

Foreign Aid, Incentives and Efficiency: Can Foreign Aid Lead to Efficient Level of Investment?

Abstract

This paper develops a two-period-two-country model in which an altruistic donor faces Samaritan's Dilemma to address two important policy questions: (i) whether foreign aid can lead to efficient level of capital investment in the recipient country and (ii) how do the form (e.g. budgetary transfers, capital transfer) and the timing of aid affect the incentives of the recipient? It finds that the capital transfer makes financial savings more attractive relative to the capital investment for the recipient. The capital transfer can lead to efficient level of capital investment. But in this case, it completely crowds out the recipient's own capital investment. In *the absence of capital transfer*, by using multi-period budgetary transfers the donor can achieve not only the efficient level of capital investment by the recipient, but also the allocation which arises when the donor can commit to its transfer policy. By tying its hands in the sense of forgoing capital transfer, the donor can give aid more efficiently.

Keywords: Foreign Aid, Capital Investment, Efficiency, Budgetary Transfers, Capital Transfer, Samaritan's Dilemma

JEL Code: F35, O12, O16, O19

1 Introduction

One of the key objectives of many donor countries and aid organizations is to promote investment and growth in the recipient countries. The effectiveness of aid in achieving its goals has been a major concern for donors, policy makers, and researchers. There is a voluminous literature which has examined its effects on investment, growth, poverty reduction and development in general. This literature finds mixed evidence with regard to its effectiveness in achieving its stated goals (e.g. Boone 1996, Burnside and Dollar 2000, Hansen and Tarp 2001, Collier and Dollar 2002, Easterly 2003, Kanbur 2004, Rajan and Subramaniam 2008, Temple 2010).

The weak effect of aid, in part, is attributed to the incentive problems associated with the strategic interactions among the donors and the recipients. It has been argued that aid by altruistic donors induces recipients to

reduce their own contribution to development efforts in order to elicit more aid from donors. Donors face a Samaritan's Dilemma and may not be able to deter recipients (through some conditionality) from indulging in such strategic behavior due to time-inconsistency and credibility problems (Buchanan 1975, Lindbeck and Weibull 1988). Empirical evidence also suggests that conditionality does not work and there is a weak relationship between aid disbursement by the donors and the implementation of required conditions or institutional reforms by the recipients (see Svensson 2003, Kanbur 2004 and Temple 2010 for a review of evidence).¹

It is increasingly being realized by policy makers that different instruments of aid affect the incentives of the recipients in different ways and the use of appropriate instruments can improve effectiveness of aid (World Bank 1998, 2005, OECD 2007). Donors provide aid in multiple ways with the financing of capital projects/project aid and the general budgetary support/program area aid being the two important instruments. It has been argued that the general budgetary support may be a superior instrument of disbursing aid compared to the capital financing as it allows for better alignment of goals of the donor and the recipient and a more efficient use of resources (World Bank 2005, OECD 2007).

This paper develops a two-period-two-country model to address three important policy questions. Firstly, whether foreign aid can lead to efficient level of capital investment in the recipient country? Secondly, whether the form of aid transfer (e.g. budgetary transfer, direct financing of capital investment) and its timing matter for the efficiency of the capital investment? Thirdly, what instruments can be used to mitigate the problems of dynamic inconsistency? There are two key aspects of the model: (i) the donor country is altruistic and behaves as a Stackelberg follower similar to Pedersen (1996, 2001), Svensson (2000), Torsvik (2005), Hagen (2006) etc. and (ii) the recipient country can make both the financial and the capital investment.

In the model, there is one donor country and one recipient country.²

¹The following quote from *The Economist* (August 19, 1995) succinctly captures this long-standing problem:...*Over the past few years Kenya has performed a curious mating ritual with its aid donors. The steps are: one, Kenya wins its yearly pledges of foreign aid. Two, the government begins to misbehave, backtracking on economic reform and behaving in an authoritarian manner. Three, a new meeting of donor countries looms with exasperated foreign governments preparing their sharp rebukes. Four, Kenya pulls a placatory rabbit out of the hat. Five, the donors are mollified and the aid is pledged. The whole dance then starts again ...*

²Throughout the paper, we use the terms donor (recipient) and donor country (recipient

The recipient faces borrowing constraint and is unable to borrow from the international financial markets.³ The donor is altruistic and cares about the welfare of the recipient. It can provide aid to the recipient through the general budgetary transfers in both periods and the capital transfer (direct financing of capital investment) in the first period. The capital transfer is earmarked for capital investment. However, it is still fungible as the recipient can adjust its own contribution to the capital investment. The recipient possesses a production technology which is increasing and concave in the capital investment. It faces a portfolio choice problem and can allocate its savings between financial savings at a fixed rate of interest and the capital investment.

In terms of timing, aid is given by the donor after observing the recipient's choices of capital investment and financial savings. The recipient takes into account how her decisions affect the level and the type of aid. We then have a sequential game with the recipient as the leader.

The main findings of this paper are as follows. Firstly, the capital transfer distorts the relative rate of return between financial savings and capital investment and makes financial savings more attractive to the recipient. The result is that the capital transfer can lead to efficient level of capital investment. But in this case, it completely crowds out the recipient's own capital investment.

Secondly, both the second period budgetary transfer and the capital transfer have disincentive effect on the recipient's own capital investment. But,

country) interchangeably.

³One of the major justifications for foreign aid has been that domestic savings are too low in poor countries to finance the required investment (savings gap) and they are not able to fill this gap by international borrowing due to financial market imperfections. Recognizing the importance of foreign aid in the development process, 1970 General Assembly Resolution of United Nations called on to the advanced countries to commit 0.7% of their GNP to the Official Development Assistance. This target has been affirmed in many international agreements over the years including recently concluded the Sustainable Development Goals 2015 (Target 17.2)). The Report of the International Conference on Financing for Development, Monterrey, Mexico, 2002 states that *...We note with concern current estimates of dramatic shortfalls in resources required to achieve the internationally agreed development goals, including those contained in the United Nations Millennium Declaration (para2, page 2, of the Report available at http://www.unmillenniumproject.org/documents/07_aconf198-11.pdf)*. Empirical literature shows that developing countries face significantly higher interest rates in the international financial markets than developed countries (e.g. Edwards 1984, Aguiar and Gopinath 2007).

the capital transfer has a larger disincentive effect on the recipient's capital investment than the second period budgetary transfer. Despite capital transfer having larger disincentive effect, whenever it is optimal for the donor to make second period budgetary transfer to the recipient, it is also optimal for her to make capital transfer.

