participatory development need to be explored before conclusions can be reached about the likely size of the effect of larger aid flows on poverty reduction. This is precisely the central issue that the present paper is set to address. One central idea on which our attempt is based is that the problem of weak aid effectiveness may also undermine programs of participatory or decentralized development. In particular, problems of corruption and opportunistic behavior do not disappear because aid is channeled through local levels.

There is actually no reason to think that patronage is less present at those levels than at the top of the government’s hierarchy. As a matter of fact, local leaders are typically enmeshed in patronage webs that go up the whole ladder linking the periphery to the center. Contrary to an idealized view accrediting everything that is local with ‘naturally democratic’ qualities, communities or municipalities may actually be more vulnerable to capture by local elites, because local power groups can easily collude beyond the control of higher-level institutions and the attention of the media (Ribot, 2000: 33; Bardhan, 2002: 192-94; Watson, 2003: 299; Leonard and Leonard, 2004: 62; Johnson *et al.*, 2005; Hickey and Mohan, 2005: 237).<sup>3</sup> Available empirical evidence about the performances of community-based projects,

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<sup>3</sup> A striking illustration of this risk is the petition recently forwarded to the central government of China by seventeen autonomous provinces and municipalities. In this petition, the signatories explicitly ask the government, through more vigilant censorship, to curb the power of national media

mainly by NGOs, is reckoned to be unimpressive (Brett, 2004; Carroll 1992; Edwards and Hulme, 1996; White and Eicher 1999; Conning and Kevane, 2002; Bardhan, 2002; Mansuri and Rao, 2004; Platteau, 2004), which confirms our doubts about the intrinsic superiority of the participatory approach compared to more conventional approaches.

For the ‘elite capture’ problem to be under control so that the participatory approach does not end up reinforcing the very structures of unequal privilege it seeks to upset, local leaders or intermediaries must be somehow disciplined. One obvious way for a donor agency to do so is to adopt a multi-year budgeting framework and set up monitoring and fraud detection mechanisms. Aid transfers can then be disbursed sequentially conditional upon satisfactory past performances (no serious fraud is detected). At equilibrium, however, some positive portion of the aid fund is embezzled by local leaders assumed to be opportunistic. As long as this portion is not deemed too large by the aid agency, it can be viewed as the price to be paid to reach the poor. In fact, the mechanism of sequential conditional transfers can be interpreted as the outright financing of a community development program followed by the payment of a conditional bonus to the local leader rather than as the disbursement of aid money in successive, conditional tranches.

If such a mechanism is assumed to be in operation, the interesting question arises as to how effectiveness in alleviating poverty is affected by increased availability of aid money reflected in a lower cost of access for donor agencies. Indeed, if the extent of elite capture is liable to rise as a result of a fall in this cost, a larger supply of aid funds does no more appear as an unmixed blessing, and these agencies are faced with delicate trade-offs. Assuming that aid agencies are local monopolists (so as to ensure proper effectiveness for the leader-disciplining mechanism), we actually show that they may be faced with delicate trade-offs. In particular, the release of more aid funds *may* result in lower performances in reaching the poor in communities already covered by a development programme before aid was increased. In other words, more aid may benefit the poor by enabling new communities to benefit from decentralised development, yet it may also harm them by aggravating the problem of elite capture in communities which were already benefiting from it.

Our analysis, it must be noted, is focused on projects supported by foreign donor agencies rather than on fiscal decentralization programs whereby municipalities or local governments receive regular tax transfers from a central state. This is a legitimate research

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which are increasingly conducting inquiries into local affairs, and show “little sense of responsibility” by criticizing the behaviour of local authorities (*Yazhou Shibao Zaixian*, Hong-Kong, as transcribed in *Courrier International*, N° 778, September 29-October 5, 2005, p. 26).

strategy since, in theory at least, elite capture is easier to control under conditions of fiscal federalism. Indeed, in so far as they are guided by the objective of self-sustainability, donors want their financial contributions to be of limited duration: aid flows are aimed at making rural communities eventually self-supporting. Reputation effects are thwarted in such a framework characterized by finitely repeated interactions between donor agencies and target communities, unlike what obtains under fiscal decentralization programs where the number of rounds played is theoretically endless.<sup>4</sup>

The outline of the paper is as follows. In Section 2, the conditions under which elite capture tends to occur are highlighted. Section 3 discusses the possibility of a Leader-Disciplining Mechanism (LDM) using sequential and conditional disbursement of aid funds in the context of decentralized bilateral relationships of limited duration. In Section 4, building on the insights presented in the previous two sections, a three-agent game-theoretical model is constructed to depict how such a mechanism operates when aid agencies behave as local monopolies. It incorporates a principal-agent relationship between an external donor agency and a local leader acting as the community representative, on the one hand, and a bargaining game between the latter and the targeted beneficiaries or the grassroots, on the other hand. Comparative statics results are derived, first using a general model and then a slightly less general version in which the fraud detection function is made more explicit. Finally, Section 5 summarizes the main findings of the paper.

## **2. Elite capture at local level**

When the time required is not spent to ensure that the poor acquire real bargaining strength and organizational skills, ‘ownership’ of the projects by the beneficiary groups is most likely to remain an elusive objective. Evidence of this failure has been observed, for example, in the case of the World Bank’s Social Funds (Narayan and Ebbe, 1997; Tandler, 2000: 16-17)<sup>5</sup>. A perverse mechanism is therefore set into motion when donor agencies skip the empowerment phase by asking intended beneficiaries to form groups or partner

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<sup>4</sup> As we know from the Folk Theorem, however, this does not mean that such programs are invulnerable to the risk of elite capture.

<sup>5</sup> A recent evaluation report thus concludes that “building capacity and social capital at the community level are time- and human resource-intensive processes, making disbursements potentially slower and less predictable”. Social funds, therefore, “may lose the strengths on which their

associations, and to ‘elect’ leaders to lead them.<sup>6</sup> In effect, such a method establishes a power relationship that is open to abuse, since the donor agency has little or no communication with the community except through these leaders who are usually its most prominent members. As pointed out by Esman and Uphoff (1984), “the shortcut of trying to mobilize rural people from outside through leaders, rather than taking the time to gain direct understanding and support from members, is likely to be unproductive or even counterproductive, entrenching a privileged minority and discrediting the idea of group action for self-improvement” (p. 249).<sup>7</sup>

Confirming the prediction of Esman and Uphoff, several studies have concluded that the formation and training of village groups in community-based projects have the effect of encouraging the entry of wealthier and more educated people into leadership positions because of the attractiveness of outside funding (Gugerty and Kremer 1999, 2000; Rao and Ibanez 2005; Brett, 2003).<sup>8</sup> Being adept at representing their own interests as community concerns expressed in the light of project deliverables, local leaders often succeed in deluding the donors into thinking that their motivations are guided by the collective good, and in overriding community preferences (Mosse 2001; Harrison 2002; Ribot 1996, 2002; Eversole 2003). Their demands are replete with the sort of pleas and vocabulary that strongly appeal to the donors (including exaggerated statements about their poverty) and, in order to create the appearance of participation, they may go as far as spending resources to build community centres, hold rallies, and initiate showcase labor-intensive activities (Conning and Kevane 2002: 383; Kumar and Corbridge, 2002: 80; Platteau, 2007).

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reputation has been built” when their focus is gradually shifted from emergency response mechanisms to longer-term welfare and institutional development objectives (World Bank, 2002 : 48).

<sup>6</sup> For Khwaja (2005), the two key components in empowerment are information and influence. Regarding the former, empowerment of the poor implies that “they are both able to provide information about their own preferences and gain information from outside that may in turn enhance their capacity to make optimal choices”. In fact, “participation can be partly thought of as a means of providing and gaining information” (p. 273). As for the latter, influence or bargaining power can be conceived as the poor’s “relative ownership” of a particular decision. Here, participation in a project decision, for example, appears “as a means of empowerment to the extent that such participation brings a greater likelihood of influencing the outcome of the decision” (p. 274).

<sup>7</sup> In the light of this diagnosis, Cernea’s contention that “NGOs insert themselves not as a third and different/independent actor, but as an emanation and representation of the community” (Cernea 1988: 10), appears almost surrealist. There is no such thing as undifferentiated societies. Behind appearances, a power structure is always hidden and it is, therefore, better to be aware of it.

<sup>8</sup> The study by Araujo et al. is especially reliable because the authors exploit the fact that the menu offered by the Ecuadorian Social Fund included basically two types of projects, and that by far the most important private good provided, latrines built in land plots belonging to community members with no previous access to toilet facilities, were clearly aimed at the poor. The theoretical prediction is that, controlling for poverty, more unequal communities would choose latrine projects less often, as a result of a concentration of power in the hands of richer people. It is largely supported by the data, strongly

As attested by many experiences of the World Bank's Social Funds –a major instrument for the financing of participatory development projects by the Bank–, “prime movers” of projects, such as village headmen or school teachers, often decide which project to choose and implement before any community meeting ever takes place and it is only later that they take the step of informing community members of their project choice (De Haan, Holland, and Kanji 2002; White 2002; Platteau, 2004). The powerless assume the images of the powerful and, since all negotiations with the external agency take place through local leaders or intermediaries, people's priorities are presented in a manner acceptable to this agency, but also suiting the objectives of the village elite (Mosse, 1994: 507-511; Tembo 2003: 95, 145; Nygren 2005). In most instances, public meetings are just “the sites that mask the real structure of power and where the selective presentation of opinion is most likely” (Chhotray, 2007: 1049).