Thirdly, the first period budgetary transfer has a positive incentive effect on the capital investment by the recipient. The donor can use the multi-period budgetary transfers (or transfers in both periods) to balance out their positive and negative incentive effects on the capital investment by the recipient. Finally, in *the absence of capital transfer*, multi-period budgetary transfers not only lead to the efficient level of capital investment by the recipient, but also achieve the same allocation which emerges when the donor country is a *Stackleberg leader* or it can *commit* to its transfer policy.

The reason that the capital transfer makes financial savings more attractive to the recipient than the capital investment is as follows. An increase in the recipient's capital investment reduces the marginal benefit of capital transfer to the donor for two reasons: (i) it reduces the marginal product of capital and thus the rate of return from the capital transfer and (ii) it increases the second period consumption of the recipient and reduces the marginal utility of consumption in the second period as perceived by the donor. On the other hand, an increase in the recipient's financial savings reduces the capital transfer only by reducing the marginal utility of consumption in the second period as perceived by the donor.

The distortion in the rates of return from financial savings and the capital investment caused by the capital transfer induces the recipient to divert more resources towards the financial savings. The result is that in the presence of capital transfer, when the capital investment is at the efficient level, it is completely financed by the capital transfer. When there is no capital transfer, this distortion disappears. Using the multi-period budgetary transfers, the donor can achieve the same allocation which emerges when it can commit to its transfer policy.

Finally, an increase in the recipient's capital investment reduces the second period budgetary transfer by increasing the second period consumption of the recipient, but as discussed above, it reduces the capital transfer both due to fall in the marginal product of capital and increase in the second period consumption of the recipient. The result is that the second period budgetary transfer has a smaller disincentive effect on the capital investment by the recipient compared to the capital transfer.

The analysis suggests that in an environment where the donor faces Samaritan's dilemma, tying the hands of the donor in the sense of foregoing the use of capital transfer as an instrument of aid can mitigate the time-consistency problem. General budgetary transfers can be more efficient instruments of giving aid than the capital transfer. The analysis also shows that these results do not depend on whether the goals of the donor and the recipient are misaligned or whether foreign capital is less suitable for domestic production. Tying the hand of the donor can be particularly important when she values the utility of the recipient high enough to give her budgetary transfer in the second period.

This paper relates to various strands of literature on foreign aid. There are studies which have examined the role of tournament (Svensson 2000), delegation (Svensson 2003, Hagen 2006), co-operation among donors (Torsvik 2005), and punishment (Blouin and Pallage 2009) in mitigating time-inconsistency problems. These papers do not address the question of incentive effects of different instruments and the efficiency of capital investment.

There is a nascent theoretical literature (Cordella and Ariccia 2007 and Jelovac and Vandeninden 2008), which has examined the incentive effects of different instruments (e.g. general budgetary support, capital financing) in the contract-theoretic framework. These papers address the question of what is the most efficient instrument to disburse a *fixed* amount of aid, when the donor can impose conditionality on the recipient and foreign capital is less productive than the domestic capital. These papers do not address the question of efficiency of capital investment and the portfolio choice in an environment with time-inconsistency problem.

This paper also relates to the theoretical literature which has examined the effect of aid on investment and growth (e.g. Pedersen 1996, Arellano et al. 2009). However, these papers do not examine the issue of whether aid can lead to efficient level of capital investment and whether the form of transfer and its timing matter.

The rest of the paper is organized as follows. Section 2 describes the model and derives the optimal strategies of the donor and the recipient when the donor is a Stackleberg follower. Section 3 characterizes the equilibrium. Section 4 analyzes the case when there is no capital transfer and derives the allocations both when the donor is a Stackleberg follower and a Stackleberg leader. Section 5 analyzes two extensions of the basic model: (i) the capital expenditure financed by the capital transfer and the domestic capital have differential productivity and (ii) the recipient country consists of heteroge-

neous individuals (rich and poor). This is followed by concluding section.

2 Model

There are two periods and two countries: one donor (d) and one recipient (r). Initially for simplicity, we assume that the inhabitants of each country are identical and the government in each country maximizes the utility of its representative inhabitant.⁴

Let y_i^j be the endowment income (income without capital investment) of country $j = d, r$ in period $i = 1, 2$. Normalize the rate of discount to be one. Apart from the endowment income, the recipient country also possesses a production technology, $f(k)$, which is increasing and concave in the capital investment, k :⁵

$$f(k) \text{ with } f_k(k) > 0, f_{kk}(k) < 0 \text{ \& } \lim_{k \rightarrow 0} f_k(k) \rightarrow \infty. \quad (2.1)$$

The production $f(k)$ takes place in period 2 and the capital investment, k , is undertaken in period 1. The recipient country chooses its consumption, c_i^r for $i = 1, 2$, and financial savings, s^r , and capital investment, k^r , in the first period to maximize its utility

$$U(c_1^r) + U(c_2^r), \text{ with } U_c() > 0, U_{cc}() < 0. \quad (2.2)$$

Assume that the international financial markets are imperfect and the low income recipient country is not able to borrow and thus $s^r \geq 0$.⁶ Normalize the interest rate on financial savings to be one. Also assume that $k^r \geq 0$.

The donor (country) is altruistic and cares about the welfare of the recipient (country). The donor can make two types of transfers to the recipient: (i) budgetary transfer in period 1 and 2, t_1 and t_2 respectively and (ii) capital transfer, k^d , in the first period.⁷ The capital transfer is earmarked to finance

⁴In section 5, we relax this assumption and allow the recipient country to consist of two groups of individuals (rich and poor). The analysis and results remain the same.

⁵Throughout the paper for any function $z(x)$, $z_x(x)$ and $z_{xx}(x)$ denote the first and the second derivative respectively.

⁶One can allow for strictly positive amount of borrowing by the recipient. The results remain the same as long as the recipient country is not able to borrow the desired amount.

⁷We assume that both the recipient and the donor countries produce and consume same commodity. Alternatively, one can assume that the recipient and the donor countries produce and consume two different goods, but these goods can be exchanged one to one

the capital investment in the recipient country. These transfers are assumed to be non-negative, $t_1, t_2, k^d \geq 0$.

The donor chooses its consumption, c_i^d , and budgetary transfers, t_i , in both periods and capital transfer, k^d , and financial savings, s^d , in the first period to maximize its utility

$$V(c_1^d) + V(c_2^d) + \lambda[V(c_1^r) + V(c_2^r)] \text{ with } V_c() > 0, V_{cc}() < 0 \quad (2.3)$$

where $0 < \lambda < 1$ is the degree of altruism and determines the relative weight which the donor puts on the welfare of the recipient. Assume that the donor does not face the borrowing constraint in the international financial markets.

The donor's budget constraints are

$$c_1^d = y_1^d - s^d - k^d - t_1 \text{ \& } \quad (2.4)$$

$$c_2^d = y_2^d + s^d - t_2. \quad (2.5)$$

The recipient's budget constraints are

$$c_1^r = y_1^r - s^r - k^r + t_1 \text{ \& } \quad (2.6)$$

$$c_2^r = y_2^r + s^r + t_2 + f(k) \quad (2.7)$$

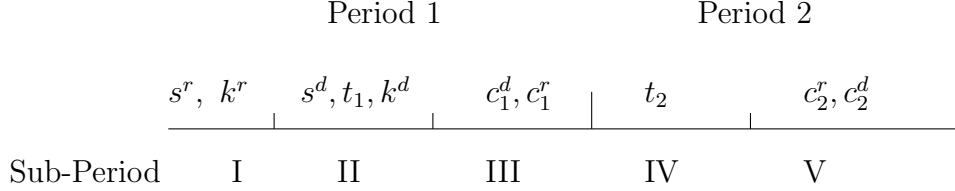
where $k = k^r + k^d$ (sum of the capital investment financed by the recipient and the donor). Note that since the recipient can adjust its capital investment, k^r , the capital transfer by the donor, k^d , is fungible.

Similar to a large literature on Samaritan's dilemma and aid (e.g. Pedersen 1996 & 2001, Svensson 2000, Torsvik 2005, Hagen 2006 etc.), we assume that the donor is a Stackelberg follower. The timing is as follows. At the beginning of the first period, the recipient chooses its financial savings and capital investment, s^r and k^r . After observing these choices, the donor chooses her saving, budgetary transfers and capital transfer, s^d , t_1 , t_2 and k^d . t_1 and k^d are disbursed at the end of the first period and the first period consumption takes place. At the beginning of the second period, t_2 is

in the competitive world market.

disbursed and the second period consumption takes place.⁸

Timing



Since, aid is given by the donor after observing the recipient's choices of capital investment and financial savings, the recipient takes into account how her decisions affect the level and the type of aid. We then have a sequential game with the recipient as the leader.

2.1 Efficient Level of Capital Investment

We first characterize the efficient level of capital investment in the recipient country as a benchmark. The efficient level of capital investment, k^* , in the recipient country is given by

$$f_k(k^*) = 1 \quad (2.8)$$

which equates the marginal product of capital to the rate of interest.

In the rest of the paper, we assume that initial conditions are such that in the *absence* of aid, $s^r = 0$ and the recipient cannot achieve the efficient level of capital investment from its own resources. The sufficient condition is

$$f_k(y_1^r) > 1. \quad (2.9)$$

Now we characterize the optimal strategies of the donor and the recipient.

⁸In this formulation, we are assuming that t_2 is being chosen in the first period itself along with t_1 and k^d . However, one can assume that t_2 is chosen at the beginning of the second period. Since, the donor gives aid after observing s^r and k^r , it does not matter whether the donor chooses aid level and its form sequentially or simultaneously. I thank a reviewer for suggesting me to clarify this point.

2.2 Donor's Problem

$$V^d \equiv \max_{s^d, k^d, t_1, t_2} V(c_1^d) + V(c_2^d) + \lambda[V(c_1^r) + V(c_2^r)]$$

subject to the budget constraints (2.4) and (2.5) taking as given the choices of the recipient (s^r, k^r) . Consumption of the donor in period 1 and 2 are given by (2.4) and (2.5) respectively. The first order conditions are

$$V_{s^d}^d \equiv V_c(c_1^d) - V_c(c_2^d) = 0; \quad (2.10)$$

$$V_{k^d}^d \equiv V_c(c_1^d) - \lambda V_c(c_2^r) f_k(k) \geq 0; \quad k^d \geq 0 \text{ \& } k^d V_{k^d}^d = 0; \quad (2.11)$$

$$V_{t_1}^d \equiv V_c(c_1^d) - \lambda V_c(c_1^r) \geq 0; \quad t_1 \geq 0 \text{ \& } t_1 V_{t_1}^d = 0 \text{ \& } \quad (2.12)$$

$$V_{t_2}^d \equiv V_c(c_2^d) - \lambda V_c(c_2^r) \geq 0; \quad t_2 \geq 0 \text{ \& } t_2 V_{t_2}^d = 0. \quad (2.13)$$

(2.10) equates the marginal cost of financial savings to its marginal benefit. One additional unit of financial savings reduces the utility of the donor by $V_c(c_1^d)$ in the first period, but increases its utility by $V_c(c_2^d)$ in the second period.

(2.11) characterizes the optimal choice of capital transfer by the donor. One additional unit of capital transfer reduces the utility of the donor by $V_c(c_1^d)$ in the first period (the marginal cost of capital transfer), but increases the utility of the donor by $\lambda V_c(c_2^r) f_k(k)$ in the second period (marginal benefit). When the donor chooses strictly positive value of capital transfer, it must be the case that the marginal benefit of capital transfer equals its marginal cost. If the marginal cost of capital transfer is higher than its marginal benefit, the donor will not make capital transfer. This may occur if the degree of altruism and the first period endowment income of the donor and the marginal productivity of capital of the recipient are relatively low or the second period income of the recipient is relatively high.

Other first order conditions can be explained in a similar fashion. (2.12) characterizes the optimal choice of first period budgetary transfer by the donor. When the donor chooses strictly positive value of first period budgetary transfer, it must be the case that its marginal benefit equals its marginal cost. If the marginal cost is higher than the marginal benefit,

the donor will not make first period budgetary transfer. This may occur if the degree of altruism and the first period income of the donor are relatively low and the first period endowment income of the recipient is relatively high.