In short, there is a serious risk that the rich control and co-opt the poor to serve their interests (Mehta, 2000: 16). This is especially likely to happen in rural societies dominated by patron-client or chief-subject relationships, that is, hierarchical, asymmetric, and highly personalized relations in which the poor's deference and loyalty to the leader(s) is perceived as the best way of ensuring their day-to-day livelihood. The ability to establish contact and to deal with external sources of funding is typically concentrated in a small elite group, and the poor have few outside opportunities. In such a social setup, enrichment of the elite and highly unequal patterns of distribution of programs' benefits are not deemed reprehensible by the poor as long as they are allowed to derive some gains from the elite's actions (Scott, 1976, 1985; Chabal and Daloz, 1999: 42; Platteau and Gaspart, 2003: 1689-1691). There is no disputing the power of the local ‘strong men’ and, when the poor sit in a village committee or association, it is essentially because they want to state their loyalty to them (Kumar and Corbridge, 2002).

Traditional or locally-based elites (elders, heads of lineage, and village chiefs) are not the only sort of leaders to benefit from CDD resources. Frequently, urban elites ‘remember’ their geographical origin and reactivate their rural roots when new funds become available which are channelled through rural groups or communities, or through local governments or municipalities. For example, in Cameroon, as soon as the decentralized program of forestry management was launched, a “localism fever” set in: members of the urban elite, consisting mainly of senior civil servants and politicians, began to join in local initiatives by getting co-

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suggesting that the programme is captured by the elite to the extent that such a choice reflects



opted or ‘elected’ in local committees or associations, or by featuring as resource persons for them. They then established “alliances with town-based companies, to whom they have promised their villages’ forests” (Oyono, 2004: 102), giving rise to accusations of “re-centralisation”. It is therefore not surprising that committee members have disconnected themselves from the rest of village communities, and that cases of financial misappropriation are widespread (in one documented case, half of the forestry fees have been embezzled by members of the management committee) (Oyono, 2005: 11).

The spawning of local (and foreign) NGOs is another recent phenomenon that must be understood in the light of the redirecting of foreign aid flows. Acting as ‘development brokers’, political entrepreneurs have been quick to understand that the creation of an NGO has become one of the best means of procuring funds from the international community (Meyer, 1995; Bebbington, 1997; Bierschenk, de Sardan, and Chauveau 2000)<sup>9</sup>. In the words of Chabal and Daloz (1999): “a massive proliferation of NGOs ... is less the outcome of the increasing political weight of civil society than the consequence of the very pragmatic realization that resources are now largely channelled through NGOs”. As a consequence, “the political economy of foreign aid has not changed significantly” because “the use of NGO resources can today serve the strategic interests of the classical entrepreneurial Big Man just as well as access to state coffers did in the past...” (pp. 22-24).

Of course, not all local leaders are opportunists ready to misappropriate foreign aid. As underlined by Mansuri and Rao (2004), a distinction needs to be made between elite *control* and *capture*, since local elites may turn out to be benevolent rather than selfishly corrupt actors. Moreover, even when project leadership and decision-making continue to be controlled by elites, resources may be targeted to deserving beneficiaries because these elites are somehow accountable to the poor (see, e.g., Dasgupta and Beard, 2007, for anecdotal evidence about Indonesia). This last observation, it must be stressed, may be supported by our model which does not lead to the prediction of a complete or even sizeable embezzlement of aid

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differences in power, rather than need.

<sup>9</sup> Thus, in the case of Benin, a West African country especially spoiled by the donors, local NGOs and associations, which are often “empty shells established with the sole purpose of capturing aid”, have multiplied within a short period of time to number several thousands. Many others wait to receive the approval of the ministry of interior (Le Monde, 26 February 2001). In Mali, there were 1,467 NGOs registered locally in December 2001 (Coulibaly 2003: 24). In non-African countries, also, NGOs often constitute “an opportunistic response of downsized bureaucrats, with no real participation or local empowerment” and, inevitably, program officers themselves become involved in the creation of community institutions (Conning and Kevane 2002: 383-84). Recently, we read in *The Economist* that NGOs “often sprout up, like plants in the sunlight, solely to bathe in this foreign money” (Special Report *Aid to Africa*, July 2-8 2005, p. 26).

resources by local elites. In fact, the share of aid proceeds ultimately accruing to the poor is influenced by the latter's bargaining power which might in turn be enhanced by well-designed, accountability-increasing participatory development schemes. On the other hand, recent and carefully designed cross-village studies conclude that intra-village inequality tends to be inversely related to targeting effectiveness (Ravallion, 2000; Rosenzweig and Foster, 2003; Galasso and Ravallion, 2005; Araujo *et al.*, 2006; Labonne and Chase, 2007). They thus confirm one of the central predictions derived from political economy models of decentralized development (Bardhan and Mookherjee, 2000, 2005, 2006), suggesting that local elites appropriate a larger share of the transfers in communities that are highly unequal to begin with. Such findings are consistent with our framework in which elite capture is assumed to prevail in communities dominated by patron-client relationships.

Impressionistic but repeated observations however suggest that, for a certain level of intra-village inequality, dedicated leaders are less likely to be found in countries of Sub-Saharan Africa than elsewhere. A tentative explanation for such a difference is that African societies have not yet gone through protracted, nationwide social struggles whereby the interests of dominated social classes or groups could be asserted vis-à-vis the ruling elite and state power (Kennedy, 1988). In other words, there is no tradition of genuine civil society movements that are emancipated from the state. This is not surprising in a context where state authorities (including chieftaincies in rural areas) have preempted important channels of potentially lucrative activities in the economy, and where dynamic individuals eager to get rich and/or to exercise their entrepreneurial talents have been absorbed into the regime's rent-generating and collecting patronage networks (see, e.g., Bayart, 1986, 1989; Boone, 1992).

Two consequences follow from this peculiar situation. First, the bargaining strength of the common people remains rather weak vis-à-vis state agents and local elites who often are in cahoots with each other. And, second, social ideals and other-regarding norms of a generalized kind without which social struggles are doomed to failure could not evolve in Africa and in other areas with similar characteristics (e.g., Haïti, Bihar state in India, Northwestern Province in Pakistan, ...). This is unfortunate in so far as such values and norms are precisely useful to promote the emergence of dedicated leaders who are moved by a progressive ideology rather than their own immediate self-interest. By contrast, in many countries of Asia and Latin America, historically-rooted ideals of social commitment are alive that have been transmitted over generations thanks to the education system and civil society movements or associations.

If the above is true, our model may have comparatively more relevance for Sub-Saharan Africa. There, indeed, instead of 'father figures' clinging to their traditional duties of

guaranteeing people's livelihoods, redistributing wealth and settling conflicts in such a way as to maintain the existing social order, the erstwhile elite often become transformed into more greedy individuals who show all the less restraint in enriching themselves at the expense of their community as they are actually legitimated by outside actors (Platteau and Abraham, 2002).

### **3. A mechanism to control the elite capture problem**

Let us consider the following three-agent decision framework. At the top is an operating aid agency (labelled *A*) which wants to disburse money with the purpose of alleviating poverty. At the bottom are the grassroots (*G*) who are the intended beneficiaries of the aid effort. Between the two is a local leader (*L*) who aims to organize the grassroots into a group or association for the sake of securing the funds on offer. Indeed, *G* must be organized into a collective to be eligible for funds: *A* will not disburse funds unless it has received evidence that a cohesive group of beneficiaries exists through which these funds can be channeled. Yet, it is ill-informed about the actual use of these funds and the information gap is exploited by the *L* for his own benefit.

What is being played between *L* and *G* is a one-stage bargaining game. In dealing with *G*, *L* thus has a leadership role, meaning the right of the first move: to the group which he has formed or helped to form, *L* makes a proposition about the way to share the funds offered by *A*. If *G* accepts the transfer proposed by *L*, they receive that amount. But if they disagree with *L*'s proposal, they create a situation in which aid money is forsaken (nobody receives anything). The prediction of economic theory in this ultimatum game is that the agent with the first move will make a proposal whereby he keeps most of the funds for himself, and the agent with the second move will accept such a deal for lack of a better alternative. In a one-period interaction framework, anticipating that *L* will thus embezzle most of the funds, *A* should refrain from disbursing money (unless it is subject to a 'budget pressure' problem).

Clearly, *L* must be disciplined through an appropriate mechanism, and this must involve the possibility of detecting embezzlements and punishing him in the event of a proven fraud. Punishment through externally-enforced legal sanctions and court action is ruled out because the judicial system is unreliable in most developing countries where poverty is widespread. Recourse to informal punishment –that is, a fully or partially self-enforcing punishment– is

therefore necessary, and the most obvious mechanism involves repetition of the aid game (over an infinite or indeterminate period of time). Yet, because they aim at making beneficiaries eventually self-supporting, donors typically want their aid transfers to be of limited and definite duration. Granting funds for a finite but indeterminate period is obviously not a realistic option. It would, indeed, create perverse incentives to under-perform in order to lengthen the project's duration, thereby creating a 'dependency' syndrome.