Similarly, when the donor chooses strictly positive value of second period budgetary transfer, it must be the case that its marginal benefit equals its marginal cost (2.13). If the marginal cost is higher than the marginal benefit, the donor will not make second period budgetary transfer. This may occur if the degree of altruism and the second period income of the donor are relatively low and the second period income of the recipient is relatively high.

From the partial differentiation of (2.11), (2.12), and (2.13), it follows that

$$\frac{dk^d}{dk^r} = -\frac{\lambda V_{cc}(c_2^r)f_k^2(k) + \lambda V_c(c_2^r)f_{kk}(k)}{V_{cc}(c_1^d) + \lambda V_{cc}(c_2^r)f_k^2(k) + \lambda V_c(c_2^r)f_{kk}(k)} < 0; \quad (2.14)$$

$$\frac{dk^d}{ds^r} = -\frac{\lambda V_{cc}(c_2^r)f_k^2(k)}{V_{cc}(c_1^d) + \lambda V_{cc}(c_2^r)f_k^2(k) + \lambda V_c(c_2^r)f_{kk}(k)} < 0; \quad (2.15)$$

$$\frac{dt_1}{dk^r} = \frac{\lambda V_{cc}(c_1^r)}{V_{cc}(c_1^d) + \lambda V_{cc}(c_1^r)} = \frac{dt_1}{ds^r} > 0; \quad (2.16)$$

$$\frac{dt_2}{dk^r} = -\frac{\lambda V_{cc}(c_2^r)f_k(k)}{V_{cc}(c_2^d) + \lambda V_{cc}(c_2^r)f_k(k)} < 0 \text{ \&} \quad (2.17)$$

$$\frac{dt_2}{ds^r} = -\frac{\lambda V_{cc}(c_2^r)}{V_{cc}(c_2^d) + \lambda V_{cc}(c_2^r)} < 0. \quad (2.18)$$

(2.14) shows that a higher capital investment by the recipient, k^r , reduces capital transfer, k^d . This happens because a higher k^r reduces the marginal benefit of capital transfer to the donor for two reasons: (i) it reduces the marginal product of capital and thus the rate of return from the capital transfer declines and (ii) it increases the second period consumption of the recipient and thus reduces the marginal utility of consumption in the second period as perceived by the donor. Since, a higher capital investment by the recipient, k^r , increases its second period consumption, it also reduces the second period budgetary transfer (2.17). For a similar reason, a higher financial savings, s^r , by the recipient reduces capital transfer (2.15) and the second period budgetary transfer (2.18).

The effect of a higher k^r or s^r on the first period budgetary transfer, t_1 , however, is completely different. A higher k^r or s^r leads to a larger first period budgetary transfer, t_1 (2.16). This happens because a higher k^r or s^r reduces the consumption of the recipient and thus increases the marginal utility of consumption in the first period as perceived by the donor. This induces the donor to increase its first period budgetary transfer.

Note that (2.14) and (2.15) imply that $|\frac{dk^d}{ds^r}| < |\frac{dk^d}{dk^r}|$ i.e. a unit increase in the recipient's capital investment has a larger negative effect on the capital transfer from the donor than a unit increase in the recipient's financial savings. As discussed above, an increase in the recipient's capital investment reduces the capital transfer due to decline in both its marginal utility of consumption in the second period and the marginal product of capital. On the other hand, an increase in the recipient's financial savings reduces only its marginal utility of consumption in the second period, but does not affect the marginal product of capital. As we will see below, the larger negative effect of the recipient's capital investment on the capital transfer induces the recipient to save more in terms of financial savings.

Also from (2.10), (2.14) and (2.17), it follows that the capital transfer has a larger disincentive effect on the capital investment by the recipient than the second period budgetary transfer, $|\frac{dk^d}{dk^r}| > |\frac{dt_2}{dk^r}|$ for any $f_k(k) \geq 1$. The reason is that an increase in k^r reduces t_2 by increasing the second period consumption of the recipient, but it reduces k^d both due to fall in the marginal product of capital and increase in the second period consumption of the recipient.

Next, we derive some additional implications of the optimal choices of the donor.⁹

Lemma 1:

- (i) If t_1 & $t_2 > 0$, then $c_1^r = c_2^r$.
- (ii) If $t_1 > 0$ & $t_2 = 0$, then $c_1^r \leq c_2^r$ and if $t_1 = 0$ & $t_2 > 0$, then $c_1^r \geq c_2^r$.

These results follow from the first order conditions of the donor. Intuitively, if the donor gives budgetary transfers in both periods, then it chooses

⁹Before any aid is given, initial conditions should be such that the donor can increase its welfare by giving aid. Using the first order conditions of the donor and the conditions that $k^r < k^*$ and $s^r = 0$ before any aid is given, one can show that if the initial conditions are such that $V_c(c_2^d) < \lambda V_c(c_2^r)$, i.e. it is optimal for the donor to make the second period budgetary transfer, then it is also optimal for her to make the capital transfer and the first period budget transfer.

them to equalize its perceived marginal utility from these two transfers and thus $c_1^r = c_2^r$. On the other hand, if the donor makes budgetary transfer only in the first period, the marginal utility to the donor from the first period budgetary transfer must be higher than its marginal utility to the donor from the second period budgetary transfer and thus $c_1^r \leq c_2^r$. Opposite happens if it makes budgetary transfers only in the second period. Note that these choices of budgetary transfers hold regardless of whether there is capital transfer.

Proposition 1:

- (i) If the donor makes budgetary transfer in the second period, $t_2 > 0$, then it also makes the capital transfer, $k^d > 0$ for any $0 \leq k^r < k^*$. In addition, if it chooses the capital transfer, $k^d > 0$, then the total capital investment in the recipient country is at the efficient level for any $0 \leq k^r < k^*$, $k \equiv k^d + k^r = k^*$.
- (ii) If the donor does not make budgetary transfer in the second period, $t_2 = 0$, but chooses the capital transfer, $k^d > 0$, then the total capital investment in the recipient country is inefficiently low for any $0 \leq k^r < k^*$, $k \equiv k^d + k^r < k^*$, except in the special case where (2.13) holds with strict equality and $t_2 = 0$.

Proof: In the appendix.

Proposition 1 shows that if there is capital transfer, then for any $0 \leq k^r < k^*$, the budgetary transfer in the second period, in general, is crucial for achieving the efficient level of capital investment. If $t_2 = 0$, the capital investment in the recipient country is likely to be inefficiently low regardless of whether $t_1 = 0$ or $t_1 > 0$.

Both the capital transfer and the second period budgetary transfer by the donor increase the second period utility of the recipient. Since the donor does not face the borrowing constraint, the marginal costs of the capital transfer and the second period budgetary transfer to the donor are same. Whether the donor uses one or both of these instruments then depends on their marginal benefit.

For any $0 \leq k^r < k^*$, since $f_k(k^r) > 1$, the rate of return on the capital transfer is greater than the rate of return from the second period budgetary transfer ($= 1$). Thus, if the donor makes the second period budgetary transfer, then it also makes the capital transfer. In addition, it makes large enough capital transfer to equalize the rates of return from both these instruments resulting in the efficient level of capital investment in the recipient country.

When the donor does not make budgetary transfer in the second period,

it values its second period utility relatively more compared to the second period utility of the recipient. In this case, it can increase its utility by reducing the capital transfer and increasing its own saving and consumption. Thus, it does not make capital transfer large enough to achieve the efficient level of capital investment in the recipient country.

2.3 Recipient's Problem

While making its choices, the recipient takes into account the effects of its choices on the transfers made by the donor. As we will see below, the first period budgetary transfer reduces the marginal cost of financial savings and capital investment of the recipient. On the other hand, the capital transfer and the second period budgetary transfer reduce the marginal benefit of financial savings and capital investment of the recipient.

$$U^r \equiv \max_{s^r, k^r} U(c_1^r) + U(c_2^r)$$

subject to the budget constraints (2.6) and (2.7) and the strategies of the donor characterized in (2.10-2.13). Consumption of the recipient in period 1 and 2 are given by (2.6) and (2.7) respectively. The first order conditions are

$$U_{s^r}^r \equiv U_c(c_1^r)(1 - \frac{dt_1}{ds^r}) - U_c(c_2^r) \left[f_k(k) \frac{dk^d}{ds^r} + \frac{dt_2}{ds^r} + 1 \right] \geq 0; s^r \geq 0 \text{ \& } s^r U_{s^r}^r = 0 \text{ \& } \quad (2.19)$$

$$U_{k^r}^r \equiv U_c(c_1^r)(1 - \frac{dt_1}{dk^r}) - U_c(c_2^r) \left[f_k(k)(1 + \frac{dk^d}{dk^r}) + \frac{dt_2}{dk^r} \right] \geq 0; k^r \geq 0 \text{ \& } k^r U_{k^r}^r = 0. \quad (2.20)$$

(2.19) characterizes the optimal choice of the financial savings of the recipient. While making the optimal choice, the recipient takes into account, the marginal cost and the marginal benefit of financial savings. Note that in the given environment, one unit increase in the financial savings reduces consumption of the recipient in the first period by less than one unit as it increases the budgetary transfer by the donor in the first period. Also, an increase in the financial savings reduces the capital transfer and the second period budgetary transfer. Thus, the net benefit from one unit of financial

savings in the second period is less than one. If the marginal cost of financial savings is higher than its marginal benefit, the recipient will not save.

(2.20) can be interpreted in a similar way. The first period budgetary transfer reduces the marginal cost of capital investment, but the capital transfer and the second period budgetary transfer reduce its marginal benefit. If the marginal cost of the capital investment is higher than its marginal benefit, the recipient will not invest.

Proposition 2: For any capital transfer $0 < k^d < k^*$, it is always optimal for the recipient to choose $k^r \geq 0$ such that the total capital investment $k \equiv k^r + k^d < k^*$. When the capital transfer $k^d \geq k^*$, then it is optimal for the recipient to choose $k^r = 0$.

Proof: In the appendix.

The result follows from the fact that the capital transfer distorts the relative rate of return between recipient's financial savings and capital investment. As discussed earlier, the recipient's capital investment has a larger negative effect on the capital transfer compared to its financial savings. This makes financial savings more attractive and induces the recipient to under-invest in capital relative to the efficient level.

Note that this under-investment relative to the efficient level is not due to the standard strategic reason as analyzed in Lindbeck and Weibull (1988) and Pedersen (1996), where the recipient under-invests in order to elicit more capital transfer. Rather it is due to the distortion in the relative rate of return between financial savings and capital investment.

3 Equilibrium

So far, we have characterized the best-reply correspondences of the donor and the recipient. Equilibria will occur at the intersections of these correspondences. In the paper, we focus on equilibria with capital transfer.¹⁰ The

¹⁰In the equilibrium without capital transfer, one only needs to consider the case in which $t_1 > 0$. In this case, equilibrium capital investment depends on the size of the positive incentive effect of the first period budgetary transfer on the recipient's capital investment and financial savings. If these incentive effects are large enough then $s^r > 0$ and the capital investment will be at the efficient level, $k^r = k^*$. Numerical simulations (not reported) show that for a wide range of parameter values such that the second period budgetary transfer increases the welfare of the donor *before any aid is given*, aid regime with capital transfer emerges in equilibrium.

results are summarized below.

Proposition 3:

- (i) If there is an equilibrium such that the total capital investment is at the efficient level, $k = k^*$, then in equilibrium, it must be the case that the recipient receives the second period budgetary transfer from the donor, $t_2 > 0$. In addition, $k^d = k^*$ and $k^r = 0$.
- (ii) If there is an equilibrium such that the total capital investment is inefficiently low, $k < k^*$, then in equilibrium, it must be the case that the recipient does not receive the second period budgetary transfer, $t_2 = 0$.

These results follow from propositions 1 and 2 and the fact that $|\frac{dk^d}{ds^r}| < |\frac{dk^d}{dk^r}|$. They imply that whenever the capital investment is at the efficient level, it is fully financed by the capital transfer and the budgetary transfers are entirely used for consumption. The recipient's contribution to the capital investment is strictly positive only when the total capital investment is inefficiently low.