Let us consider an aid agency which decides to spread its aid transfers over several successive periods and to make later disbursements explicitly conditioned by proper use of the previous tranche of money. Repeated game theory teaches us that such a mechanism is of no avail, though: anticipating  $L$ 's opportunistic behaviour,  $A$  refuses to release any aid money.<sup>10</sup> This said, if  $A$  is committed to releasing a tranche whenever no fraud has been detected in the use of the previous tranche, the above outcome would not obtain:  $L$  would not embezzle the whole money disbursed except in the last round of the game. In other words, because  $L$  is keen to keep the probability of being detected within an acceptable range (assuming that this probability increases with the extent of the fraud) so as to remain entitled to the next tranches of money, a positive share of the aid flow reaches  $G$  at equilibrium.

The assumption of a committed  $A$  implies that, in the event of no fraud detection, the last tranche of money is released even though  $A$  knows quite well that it will be appropriated by  $L$ . This may seem a strong assumption to make, unless the last-stage transfer is conceived by  $A$  as a bonus awarded to  $L$  conditional on proper use of the aid money disbursed at the beginning of the game. One might object that such an arrangement is unacceptable to ethically motivated agencies because they would endure an important moral loss if they were to hand over money to an intermediary whom they know would appropriate it with complete certainty. Are we therefore to conclude that CBD leads to a deadlock in the presence of opportunistic leaders and ethically motivated aid agencies? Not necessarily. In the above, indeed, we have implicitly assumed that the formation of village groups, associations, or councils for the purpose of externally supported development does not confer any leverage upon their grassroots members. In other words, these collective entities are entirely manipulated by the local leader (or by a colluding elite, in case there are several leaders). In

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<sup>10</sup> The reasoning is as follows. A rational  $L$  will embezzle the last tranche knowing that he cannot be punished at a later stage. Anticipating it,  $A$  will not disburse that last tranche, thus depriving itself of the possibility to use a credible threat to punish  $L$  during the previous period. As a result,  $L$  misappropriates the money of the previous tranche as well, and  $A$ 's strategic response is to cancel that tranche too. By backward induction, it is evident that even the first tranche will not be disbursed with the consequence that  $G$  will not obtain any aid.

reality, one may hope that, through collective organization, even at the initiative of the leader, the poor increase their bargaining power vis-à-vis him.

One simple way to conceptualize this effect is by viewing the leader-grassroot relationship as a patron-client relationship. In the social game that both parties play in their everyday life, the poor taken individually have more to lose than the leader from a break of cooperation. If the poor act cooperatively, on the contrary, the reverse situation obtains: it is now the leader who stands to lose more from a break of cooperation. There are thus two games being played, viz. the finitely repeated *aid game* where  $G$  organized as a group interact with  $A$  through  $L$ , and the infinitely repeated *social game* in which  $G$  interact with  $L$  in a direct manner. Being thus embedded in the *aid game*, the *social game* imparts an infinite-horizon dimension to it. Under the circumstances considered, even in the last round of the aid game,  $G$  will be able to benefit from the aid flow thanks to the new collective bargaining power wielded in the social game.

True, the leverage which  $G$  are able to exercise vis-à-vis  $L$  as a result of their collective organization for the aid game can also yield benefits in the first rounds of that game. If this leverage is important, there is obviously no need for  $A$  to implement a Leader-Disciplining Mechanism:  $G$  are powerful enough to defend their interests and CBD is a winning formula. Here, we assume that  $G$ 's bargaining power is not strong enough to allow them to earn a significant share of the aid funds supplied by  $A$ . As a result, the latter wants to increase the share of the poor by providing a LDM together with the aid fund. In the final period of the aid game, however,  $G$  use whatever bargaining strength they have to prevent  $L$  from extracting the totality of the last tranche of aid money. Banking on that strength,  $A$  agrees to release the last tranche provided that  $L$  has not been found cheating during the previous rounds.

Before embarking upon the task of presenting our model, three important remarks are in order. First, the ethical orientation of  $A$  implies that it will not forgive  $L$  for a proven act of malfeasance, even if it involves a positive cost to itself. This is a fortunate implication precisely because a cost is likely to follow from the need to redirect aid funds withdrawn from a failing association or community. Without this moral component of  $A$ 's preference, the punishment threat would not be credible and, as a result, the mechanism of sequential aid disbursement would be useless.<sup>11</sup>

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<sup>11</sup> In his analysis, Svensson (2003) proposes a mechanism corresponding to a tournament game for a group of recipient countries in order to surmount the same problem (the recipient government anticipates that the donor organization will release funds regardless of its actual performance, because

Second, an important shortcoming of the LDM is that not only the leader but also the intended beneficiaries are sanctioned in the event of fraud detection. For this reason, it is not in the interest of  $G$  to report malpractices to  $A$  at the end of a period lest they should lose any entitlement to the next tranches of money. To secure their assistance in fraud detection, could  $A$  propose  $G$  a deal whereby further tranches of aid money would be released provided that they remove a leader whom they will have denounced? The problem, as illustrated by a field experience which we have reported in detail elsewhere (Platteau and Gaspart, 2003: 1689-1691), is that  $G$  may well choose to side with  $L$  and refuse to inform  $A$  against him. This is because the grassroots do not consider to have been deceived by  $L$  as long as he has handed them their legitimate share of the aid funds, say, the share which their bargaining strength entitles them to receive in the light of long-term considerations arising from the social game. Whichever the reason, the end result is that the long-term cost of severing links with  $L$  (which includes the risk that the malevolent leader is replaced by a still worse person) exceeds the short- or medium-term benefit of aid money. On the other hand,  $A$  may be reluctant to make this kind of deal with  $G$ , fearing that  $G$ , or some fraction of  $G$  (including rivals of  $L$ ) might denounce  $L$  on false grounds just to settle private accounts with him or his family or clan (Platteau and Abraham, 2002).

Third, and most critically, throughout the whole argument, we have assumed the presence of a single leader in the community. If there were several leader/patrons competing with each other for access to external funds, the grassroots would be in an ideal position: with perfect competition, they would even be awarded the totality of the aid money in equilibrium. As a consequence, there would be no need for the aid agency to operate a LDM, and the question raised in Section 1 would have a straightforward answer: increased aid supply will have a commensurate impact on poverty alleviation because aid availability cannot affect the extent of local embezzlements.

The assumption of perfect leader competition is nevertheless unreasonable on several grounds. When there are several patrons inside a community, they are usually the leaders of separate factions corresponding to vertically structured groups of people linked through kinship ties. The implication is that competition between faction heads is quite restricted as members do not easily shift factions. Moreover, since local patrons are necessarily few, it is highly tempting for them to collude in order to exploit the aid offer to their advantages. By

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the latter is altruistic or constrained by the ‘budget pressure’ problem). Such a mechanism would be extremely difficult to implement in the kind of foreign aid game considered here, since donors are

requiring that a single village association stands as their local partner, aid agencies actually encourage collusive agreements between local patrons. Thus, in a study about micro-watershed projects in Andhra Pradesh (India), Vasudha Chhotray (2007) has recently argued that the “strategy of securing consensus only expedited the accommodation of factional interests”, that is, the forging of some form of compromise in sharing power among contending factions. As a consequence, elite politics continued to prevail and “subaltern politics”, which could potentially strengthen the power of lower castes and classes, was effectively curtailed (pp. 1047-53).<sup>12</sup>

In spite of this undesirable effect, playing upon competition among local patrons may prove a dangerous tactic to follow for external aid agencies. Such competition, indeed, may be highly destructive if it prompts vicious inter-personal feuds and savage bickering between rival factions, thereby undermining local capacities for collective action and dispute resolution.

#### **4. Modelling the LDM under conditions of monopolistic supply of CBD aid**

Since supply of CBD aid is assumed to be scarce relative to potential demand, the aid agency is in the position of a local monopolist, implying that a community has no alternative source of external funding should the relationship fail to be established. The presence of an opportunistic leader via whom the funds must be channelled, compels  $A$ , which is driven by humanitarian motives, to strive to discipline  $L$ 's behaviour. Towards that end,  $A$  uses a sequential conditional disbursement procedure. To keep things simple without any loss of substance, we assume a two-period framework in which the second tranche is released only if no fraud has been detected at the end of the first period. Two instruments are available to  $A$ , viz. the inter-temporal allocation of the aid money between the two successive periods, and the supervision effort devoted to fraud detection. Since the latter is costly, an obvious trade-off arises: more supervision reduces the risk of elite capture yet, on the other hand, it diminishes the net amount of money available for the grassroots.

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numerous and uncoordinated, and the sunk cost of setting up partnership relationships with local communities are quite high.

<sup>12</sup> In the case of one village, however, the covered area was so large that it required two projects, thus allowing the presence of two different committees which were manned by each rival faction in the village (Chhotray, 2007: 1048).