As discussed earlier, the capital transfer makes financial savings more attractive to the recipient relative to the capital investment. While making its choices, the recipient takes into account that for any $k^r < k^*$, the donor will make large enough capital transfer such that the capital investment is at the efficient level. In order to elicit larger capital transfer, it reduces its own capital investment to zero.¹¹

4 Allocations in the absence of capital transfer

The above analysis suggests that the form and the timing of aid have differential effects on the incentives of the recipient. The first period budgetary transfer increases the incentive of the recipient to save and to make capital investment. On the other hand, the second period budgetary transfer and the capital transfer have a disincentive effect on the capital investment and saving. In particular, the capital transfer is highly distortionary as it creates

¹¹This result follows even in the special case where (2.13) holds with strict equality and $t_2 = 0$, in equilibrium, since the recipient takes into account that the donor will make large enough capital transfer such that the capital investment is at the efficient level.

a wedge between the rates of return from capital investment and financial savings for the recipient. In addition, whenever it is optimal for the donor to make second period budgetary transfer, it is optimal for her to make more distortionary capital transfer. This raises the question whether restricting the use of capital transfer can mitigate the effects of the strategic behavior by the recipient and what would be the resulting allocations.

Now, we show that in *the absence of capital transfer*, the multi-period budgetary transfers can achieve not only the efficient level of capital investment, but also the allocations achieved when the donor can commit to its transfer policies (or when the donor is a Stackleberg leader).¹² By using the multi-period budgetary transfers, the donor can balance the incentive and the disincentive effects of budgetary transfers on the recipient's capital investment and financial saving. The analysis suggests that in this environment by forgoing the use of capital transfer, the donor can mitigate the adverse effects of the strategic behavior by the recipient.

Suppose that the initial conditions are such that, it is optimal for the donor to use all the three instruments of aid. However, there is a rule which forbids the use of capital transfer as an instrument of aid. Thus, the donor can only make budgetary transfers in both periods. Let us first look at the allocations when the donor is the Stackelberg follower (under discretionary transfer policy).

4.1 Allocation when the donor is a Stackleberg follower

As shown in the appendix, there exists an equilibrium such that the financial savings by the recipient is strictly positive, $s^r > 0$, and the capital investment is at the efficient level. The optimal allocations are given by

$$c_1^r = c_2^r = \frac{1}{2}[y_1^r + y_2^r + t_1 + t_2 + f(k^*) - k^*]; \quad (4.1)$$

$$k^r = k^* \text{ \& } \quad (4.2)$$

¹²When the donor can commit to its transfer policy and she also makes capital transfer, it is easy to show that the recipient chooses k^r such that $f_k(k) = 1$ for any $0 < k^d < k^*$, if $s^r > 0$. However, as shown earlier, under discretionary transfer policy the recipient always chooses k^r such that $f_k(k) > 1$. Thus, when there is capital transfer, the allocations under discretionary transfer policy and when the donor can commit do not coincide.

$$c_1^d = c_2^d = \frac{1}{2}[y_1^d + y_2^d - t_1 - t_2] \quad (4.3)$$

where the optimal choices of t_1 and t_2 satisfy (2.12) and (2.13) respectively. In this equilibrium, the positive incentive effect of the first period budgetary transfer on financial savings and capital investment are exactly offset by the negative incentive effect of the second period budgetary transfer.

4.2 Allocation when the donor is a Stackleberg leader

Now suppose that the donor is a Stackleberg leader. It makes only budgetary transfers and can commit to its optimal transfer policy. Fully aware of the donor's policy, the recipient makes its financial savings and capital investment decisions. The recipient's problem is to maximize its utility subject to its budget constraints (2.6) and (2.7) for a given t_1 and t_2 . It can be shown that the optimal strategies of the recipient are given by

$$c_1^r = c_2^r = \frac{1}{2}[y_1^r + y_2^r + t_1 + t_2 + f(k^*) - k^*]; \quad (4.4)$$

$$f_k(k^r) = 1 \text{ \& } k^r = k^* \quad (4.5)$$

which coincide with (4.1) and (4.2) respectively.

The donor maximizes its utility subject to its budget constraints (2.4 & 2.5) and the strategies of the recipient given in (4.4) and (4.5). The first order conditions are

$$s^d : V_c(c_1^d) = V_c(c_2^d); \quad (4.6)$$

$$t_1 : V_c(c_1^d) = \lambda V_c(c_1^r) \text{ \& } \quad (4.7)$$

$$t_2 : V_c(c_2^d) = \lambda V_c(c_2^r). \quad (4.8)$$

(4.7) and (4.8) are identical in form to (2.12) and (2.13) respectively.¹³ Using (2.4), (2.5), and (4.6), we have

$$c_1^d = c_2^d = \frac{1}{2}[y_1^d + y_2^d - t_1 - t_2] \quad (4.9)$$

¹³We only consider the case, in which t_1 & $t_2 > 0$.

which coincides with (4.3). Thus the allocations when the donor can commit are identical to the allocations under discretionary transfer policies, if the donor can make budgetary transfers in both periods.

Proposition 4: In the absence of capital transfer, if the donor makes budgetary transfers in both periods the allocations under *discretionary* transfer policies and the allocations when the donor can *commit* to her transfer policies coincide.

As discussed earlier, when the donor gives both the budgetary and the capital transfers (under discretionary policies), the allocation is distorted due to two reasons. Firstly, transfers incentivize the recipient to behave strategically to attract more transfers. Secondly, different types of aid have different incentive effects. The budgetary transfers affect the optimal choices of the recipient by relaxing the budget constraint of the recipient. However, the capital transfer also distorts the relative rate of return between financial savings and capital investment.

In the absence of capital transfer, the distortion in the relative rate of return between financial savings and capital investment disappears. Then the donor can use the positive incentive effect of the first period budgetary transfer on the recipient's financial savings and capital investment to balance out the disincentive effect of the second period budgetary transfer on the recipient's financial savings and capital investment. Thus, she is able to achieve the same allocations under *discretionary* transfer policies as she can achieve, when she can *commit* to her transfer policies.

5 Extensions

So far we have assumed that the domestic capital and the capital transfer are equally productive and the recipient country consists of identical individuals. However, the projects financed by the donor may be less productive (possibly due to lack of perfect fit with the physical environment of the recipient) or it may be more productive (possibly due to superior technology or expertise).

Similarly, there may be heterogeneity in the recipient country with some inhabitants being rich and others poor. The donor may just care about the welfare of poor individuals in the recipient country rather than the welfare of all its inhabitants. There is also concern that aid may be diverted by the recipient government towards the consumption of rich individuals.

Now, we relax these two assumptions and derive allocations under discretionary transfer policies. We assume that the donor can use both the budgetary transfers and the capital transfer as in section 2.

5.1 Differential Productivity

Suppose that domestic capital and capital transfer have differential productivity. Specifically, let the production function has the following form

$$f(k) \equiv f(k^r + \delta k^d) \quad (5.1)$$

where the total effective capital, $k = k^r + \delta k^d$ and $\delta > 0$. δ captures the differential productivity of domestic and foreign capital. If $\delta < 1$ the marginal productivity of capital transfer is lower and if $\delta > 1$ the marginal productivity of capital transfer is higher than the domestic capital. Rest of the model remains as in section 2.

Let us first characterize the efficient level of effective capital. In the case $\delta < 1$, since the domestic capital has higher productivity, only the domestic capital will be used in production ($k = k^r$) and the efficient level of total effective capital in the recipient country, k^* , will be given by $f_k(k^*) = 1$. On the other hand, if $\delta > 1$, only the foreign capital will be used in production ($k = \delta k^d$) and the efficient level of total effective capital in the recipient country, k^{**} , will be given by $f_k(k^{**}) = \frac{1}{\delta}$.

Proposition 5: Suppose that the domestic capital and the capital transfer have differential productivity:

- (i) If the recipient receives the second period budgetary transfer, $t_2 > 0$, it also receives the capital transfer, $k^d > 0$. In addition, in this case the recipient's own contribution to the capital investment, $k^r = 0$.
- (ii) If the domestic capital is more productive than the foreign capital, $\delta < 1$, the capital transfer does not lead to the efficient level of total effective capital investment in the recipient country.

Proof: In the appendix.

As discussed earlier, if the donor values the utility of the recipient high enough to make the second period budgetary transfer, it also values it high enough to make the capital transfer. Since, the capital transfer makes the

financial savings more attractive relative to the capital investment, it is optimal for the recipient to reduce its own contribution to capital investment to zero.

The intuition for the result in proposition 5(ii) is as follows. When the foreign capital is less productive, it reduces the rate of return from the capital transfer to the donor. When the effective capital investment is at the efficient level, the return from the capital transfer becomes too low to the donor. Thus, she reduces the capital transfer. At the same time, for the recipient who wants to elicit more capital transfer it is not optimal for her to undertake the efficient level of capital investment.

5.2 Heterogeneity in the Recipient Country

Suppose now that the recipient country has two groups of individuals: rich individuals (indexed e) and poor individuals (indexed p). Let y_i^j be the endowment income of type $j = e, p$ in time $i = 1, 2$, with $y_i^e > y_i^p$. As before, the government in the recipient country chooses capital investment, k^r , and financial savings, s^r . In addition, it can reallocate income between these two groups using lump-sum tax/transfer, T_i^j . Also assume that it can commit to its tax/transfer policies. As in section 2, the donor country makes transfers after observing the financial savings and the capital investment of the recipient.

The consumption of rich and poor in the recipient country are given by

$$c_i^j = y_i^j - T_i^j, \quad \forall i = 1, 2 \text{ \& } j = e, p. \quad (5.2)$$

The government budget constraints in the recipient country are

$$T_1^e + T_1^p + t_1 - k^r - s^r = 0. \quad (5.3)$$

$$T_2^e + T_2^p + t_2 + f(k) + s^r = 0 \quad (5.4)$$

where $k = k^r + k^d$. Suppose that the government in the recipient country maximizes the inter-temporal utility function

$$\max_{c_i^j, T_i^j, k^r, s^r} U(c_1^e) + U(c_2^e) + \mu[U(c_1^p) + U(c_2^p)] \quad (5.5)$$

where $\mu > 0$ is the parameter which determines the relative weight the government in the recipient country puts on the welfare of the poor, subject

to the budget constraints (5.2-5.4) and the strategies of the donor country discussed below.

Suppose that the donor country cares about the welfare of the poor in the recipient country and its inter-temporal utility function continues to be given by (2.3) with c_i^r replaced by c_i^p for $i = 1, 2$. Rest of the structure of the problem remains as in section 2.

It is straightforward to show that the optimal strategies of the donor continue to be characterized by (2.10)-(2.13) with c_i^r replaced by c_i^p . Thus, the results stated in proposition 1 regarding the behavior of the donor continue to apply.

Assuming that the recipient government can achieve its optimal distribution of consumption between rich and poor using lump-sum tax/transfers and commits to its tax/transfer policies, the first-order condition of the government in the recipient country for the optimal choice of the distribution of consumption between the rich and the poor is given by

$$c_i^e : U_c(c_i^e) = \mu U_c(c_i^p) \quad \forall i = 1, 2. \quad (5.6)$$

(5.6) equates the marginal cost and the marginal benefit of the redistribution of consumption between the rich and the poor inhabitants as perceived by the government. The recipient government chooses the levels of consumption such that the redistribution of consumption between the rich and poor does not make the government better-off.¹⁴

¹⁴By assuming that the recipient government commits to its tax/transfer policies, we are ruling out strategic use of tax/transfer policies by the recipient government to increase aid from the donor. In case, the recipient government uses tax/transfer policies strategically, the first order conditions for the optimal choice of the distribution of consumption is given by

$$c_1^e : U_c(c_1^e) = \mu U_c(c_1^p) \left[1 - \frac{dt_1}{dc_1^e}\right] \& \quad (5.7)$$

$$c_2^e : U_c(c_2^e) = \mu U_c(c_2^p) \left[1 - \frac{dt_2}{dc_2^e} - f_k(k) \frac{dk^d}{dc_2^e}\right]. \quad (5.8)$$

As the donor cares about the utility of the poor, it is straight-forward to show that $\frac{dt_1}{dc_1^e}, \frac{dt_2}{dc_2^e} \& \frac{dk^d}{dc_2^e} > 0$. Aid will incentivize the recipient government to reduce the consumption of poor relative to the rich. The first-order conditions for s^r and k^r will continue to be given by (2.19)-(2.20) with c_i^r replaced by c_i^p for $i = 1, 2$. Pedersen (2001) analyzes the case in which the the recipient government uses tax/transfer strategically to elicit more (budgetary) aid from the donor.