### *The model*

The model is a three-stage extensive form game with the three players mentioned ( $A$ ,  $L$ , and  $G$ ). In the first step,  $A$  chooses three positive quantities of money, namely the amount of aid money released at the beginning of the first period ( $X_1$ ), the amount conditionally disbursed at the end of this first period ( $X_2$ ) if no fraud has been detected, and the supervision expenses ( $Z$ ). In the second stage,  $L$  decides which part of the first tranche he hands over to  $G$  ( $\alpha_1$ ), and which part he appropriates for himself ( $1-\alpha_1$ ). In the third stage,  $L$  and  $G$  bargain over how  $X_2$  is to be shared between  $G$  ( $\alpha_2$ ) and  $L$  ( $1-\alpha_2$ ). Finally, a move of nature gives  $A$  enough evidence against the  $L$ 's fraud, or it does not. If it does,  $X_2$  is not disbursed.

We denote by  $\psi$  the probability that  $L$ 's fraud can be convincingly proven. This probability depends on the extent of the fraud ( $1-\alpha_1$ ), and on supervision expenses ( $Z$ ). We also assume that the fraud detection function is multiplicatively separable, i.e.,  $\psi = f(Z,k)g(1-\alpha_1)$ , where  $f$  is increasing and weakly concave in  $Z$  (and in  $k$ ), while  $g$  is increasing and strictly convex. The latter assumption means that the probability of detecting dishonest behaviour increases at a rising rate with the extent of the embezzlement. (For example, if facilities intended for use by  $G$  have not been constructed, detection of fraud is easier than if kickbacks have been received from a dealer in return for allowing him to overcharge and supply low-grade materials.) The degree of effectiveness of the fraud detection technology, which is exogenously given, is measured by the parameter  $k$ . It can reflect two different things, viz.  $A$ 's organizational skills and experience in monitoring, or the vulnerability of the type of project considered to fraudulent behaviour (since some types of projects are more easily manipulated than others). Finally, we assume that  $f(0,k) = g(0) = 0$ . In words, no fraud can be detected casually (that is, in the absence of a supervision effort), and no mistake can be made (if  $L$  does not extract any rent, he cannot be found guilty).<sup>13</sup>

The unit cost of aid money for  $A$  is an exogenous parameter denoted by  $\lambda \in ]0;1[$ . It corresponds to the interest rate if that money has to be borrowed, or the cost of mobilizing it during fund-raising campaigns, if it is not. Another parameter of interest reflects what is being done with the aid funds saved in the event of fraud detection. It is denoted by  $\eta \in ]0;1[$  and is interpreted as the share of saved money that can be transferred to other beneficiaries

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<sup>13</sup> If  $L$  can cheat by increasing taxation of  $G$  through rather obscure channels while openly distributing most of the aid money to them, fraud becomes all the more difficult to detect. One way of conceptualizing this is to consider that  $k$  is such that  $Z$  must be very large to make  $\psi$  positive.



after the deduction of some transaction costs. It is valued at unitary cost  $\lambda$ , the same shadow price as obtains during the first period.

Assuming that  $A$  is driven by humanitarian motives, so that its utility is proportional to the amount of aid money reaching the poor,<sup>14</sup> and assuming that it is risk-neutral, we can write its expected utility function as follows:

$$EU_A = \alpha_1 X_1 + \alpha_2 X_2 (1 - \psi) - \lambda (X_1 + X_2 + Z) + \lambda \eta X_2 \psi$$

The last term reflects the fact that, with probability  $\psi$ , the amount  $\eta X_2$  needs not be mobilized again in the second period: it is saved aid money. Note that this modelling approach in which we assume the shadow cost of funds,  $\lambda$ , to be identical for present and future projects dispenses us with the need to write a recursive utility function for  $A$ . Thus, if a project currently undertaken is prematurely ended due to the discovery of fraud, a fraction of the aid money earmarked for the second tranche and withheld by  $A$  is available for a project in a new community. This explains why the funds rescued from the interrupted project carry a marginal utility equal to  $\lambda$  for each unit of aid money shifted from the current (failing) to the new project. Because the marginal utility of one unit of aid money is known in advance ( $\lambda$  is exogenously given), there is no need to write the utility of the new project.

We can now embark upon solving the game starting from the third stage, bearing in mind that the cooperative nature of this stage game can be interpreted as the reduced form of an alternating offer subgame. The threat point of the bargaining game considered is a situation where  $G$  receive only a share of the funds of the first tranche ( $\alpha_1 X_1$ ) while  $L$  embezzles the remaining share plus the whole conditional payment made by  $A$  at the end of the first period, that is,  $L$  gets an expected total of  $(1 - \alpha_1) X_1 + (1 - \psi) X_2$ . On the other hand, if an agreement is reached,  $G$  receive an exogenous benefit representing their payoff from the social game,  $\Pi_G$ , plus their agreed share of the second tranche of aid money,  $\alpha_2 X_2 (1 - \psi)$ . As for  $L$ , he also receives the benefit from the social game,  $\Pi_L$ , in addition to his agreed share of that second tranche,  $(1 - \alpha_2) X_2 (1 - \psi)$ . In this way, the non-negligible interest of preserving the basis for future cooperation (including the possibility of another aid offer) within the community is taken into account.

The payoffs of  $G$  and  $L$  are thus given, respectively, by the following utility functions:

$U_G = \alpha_1 X_1 + \alpha_2 X_2(1-\psi) + \Pi_G$ , if an agreement is struck between  $L$  and  $G$  in the bargaining stage,

$U_G = \alpha_1 X_1$ , otherwise.

$U_L = (1-\alpha_1)X_1 + (1-\alpha_2)X_2(1-\psi) + \Pi_L$ , if an agreement is found between  $L$  and  $G$  in the bargaining stage,

$U_L = (1-\alpha_1)X_1 + X_2(1-\psi)$ , otherwise.

Since the boundary of the utility possibility set is a 45° line, the standard bargaining solution can be interpreted as Nash's solution, Kalai & Smorodinsky's solution, the equal gain solution or any other symmetrical, individually rational and translation-invariant solution. We refer the reader to Thomson (1996) for an overview of bargaining solutions and their respective properties. The outcome of the third stage of the game is readily computed as the solution of the maximization problem of the following Nash bargaining product with respect to  $\alpha_2$ :

$$\text{Max}_{\alpha_2} (\alpha_2 X_2(1-\psi) + \Pi_G) ((1-\alpha_2)X_2(1-\psi) + \Pi_L - X_2(1-\psi)),$$

$$\text{which yields: } \alpha_2 X_2(1-\psi) = \frac{\Pi_L - \Pi_G}{2} = \frac{\Delta}{2} \quad (1)$$

The RHS of (1) is the manner in which we measure the leverage exercised by  $G$  thanks to their joint threatening ability to pull out of the social game. Since this power is exogenously fixed, we must conclude that the expected amount of aid accruing to  $G$  in the second period, corresponding to the LHS, is a constant. In other words, any marginal increase of the second tranche is appropriated by  $L$ : if  $A$  raises  $X_2$ ,  $L$  will respond by diminishing  $\alpha_2$ . Another straightforward implication of (1) is that  $G$  can expect a positive share of the second tranche only if  $\Delta > 0$  (and the larger  $\Delta$  the smaller the expected amount of aid money captured by  $L$  in the second period).

To assume that  $\Delta > 0$ , or  $\Pi_L > \Pi_G$ , is to consider that, taken collectively, the grassroots provide their local patron with a flow of services that carry a large value to him. This is

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<sup>14</sup> If, instead, the aid agency is somewhat selfish, say, because it wants to protect the jobs of its employees, it is evident that the interests of the poor will be less well served than is predicted by the model set up in this paper.

because his physical, human and social capital endowment enables him to draw significant benefits from such services in ordinary life. Being the party who obtains the highest benefit in the social game,  $L$  is also the one who has most to lose from a failure to reach agreement in the (second round of the) aid game. When there is no collective organization of the grassroots, and the leader is able to deal with each of them individually, he has an edge on them.

Reduced dependence of the individual  $G$  on their leader-patron is the reason why this edge is reversed as a result of the aid game, owing to an objective and/or a subjective effect. The objective effect occurs if the new resources brought by the aid intervention and the solidarity links it helps to foster through the new collective body provide an alternative insurance to that traditionally supplied by  $L$ . The subjective effect is observed if, thanks to their newly achieved unity,  $G$  become aware of the collective strength arising from the important services which they jointly provide to  $L$ . Note that, since we assume that the LDM is aimed at raising the share of the poor beyond what they could achieve through their own leverage, we have that:  $\alpha_1^* > \alpha_2 = \Delta / 2X_2(1-\psi)$ . This implies that we are interested only in groups where the leverage of the poor, as measured by  $\Delta$ , is not too high.

It might be objected that there are many circumstances under which the above scenario will not materialize, essentially because the local leader-patron is able to keep his poor clients divided and to continue to deal with them on an individual basis. In other words, the local organization created for the purpose of receiving aid is manipulated by  $L$ . In such circumstances where  $\Delta \leq 0$ , CBD is doomed to failure. Indeed, we then have the corner solution  $\alpha_2 X_2(1-\psi) = 0$ , implying that the whole mechanism unravels: since  $G$  will get nothing out of the second tranche,  $A$  will not disburse it and, consequently,  $L$  will not be disciplined in the use of the first tranche. Anticipating that behaviour,  $A$  will not disburse the first tranche either.

Alternatively, instead of considering  $X_1$  and  $X_2$  as two successive tranches of aid money disbursed by  $A$ , one might treat  $X_1$  as the project size and  $X_2$  as an incentive payment or a bonus granted to  $L$  upon completion of the project conditional on proper management of the aid fund, that is, on the condition that no fraud has been detected during the inspection procedure. According to this new approach,  $L$  is free to spend the bonus as he wishes, and if he decides not to redistribute any share of it to  $G$ , this is not seen as a problem by  $A$ . Like the amount  $Z$  devoted to monitoring, the award does not enter into  $A$ 's utility function in so far as it does not reach  $G$ . Like  $Z$  again, it serves to discipline  $L$  when he decides how to allocate

the project money,  $X_1$ . If such is the approach followed by  $A$ , –whereby  $A$  is committed to disbursing  $X_2$  even if it knows that it will be entirely kept by  $L$ –, the LDM does not unravel when  $\Delta \leq 0$ .

Before turning to the second stage of the game, it is worth emphasising that, if they are appropriately designed to increase accountability of local elites (say, through a good display of information about the project in public places, or the creation of an open community forum where project reports can be read and explained to illiterate people, etc), participatory development schemes may have the effect of actually increasing the value of  $\Delta$  through a fall in the poor's perceived benefits from the social game,  $\Pi_G$ . As a consequence, the share of aid proceeds accruing to the intended beneficiaries will be larger compared with the situation in which the design of the programme is less appropriate.

We are now ready to solve the game by maximizing  $U_L$  with respect to  $\alpha_1$ , given the outcome of the third stage. We get the following first-order condition, that is also sufficient for a global maximum since the convexity of  $g$  guarantees that the second-order condition holds:

$$\begin{aligned} & -X_1 + X_2 f(Z, k) g'(1 - \alpha_1) = 0, \quad \text{at an interior solution, or} \\ & -X_1 + X_2 f(Z, k) g'(1 - \alpha_1) > 0 \text{ and } \alpha_1 = 1, \text{ or} \\ & -X_1 + X_2 f(Z, k) g'(1 - \alpha_1) < 0 \text{ and } \alpha_1 = 0 \end{aligned} \tag{2}$$

By looking at  $A$ 's utility function, it can be seen that no corner solution for  $L$  may arise if  $A$  ends up with an interior solution to its own maximization. If  $\alpha_1 = 0$ , then  $X_1$  will be set to 0. If  $\alpha_1 = 1$ , then  $U_A$  increases unboundedly with  $X_1$  whenever  $X_2$  is set to 0. An interior solution for all three variables controlled by  $A$  requires only mild conditions on  $f$  and  $g$ . Anyway, the cases where interiority fails to hold are beyond the scope of our argument, concerned with the reliance on conditional payments ( $X_2 > 0$ ) and fraud detection ( $Z > 0$ ) with a view to disciplining the local leader ( $0 < \alpha_1 < 1$ ). Hence, from now on, we will proceed with first-order conditions expressed as equalities.

Before moving to the maximization of  $U_A$ , we briefly outline the shape of  $L$ 's best response curve. The implicit function theorem applied to equation (2) yields the following results:

$$\begin{aligned}
\frac{\partial \alpha_1}{\partial X_1} &= -\frac{1}{X_2 f(Z, k) g''(1 - \alpha_1)} < 0 \\
\frac{\partial \alpha_1}{\partial X_2} &= \frac{X_1}{X_2^2 f(Z, k) g''(1 - \alpha_1)} > 0 \\
\frac{\partial \alpha_1}{\partial Z} &= \frac{f^Z(Z, k) g'(1 - \alpha_1)}{f(Z, k) g''(1 - \alpha_1)} > 0
\end{aligned} \tag{3}$$

where  $g'(-)$  and  $g''(-)$  are the first and second derivatives of the function  $g$  (both assumed to be positive), while  $f^Z$  is the first derivative of the function  $f$  with respect to  $Z$  (also positive).

Here is the heart of the LDM: when  $A$  decreases the amount of the first tranche (or the project size), for given levels of the conditional transfer (the second tranche or the bonus) and the supervision effort, or when  $A$  increases the conditional transfer for given levels of the first tranche (or the project size) and the supervision effort,  $L$  is induced to raise the share accruing to  $G$  during the first period (during the project phase). Larger supervision expenses, which increase the probability of fraud detection, also reduce  $L$ 's willingness to take risks by embezzling a large share of the project funds, especially since he is a full residual claimant of the conditional payment  $X_2$ . Note that a better ability to monitor on the part of the aid agency has the same expected effect:

$$\frac{\partial \alpha_1}{\partial k} > 0.$$

We are now ready to proceed to the maximization of  $EU_A$ . Taking into account the outcome of the third stage of the game, we can rewrite  $EU_A$  as follows:

$$EU_A = \alpha_1 X_1 + \Delta / 2 - \lambda(X_1 + X_2 + Z) + \lambda \eta X_2 \psi$$

Then, rather than using equation (2) as a constraint and relying on a Lagrangean, we use the results shown in (3) to take  $L$ 's best response curve into account. We obtain the following first-order condition with respect to  $X_1$ :

$$\frac{\partial EU_A}{\partial X_1} = 0 = \alpha_1 - \frac{X_1}{X_2 f(Z, k) g''(1 - \alpha_1)} - \lambda + \lambda \eta \frac{g'(1 - \alpha_1)}{g''(1 - \alpha_1)}$$

Bearing (2) in mind, this first-order condition yields a closed-form, albeit implicit, solution for  $\alpha_1$ :

$$\alpha_1 = \lambda + (1 - \lambda\eta) \frac{g'(1 - \alpha_1)}{g''(1 - \alpha_1)} \quad (4)$$

It is immediately apparent that, given our assumptions (in particular, the fact that  $g''' > 0$ ), the share allocated to  $G$  during the first period (the share of  $G$  in the project funds) exceeds the cost of access to funds for the aid agency:  $\alpha_1 > \lambda$ .

The second-order condition, which plays a crucial role for the comparative statics results with respect to  $X_1$ , does not hold automatically and has therefore to be assumed. It actually amounts to a mild regularity condition on the function  $g$ :

$$\frac{d^2 EU_A}{dX_1^2} = \frac{-1}{X_2 f(Z) g''(1 - \alpha_1)} \left( (1 - \lambda\eta) \left( 1 - \frac{g'(1 - \alpha_1) g'''(1 - \alpha_1)}{g''^2(1 - \alpha_1)} \right) + 1 \right) < 0 \quad (5)$$

This condition holds as soon as the third derivative of  $g$  is not too large at the optimum.

Since equation (4) is an independent, closed-form solution for  $\alpha_1$ , the static comparative effects can be immediately computed to determine the way in which the critical parameters of the model influence the share of the first tranche (or the project size) that accrues to  $G$ . However, in order to confront these results with the impact of the same parameters on the amount of the second tranche (or the bonus or incentive payment) and on the supervision effort, we will first state the other necessary conditions for  $A$ 's optimization.

Bearing (1) and (2) in mind, so that the outcomes of the second and third stages of the game are duly taken into account,  $EU_A$  can be rewritten as follows:

$$EU_A = \alpha_1 X_2 f(Z, k) g'(1 - \alpha_1) + \Delta/2 - \lambda Z - \lambda X_2 (1 - \eta f(Z, k) g(1 - \alpha_1) + f(Z, k) g'(1 - \alpha_1))$$

Maximizing the above with respect to  $X_2$  yields:

$$\frac{1}{f(Z, k)} = \left( \frac{\alpha_1}{\lambda} - 1 \right) g'(1 - \alpha_1) + \eta g(1 - \alpha_1) \quad (6)$$

Maximization of the same with respect to  $Z$  yields:

$$\frac{1}{f^Z(Z, k)X_2} = \left( \frac{\alpha_1}{\lambda} - 1 \right) g'(1 - \alpha_1) + \eta g(1 - \alpha_1) \quad (7)$$

Combined with (6), (7) leads to a simple equilibrium relationship between  $X_2$  and  $Z$ :

$$X_2 = \frac{f(Z, k)}{f^Z(Z, k)} \quad (8)$$

The immediate implication of (8) is that  $X_2$  and  $Z$  move together: when  $A$  decides to devote more effort to monitoring  $L$ 's behaviour during the (first) project phase, it simultaneously increases the amount of the second tranche (or the incentive payment to  $L$ ). We know from (3) that an increase in  $X_2$  or in  $Z$  have the same effect of increasing  $\alpha_1$ : they are substitutable instruments available to discipline  $L$ . It is also evident from (3) that an increase in  $Z$  has the effect of enhancing the marginal incentive impact of a given amount  $X_2$ , and vice-versa:  $\partial^2 \alpha_1 / \partial Z \partial X_2 > 0$ . As a result, the aid agency is induced to raise  $X_2$  when  $Z$  is larger, and to raise  $Z$  when  $X_2$  is larger.

Second-order conditions with respect to  $X_2$  and to  $Z$  have no particular interest and are simply assumed. Like equation (5), they hold under mild regularity conditions on  $f$  and  $g$ .

### *Comparative statics*

Beyond the multiplicative separability of the fraud detection function, very little needs to be assumed to get the closed-form solution for  $\alpha_1$  given by equation (4). A simple application of the implicit function theorem yields the following results (see Appendix I, for the proof), which are going to drive a lot of the expressions derived later:

$$\frac{\partial \alpha_1}{\partial \lambda} > 0; \quad \frac{\partial \alpha_1}{\partial \eta} < 0 \quad (9)$$

The first result represents the main claim of the paper and can be stated thus.

*Proposition 1: When access to aid money for decentralised development is easier (resulting in a lower  $\lambda$ ), elite capture increases implying that the share accruing to the poor becomes smaller.*

The adverse distributive impact of low-cost aid money is to be understood in the light of the incentive structure described in the model. It suggests that massive injections of cheap money dedicated to the struggle against poverty may have the effect of enriching and

consolidating local elites, much in the same way as windfall incomes from natural resources can be a curse because they give rise to greater rent-seeking activity (see, e.g., Tornell and Lane, 1998). In this sense, the fear that the participatory approach may “reinforce the very structures of unequal privilege they seek to upset” (Ribot, 2000: 33) is legitimate.

The second result emerging from (9) can be stated thus:

*Proposition 2: The interests of the poor are adversely affected when aid agencies can easily reallocate funds in the event of a project failure, that is, when their commitment to a given community project is low ( $\eta$  is high). Conversely, when the transaction cost of establishing a partnership link with a community is high, an aid agency is more inclined to pay attention to the elite capture problem, which benefits the poor.*

Therefore, aid organizations working in remote and backward areas are predicted to be more effective in reaching the intended beneficiaries than those operating in areas where all sorts of communication (physical, psychological, cultural, etc) with the inhabitants are easier.

A more complete elucidation of the causality running through the model requires the computation of comparative statics for the other variables as well. If the optimal value of  $\alpha_1$  provided by equation (4) is used in equation (7), the latter provides in turn a closed-form solution for  $Z$ , and it needs not be further reworked to yield the following (see Appendix II, for the proof):

$$\frac{dZ}{d\lambda} = \frac{\alpha_1 X_1}{\lambda^2} > 0; \quad \frac{dZ}{d\eta} = -\psi X_2 < 0 \quad (10)$$

Since we know from (8) that  $X_2$  moves in the same direction as  $Z$ , we can also deduce that:

$$\frac{dX_2}{d\lambda} > 0; \quad \frac{dX_2}{d\eta} < 0 \quad (11)$$

As expected, when the cost of access to aid money is higher,  $A$  uses its two instruments more intensively. The same effect is predicted when the transaction cost of setting up partnership links with target communities is higher. It is, moreover, immediately evident from (7) that  $dZ/dk < 0$ , implying that an aid agency which possesses a less effective monitoring technology makes up for this deficiency by increasing its monitoring expenditures. Since  $f(Z,k)$  is equal to a quantity which varies independently of both  $Z$  and  $k$ , –



see (6)–, variations in  $Z$  exactly compensate variations in  $k$ . This explains why  $\alpha_1$  appears to be independent of  $k$ :  $\partial\alpha_1/\partial k = 0$  (see equation (4)).

Finally, there remains the more complex task of studying the effect of a variation in  $\lambda$ , or in  $\eta$ , on  $X_1$ , the amount of the first tranche or the project size. From (2) and (8), we get that

$$X_1 = \frac{(f(Z, k))^2 g'(1 - \alpha_1)}{f^Z(Z, k)}. \quad \text{The influence of } \lambda, \text{ or } \eta, \text{ on } X_1 \text{ is thus exerted via } Z \text{ and } \alpha_1.$$

Because the expression for the  $d\alpha_1^*/d\lambda$  effect is especially intricate (see Appendix I), tedious algebraic work is involved in computing the total net effect of variations in  $\lambda$  and  $\eta$ . Such work leads to the conclusion that both  $dX_1/d\lambda$  and  $dX_1/d\eta$  have indeterminate signs.

This indeterminacy follows from the fact that there are two factors pushing in opposite directions. Take the case of a variation in  $\lambda$ . On the one hand, a more difficult access to aid funds for the operating aid agency (a higher  $\lambda$ ) is negatively felt in its utility function where the cost of the operating fund, whether it is used for monitoring expenses or for distribution to the village association, appears explicitly. On that count, the agency is expected to reduce its aid commitment, and  $X_1$  should fall. On the other hand, when  $\lambda$  is higher, the agency is induced to extract a larger value of  $\alpha_1$  from the local leader, otherwise the project might just as well be closed down (bear in mind that  $d\alpha_1/d\lambda > 0$ ). In order to obtain such a response, high values must be chosen for  $Z$  and for  $X_2$  because  $\partial\alpha_1/\partial X_2 > 0$  and  $\partial\alpha_1/\partial Z > 0$ . Doing so creates a directly unproductive cost for the project, which must be diluted over a large amount of directly productive expenses  $X_1$ . It must, indeed, be remembered that, at the margin,  $X_2$  is only a cost to  $A$  because  $L$  is the full residual claimant of it once the lumpsum transfer  $\Delta/2$  is made to  $G$ . The only justification for a positive  $X_2$  is that it eases  $A$ 's incentive constraint, i.e. it induces  $L$  to keep  $\alpha_1$  high. This happens to be the *raison d'être* of  $Z$  as well, because no fraction of it never makes it to  $G$ . In other words,  $X_2$  and  $Z$  are productive only in an indirect way, through  $L$ 's best response.

In an analogous manner, an increase in  $\eta$  gives rise to two opposite effects. On the one hand, since it is easier to reallocate aid funds to another community if needed,  $A$  is inclined to increase the project size. Yet, on the other hand, an easier access to alternative projects diminishes  $A$ 's incentive to monitor  $L$ 's behaviour, hence the predicted fall in  $Z$  and  $X_2$ , and therefore in  $\alpha_1$ —see the results stated in (9), (10), and (11). Because  $Z$  and  $X_2$  are fixed costs that need to be amortized over the aid project,  $X_1$  is expected to fall.

The ambiguous impact of a variation of  $\lambda$  (or  $\eta$ ) on  $X_1$  is apparent from the above equation which defines  $X_1$  as the product of a term dependent on  $Z$ ,  $[f(Z)]^2 / f^Z(Z)$ , and a

term dependent on  $\alpha_1$ ,  $g'(1-\alpha_1)$ . As a matter of fact, the term in  $Z$  increases with  $\lambda$  (since a rise in  $\lambda$  causes  $Z$  to increase, and  $f(Z)$  is concave) while the term in  $\alpha_1$  decreases (since a rise in  $\lambda$  causes  $(1-\alpha_1)$  to decrease, and  $g(1-\alpha_1)$  is convex). Therefore, we may expect  $X_1$  to grow with  $\lambda$  if the probability of fraud detection,  $\psi$ , is strongly influenced by  $Z$ . In other words, if the aid agency is quite effective in discouraging elite capture through monitoring expenditures, it will react to an increase of the cost of access to aid money by raising the size of its assistance to the targeted community.

If poverty alleviation is the central objective pursued by the aid agency, it should feel concerned about the manner in which the absolute amount of aid money that goes to the poor evolves in response to a change in an exogenous parameter. Formally, its preoccupation should be with the way  $\alpha_1 X_1$  reacts to a variation in either  $\lambda$  or  $\eta$ . (Bear in mind that the absolute amount of the second tranche,  $\alpha_2 X_2$ , is entirely determined by the bargaining power of the poor, as measured by  $\Delta$ ). Computing these two derivatives is much more cumbersome than computing the effects of changes in  $\lambda$  or  $\eta$  on  $X_1$ . Again, we are led to the conclusion that the signs of  $d(\alpha_1 X_1)/d\lambda$  and  $d(\alpha_1 X_1)/d\eta$  are indeterminate. But we know from the above discussion that, if the aid agency is quite effective in monitoring elite capture, the impact of a rise of  $\lambda$  on  $\alpha_1 X_1$  can be determined, and is actually positive (since both components,  $\alpha_1$  and  $X_1$ , increase). If monitoring is only mildly effective, a higher cost of aid money may either increase or decrease the amount of it that will end up in the hands of the poor. The converse reasoning can be applied when  $\lambda$  declines. Hence the following proposition:

*Proposition 3: When access to aid money becomes costlier, the amount of resources reaching the poor may either increase or decrease in communities already covered by decentralised development assistance. However, if aid agencies are quite effective in detecting fraudulent behaviour at local level, a positive impact is expected. Conversely, under the same condition, the objective of poverty alleviation is less effectively attained in these communities when aid money becomes cheaper.*

The above conclusion obviously deals with a partial effect: it relates only to those communities already covered by a development project. In order to assess the total impact of a rise in  $\lambda$  on poverty alleviation, the assumption that the aid money supply is infinitely elastic must be relaxed, and the effect on the number of communities acceded by a development assistance program must be considered. Since a more restricted supply of aid funds generally accompanies a rise in  $\lambda$ , it is evident that the total impact of more expensive aid money on

poverty alleviation is indeterminate. A more precise conclusion can nevertheless be inferred, insofar as a higher (positive) value of  $d\alpha_1/d\lambda$  increases the likelihood that the total impact will be positive. Conversely, a decline of  $\lambda$  accompanied by an increase in the total amount of aid money available might possibly lead to worse poverty reduction performances, under the same condition of a strong  $d\alpha_1/d\lambda$  effect.

Since  $\frac{d\alpha_1}{d\lambda} = \frac{2 - \lambda\eta - \eta(g'(-)/g''(-))}{2 - \lambda\eta} > 0$ , a large  $d\alpha_1/d\lambda$  implies that  $g'(-)$  is small

(compared to  $g''(-)$ ), meaning that the probability of fraud detection is not too much influenced by the sheer size of aid embezzlement by local leaders, but is strongly sensitive to monitoring efforts by aid agencies. Under such conditions, indeed, aid agencies are induced to increase their monitoring budget so as to better discipline local leaders when aid funds become more costly (see supra). It is also evident that the value of  $d\alpha_1/d\lambda$  decreases with  $\eta$ , which again conforms with intuition: the lower the cost of re-directing aid money to an alternative community/project in the event of discovery of fraudulent behaviour, the less effective the aid agency in disciplining local leaders.

Clearly, the fact that the objective of poverty alleviation might be better achieved as a result of tighter conditions for access to aid money, or that cheaper aid funds might not help reduce poverty, is a challenging conclusion that needs careful pondering by the international donor community. Our next proposition can be stated thus:

*Proposition 4: When aid money is costlier, the amount of resources reaching the poor may either increase or decrease overall. The paradoxical result of a positive impact of dear aid money on poverty alleviation is more likely to obtain if the probability of fraud detection is quite sensitive to monitoring efforts of aid agencies, and/or if the cost of re-directing aid flows is high.*

Before turning to a particular case, it may be noted that the equilibrium number of projects/communities is easily obtained given the state of the market for aid money, and assuming that they are all identical. Indeed, once the equilibrium values of  $X$  and  $\lambda$  have been set in the market for aid funds, we can determine sequentially the optimal values of  $\alpha_1$ ,  $Z$ ,  $X_2$ , and  $X_I$ , on the basis of (4), (6), (8), and the expression of  $X_I$  obtained by using (2) and (8). The optimal value of  $n$ , the number of projects/communities, or the number of aid agencies (assuming that each agency carries out one project and cater to one community), is then directly deduced from the expected budget balance constraint defined as follows:

$$X_1 + X_2(1 - \eta\psi(Z, \alpha_1)) + Z = X^* / n$$

*A particular case*

It is not difficult to find functional forms of  $f(-)$  and  $g(-)$ , for which it is possible to predict the complete set of effects produced by variations in  $\lambda$  or  $\eta$ . In particular, when  $g(-)$  has a quadratic form,  $g(1 - \alpha_1) = (1 - \alpha_1)^2$ , while  $f(-)$  is kept in its general form, the direction of  $dX_1/d\lambda$ ,  $dX_1/d\eta$ ,  $d(\alpha_1 X_1)/d\lambda$ , and  $d(\alpha_1 X_1)/d\eta$  can be accurately predicted. The complete set of equilibrium conditions that obtain under the assumption of a quadratic  $g(-)$  function, are given below (the first three equations correspond to the first-order conditions of  $A$ 's optimization problem with respect to  $X_1$ ,  $X_2$ , and  $Z$ , respectively):

$$\alpha_1 = \frac{\lambda(1 - \eta) + 1}{2 - \lambda\eta} \quad (12)$$

$$\frac{1}{f(Z, k)} = \frac{(1 - \lambda)^2}{\lambda(2 - \lambda\eta)} \quad (13)$$

$$X_2 = \frac{f(Z, k)}{f^Z(Z, k)} \quad (14)$$

$$X_1 = \frac{2\lambda X_2}{1 - \lambda} \quad (15)$$

$$\psi = \frac{\lambda}{2 - \lambda\eta} \quad (16)$$

$$\alpha_1 X_1 = \lambda(X_1 + X_2) \quad \text{or} \quad \lambda = \frac{\alpha_1 X_1}{X_1 + X_2} \quad (17)$$

Equation (17) is especially interesting because it captures the role of  $\lambda$  well: at equilibrium, the cost of access to aid money must be equal to the average return of aid investment as measured by the share of 'pure aid money' (that is, the budget of the aid agency less the monitoring expenditures) that reaches the intended beneficiaries during the project period. This 'average return' must, therefore, increase commensurately with  $\lambda$ . The comparative-static results are as follows:

$$\begin{aligned} \frac{dX_1}{d\lambda} > 0; \frac{d(\alpha_1 X_1)}{d\lambda} > 0; \frac{d\alpha_1}{d\lambda} > 0; \frac{dX_2}{d\lambda} > 0; \frac{dZ}{d\lambda} > 0 \\ \frac{dX_1}{d\eta} < 0; \frac{d(\alpha_1 X_1)}{d\eta} < 0; \frac{d\alpha_1}{d\eta} < 0; \frac{dX_2}{d\eta} < 0; \frac{dZ}{d\eta} < 0 \end{aligned} \quad (18)$$

With the quadratic  $g(-)$  function, both tranches of aid money to a community (or both the project size and the bonus payment) increase as a result of a rise of the cost of access to aid money. Consequently, the absolute amount reaching the poor also increases. This is not surprising since the chosen functional form does not correspond to a large effect on fraud detection of the sheer size of fund embezzlement. As for the total impact on poverty alleviation,  $\alpha_1 X^*$ , it remains indeterminate.

Identical results are obtained when reallocation of aid funds in the event of fraud detection is more difficult or costly. The underlying mechanism is the same as before, viz. the willingness of  $A$  to better discipline  $L$  as a response to the parametric change. One serious implication of this result is the following: if aid agencies are under the pressure to show quick and visible results to satisfy their fund providers, so that they prefer to work with easily accessible rather than remote communities, they will be less effective in reaching the local poor. There would then be two sources of inefficiency in the struggle against poverty: a selection bias that favours well located communities where the incidence of poverty is generally the lowest, on the one hand, and a comparative ineffectiveness in reaching the poor in these communities, on the other hand.

Finally, the effect of a parametric change in the effectiveness of the fraud detection technology, measured by  $k$ , is easy to trace back from the above set of equations. Such a change gives rise to a proportional inverse variation in  $Z$  (see equation (13)) and the associated variation in  $X_2$  (see equation (14)). For example, an increase in  $k$  causes a fall in  $Z$  and  $X_2$ . As is evident from equation (15),  $X_1$  falls in exactly the same proportion as  $X_2$ . The share accruing to the grassroots,  $\alpha_1$ , is left unchanged (see equation (12)), which is also true of the ratio  $\alpha_1 X_1 / (X_1 + X_2)$ , and the detection probability,  $\psi$  (see equations (16) and (17)).

#### *A final remark*

From our general model, it is easy to show that the utility of the aid agency,  $EU_A$ , decreases as a result of an increase in  $\lambda$  (or a decrease in  $\eta$ ).  $A$ 's utility function can be rewritten thus:

$$EU_A = (\alpha_1 - \lambda)X_1 - \lambda Z - \lambda X_2(1 - \eta\psi) + \frac{\Delta}{2}$$

Using equations (2) and (7), as well as the definition of  $\psi$ , the expression for  $A$ 's indirect utility can be readily simplified:

$$EU_A^* = \frac{\lambda(1 - \eta f(Z, k)g(-))}{f(Z, k)g'(-)} X_2 f(Z, k)g'(-) - \lambda Z^* - \lambda X_2(1 - \eta f(Z, k)g(-)) + \frac{\Delta}{2} = \frac{\Delta}{2} - \lambda Z^*$$

Bearing in mind our general results about the signs of  $dZ/d\lambda$  and  $dZ/d\eta$ , and applying the envelop theorem, we immediately verify that:<sup>15</sup>

$$\frac{dEU_A}{d\lambda} = -Z^* - \lambda \frac{dZ^*}{d\lambda} < 0; \quad \frac{dEU_A}{d\eta} = -\lambda \frac{dZ^*}{d\eta} > 0 \quad (19)$$

Therefore, a threshold value of  $\lambda$  exists above which (or a threshold value of  $\eta$  exists below which)  $EU_A$  becomes negative, and the agency prefers to abstain from committing aid money to a project:  $X_1 = X_2 = Z = 0 = \max U_A$ . (For some particular functional forms of  $f$  and  $g$ , this threshold value above which  $A$  decides to quit can be computed). In other words, if a rise of  $\lambda$  is deemed justified, there is an upper limit which cannot be trespassed.

To understand our last point, consider the limit situation in which  $\lambda$  takes on the value  $\lambda^{max}$ , such that the aid agency's expected utility is just equal to zero:  $Z^* = \Delta/2 \lambda^{max}$ . Clearly, for a given value of  $\lambda$ , and for  $\lambda^{max}$  in particular, a higher  $\Delta$  has the effect of causing  $Z^*$  to become smaller than  $\Delta/2 \lambda^{max}$ , with the result that  $EU_A$  becomes strictly positive. By way of consequence, with a larger  $\Delta$ , a higher critical value of  $\lambda$  becomes feasible (bear in mind that  $Z^*$  increases with  $\lambda$ ). Since we know with certainty that the distribution of aid proceeds is more equitable when  $\lambda$  is higher ( $da_1/d\lambda > 0$ ), we can conclude that:

*Proposition 5: A stronger bargaining power in the hands of the grassroots enables them not only to extract a higher amount of aid money during the second period of the project (or upon completion of the project if a bonus payment is made), but also to obtain a larger share of the first tranche (or the project fund), if  $\lambda$  can be raised. Hence, the greater the bargaining power of the poor, the higher the social value of increasing  $\lambda$ .*

The leverage wielded by the poor thus exerts two distinct favourable effects, a direct effect which takes place during the second period (see (1)), and an indirect effect which takes place during the first period.

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<sup>15</sup> An implication of this result is that, at any interior solution,  $A$  and  $L$ , rather than  $A$  and  $G$ , share common concerns with regard to the parameters of the model, i.e.  $dUA/d\alpha_1 < 0$  and  $dU_L/d\alpha_1 < 0$ , when  $\lambda$  and  $\eta$  vary.

## 5. Conclusion

When communities have well-established organizations where the poor are sufficiently empowered, the participatory approach is on safe grounds. The problem arises when local organizations do not exist or when they are dominated by strong elites driven by their peculiar interests. Unfortunately, this situation is more frequent than currently assumed by the proponents of CDD. Till the poor are sufficiently empowered to effectively participate in decision-making and claim their rightful dues, the elite capture problem must be somehow overcome if such an approach is to prove more successful than the top-down approaches applied so far by many donor agencies. Rather than being confined to the top of the socio-political structure, corruption typically permeates the whole chain of vertical patron-client ties that form the pyramid of power in poor countries. Local elite capture thus appears as a reflection or an outcome of corruption at the central level, a hard reality that too many discourses on civil society tend to obscure. One realistic manner of tackling such a problem is for donor agencies to follow sequential and conditional disbursement procedures so as to substitute for the poor's lack of power in target communities. These procedures can be interpreted either as disbursement of aid money in successive tranches, or as implementation of a main community development project followed by the conditional payment of a bonus to the local leader.

When the supply of CDD aid is rather scarce with the result that donor agencies find themselves in the position of local monopolies, such a solution may yield promising results in the sense that the share accruing to the poor at equilibrium will be sufficiently large. However, this will depend on various factors, foremost among which is the cost of obtaining funds for operating aid agencies: if this cost is too low, the share of aid funds that will eventually reach the intended beneficiaries will be small. The underlying rationale emerges when it is understood that the share accruing to the poor can be thought of as the 'return' on an investment project in CDD aid so that, at equilibrium, this return must be equal to the cost of access to aid funds. If such a cost is low, the aid agency feels little pressure to discipline local leaders or intermediaries, and the share accruing to the poor will be small.

This said, the main concern of aid agencies, and the international donor community in general, seems increasingly to be the alleviation of absolute poverty rather than the reduction of relative deprivation. What, therefore, matters is less the share than the absolute amount of aid resources that eventually reach the poor as a result of participatory development efforts. In this perspective, a widespread view holds that the extent to which poverty can be alleviated

is roughly commensurate to the total amount of aid available for this purpose. What we show in this paper is that such a view is much too simple. Because more plentiful aid has the effect of lowering the cost of access to aid funds for specialised agencies, not only will the distribution of aid proceeds become more unequal, but it is also possible that poverty will be less effectively reduced. This perverse effect is more likely to obtain if monitoring efforts by aid agencies, rather than the sheer size of aid embezzlement by local leaders or intermediaries, influence the probability of fraud detection, so that these agencies are induced to increase their monitoring expenses when the cost of access to aid funds rises. It is also more likely if the cost of re-directing aid flows to a new community/project in the event of discovery of fraudulent behaviour is high.

That making aid resources more abundant does not necessarily lead to poverty reduction, but might prove a self-defeating strategy in some circumstances, is in itself quite a challenging finding. As a matter of fact, it ought to compel the donor community to seriously ponder over the issue of aid effectiveness and the mechanics of elite capture in decentralised settings. As recently pointed out by *The Economist*, “generosity is not the only virtue donors must show. They must also be free of illusion, lest they succumb too quickly to disillusion. The aid industry needs fewer manias and less depression” (Special Report *Aid to Africa*, July 2, 2005, p. 27).

Adverse dynamic effects may also result from massive disbursements of aid money through communities. For one thing, local leaders are thus enabled to gain increasing legitimacy from interactions with the outside world rather than with their own people. For another thing, an unhealthy situation is created in which excessively high value is placed on the sort of skills needed to attract money from abroad, skills which tend to be heavily concentrated in the hands of a narrow educated elite. Outside money clearly corrupts the process of local institutional development if it allows indigenous leaders to eschew negotiation with members for support and material contributions, thereby preventing autonomous organization-building and a genuine development of civil society. There is a striking parallel between the effects of aid generosity and natural resource abundance. Indeed, both situations do not produce the expected positive effects because the windfall incomes they generate give rise to a lot of rent-seeking activity.

Finally, aid agencies that cater to easily accessible rather than remote communities where poverty is generally most pervasive, perhaps because they need quick and visible results to satisfy their fund providers, are less effective in reaching the local poor.



### Appendix I: Derivation of (9)

Application of the implicit function theorem to equation (4) yields:

$$\frac{d\alpha_1^*}{d\lambda} = - \left[ \frac{1 - (1 - \lambda\eta) \frac{g''(1 - \alpha_1)(-1)g''(1 - \alpha_1) + g'(1 - \alpha_1)g'''(1 - \alpha_1)}{(g''(1 - \alpha_1))^2}}{-1 + \eta \frac{g'(1 - \alpha_1)}{g''(1 - \alpha_1)}} \right]^{-1}$$

Using (4) again, the denominator of the above expression can be rewritten

$-1 + \frac{\alpha_1\eta - \lambda\eta}{1 - \lambda\eta}$ . Since the second term is necessarily smaller than 1, we can take it for granted

that the denominator is negative. The sign of the derivative therefore depends on the sign of the numerator as follows:

$$\text{sign} \frac{d\alpha_1^*}{d\lambda} = \text{sign} \left[ 1 + (1 - \lambda\eta) \left( 1 - \frac{g'(-)g'''(-)}{(g''(-))^2} \right) \right]$$

On the basis of the second-order condition stated in (5), we can conclude that the above sign is positive. As a consequence,  $d\alpha_1 / d\lambda > 0$ .

Likewise, we have that:

$$\frac{d\alpha_1^*}{d\eta} = - \left[ \frac{1 - (1 - \lambda\eta) \left( -1 + \frac{g'(1 - \alpha_1)g'''(1 - \alpha_1)}{(g''(1 - \alpha_1))^2} \right)}{\lambda \frac{g'(1 - \alpha_1)}{g''(1 - \alpha_1)}} \right]$$

Since the numerator is the same as in the previous expression, and the denominator is now positive, we must conclude that  $d\alpha_1 / d\eta < 0$ .

## Appendix II: Derivation of (10)

First, we are interested in determining the sign of  $dZ/d\lambda$  on the basis of equation (6). Since  $\alpha_1$  figures out in this equation, we have to take account of equation (4) where  $\alpha_1$  appears to be determined by the parameters  $\lambda$  and  $\eta$  only. We thus want to sign  $dZ/d\lambda$  on the basis of the total differential:  $dZ = \frac{\partial Z}{\partial \alpha_1} d\alpha_1 + \frac{\partial Z}{\partial \lambda} d\lambda$ , bearing in mind that the LHS of equation (6) is defined as  $1/f(Z,k)$  and not as  $Z$ . We can now compute the two following partial derivatives, the first one on the basis of equations (6) and (4), and the second one on the basis of equation (6) alone:

$$\begin{aligned} \frac{\partial(1/f(Z,k))}{\partial \alpha_1} &= -\left(\frac{\alpha_1 - \lambda}{\lambda}\right)g''(1-\alpha_1^*) + g'(1-\alpha_1^*)\frac{1}{\lambda} - \eta g'(1-\alpha_1^*) \\ &= -\frac{g'(1-\alpha_1^*)}{g''(1-\alpha_1^*)}\left(\frac{1}{\lambda} - \eta\right)g''(1-\alpha_1^*) + g'(1-\alpha_1^*)\frac{1}{\lambda} - \eta g'(1-\alpha_1^*) = 0 \\ \frac{\partial(1/f(Z,k))}{\partial \lambda} &= -\frac{\alpha_1^*}{\lambda^2}g'(1-\alpha_1^*) \end{aligned}$$

Taking account of these two results and bearing (2) and (8) in mind, it is straightforward to find:

$$\begin{aligned} \frac{dZ}{d\lambda} &= \frac{\partial Z}{\partial(1/f(Z,k))} \frac{\partial(1/f(Z,k))}{\partial \lambda} = \frac{(f(Z,k))^2}{f^Z(Z,k)} \frac{\alpha_1^*}{\lambda^2} g'(1-\alpha_1^*) \\ &= \frac{\alpha_1^*}{\lambda^2} X_2 f(Z,k) g'(1-\alpha_1^*) = \frac{\alpha_1^* X_1}{\lambda^2} > 0 \end{aligned}$$

Bearing in mind the definition of  $\psi$ , the impact of a variation in  $\eta$  on  $Z$  is found in an analogous manner:

$$\frac{dZ}{d\eta} = \frac{\partial Z}{\partial(1/f(Z,k))} \frac{\partial(1/f(Z,k))}{\partial \eta} = \frac{-(f(Z,k))^2}{f^Z(Z,k)} g'(1-\alpha_1^*) = -X_2 \psi < 0$$

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