The optimal choices taxes/transfers, $T_i^j \forall i = 1, 2 \text{ \& } j = e, p$, are given by (5.2). The first-order conditions for s^r and k^r continue to be given by (2.19)-(2.20) with c_i^r replaced by c_i^p for $i = 1, 2$. Thus, the results stated in proposition 2 regarding the optimal choice of k^r continue to apply. Since the introduction of heterogeneity among the inhabitants of the recipient country and tax/transfer scheme does not change the optimal strategies of the recipient government regarding financial saving and capital investment or the donor government's optimal strategies regarding budgetary transfers and capital transfers, the analysis and policy implications remain the same as discussed in sections 2 and 3.

6 Conclusion

This paper developed a two-period and two-country model in which an altruistic donor country faces Samaritan's Dilemma to address three important policy questions. Firstly, whether foreign aid can lead to efficient level of capital investment in the recipient country. Secondly, whether the form of aid transfer (e.g. budgetary transfer, direct financing of capital investment) and its timing matter for the efficiency of the capital investment. Thirdly, what instruments can be used to mitigate the problems of dynamic inconsistency?

The paper finds that the capital transfer makes financial savings more attractive relative to the capital investment for the recipient. The result is that when the capital investment is at the efficient level, the capital transfer completely crowds out the recipient's own capital investment. In the case of capital transfer, the recipient contribution to the capital investment is strictly positive, only when the total capital investment is inefficiently low.

The analysis has a number of policy implications. It suggests that when the donor faces time-inconsistency problem, the capital transfer can be highly distortionary. In such a situation, the general budgetary support can be a superior instrument of disbursing aid compared to the capital financing. These results do not depend on whether the goals of the donor and the recipient are aligned or domestic and foreign capital are equally productive. The analysis also shows that by using multi-period budgetary transfers rather than the capital transfer, the donor can achieve not only the efficient level of capital investment, but also the same allocation when it can commit to its transfer policy.

The analysis suggests that by tying its hand in the sense of forgoing capital

transfer, the donor can give aid more efficiently. Adopting such a rule would, of course, require commitment or the institutional arrangement on the part of the donor. However, such a rule just restricts the types of instruments which the donor can use. The donor is free to respond to the choices of the recipient. Such a rule does not pre-commit the donor to the level of aid, regardless of the choices of the recipient. Nor does it impose any conditionality on the recipient. Assuming that such institutional commitment is possible or in this particular case the donor can strategically limit its freedom of action is common in the literature dealing with the time-inconsistency problem (e.g. Kydland and Prescott 1977, Svensson 2000, 2003, Torsvik 2005, Hagen 2006, Kumar 2015).

Appendix

Proof of Proposition 1:

Suppose that $t_2 > 0$, then (2.10) and (2.13) imply that

$$V_c(c_1^d) = \lambda V_c(c_2^r). \quad (A1)$$

Now suppose that $k^d = 0$, then for any $0 < k^r < k^*$, the LHS of (2.11) will be less than the RHS of (2.11) as $f_k(k^r) > 1$. Thus, the donor can be better-off by making capital transfer and thus the optimal $k^d > 0$. In addition, (A1) and (2.11) imply that for any $0 < k^r < k^*$, the donor will choose k^d such that $f_k(k) = 1$. This proves proposition 1 (i).

Now suppose that $t_2 = 0$. Then (2.10) and (2.13) imply that

$$V_c(c_1^d) \geq \lambda V_c(c_2^r). \quad (A2)$$

Then when $k^d > 0$, A2 and (2.11) imply that it must be the case that

$$f_k(k) \geq 1. \quad (A3)$$

The proposition 1 (ii) follows from A3.

Proof of Proposition 2:

First, suppose that s^r & $k^r > 0$. Then, (2.16), (2.19) and (2.20) imply that

$$\left[f_k(k) \frac{dk^d}{ds^r} + \frac{dt_2}{ds^r} + 1 \right] = \left[f_k(k) \left(1 + \frac{dk^d}{dk^r} \right) + \frac{dt_2}{dk^r} \right]. \quad (A4)$$

Since the marginal cost of financial savings and capital investment is same, at the optimum the marginal benefits from both must be the same.

From (A4) it follows that $f_k(k) = 1$ only if $\frac{dk^d}{ds^r} = \frac{dk^d}{dk^r}$ and $\frac{dt_2}{ds^r} = \frac{dt_2}{dk^r}$. (2.17) and (2.18) imply that $|\frac{dt_2}{dk^r}| = |\frac{dt_2}{ds^r}|$ if $f_k(k) = 1$. However, as discussed earlier, (2.14) and (2.15) imply that $|\frac{dk^d}{ds^r}| < |\frac{dk^d}{dk^r}|$ i.e. one unit increase in the recipient's capital investment has a larger negative effect on the capital transfer from the donor than a unit increase in the recipient's financial savings. Thus, at $f_k(k) = 1$ the marginal benefit from financial savings (the LHS of A4) is greater than the marginal benefit from capital investment (the RHS of A4). Thus, the reallocation of resources towards financial savings away from capital investment makes the recipient better-off. Therefore, the

recipient chooses k^r such that $f_k(k) > 1$ for any $0 < k^d < k^*$. This is true regardless of whether the recipient receives budgetary transfers or not.

In the case, $s^r = 0$ and $k^r > 0$, (2.16), (2.19) and (2.20) imply that

$$\left[f_k(k) \left(1 + \frac{dk^d}{dk^r} \right) + \frac{dt_2}{dk^r} \right] \geq \left[f_k(k) \frac{dk^d}{ds^r} + \frac{dt_2}{ds^r} + 1 \right]. \quad (A5)$$

The marginal benefit from capital investment is higher than the marginal benefit from financial savings. However, (2.14), (2.15), (2.17), and (2.18) imply that in order for (A5) to hold, it must be the case that the recipient chooses k^r such that $f_k(k) > 1$.

The above analysis shows that it is always optimal for the recipient to choose k^r such that $f_k(k) > 1$ for any $0 < k^d < k^*$. Suppose now that $k^d \geq k^*$. In this case, $f_k(k) \leq 1$ for any $k^r \geq 0$. Now if $k^r > 0$, then either (A4) or (A5) must hold. But then it implies that $f_k(k) > 1$, which is a contradiction. The only possibility then is that the recipient sets $k^r = 0$.

Allocations under discretionary transfer policies in the absence of capital transfer

When t_1 & $t_2 > 0$, Lemma 1 implies that $c_1^r = c_2^r$ and the marginal utilities of consumption for both periods for the recipient are equalized. Also from (2.16) and (2.18) it follows that $\frac{dt_1}{ds^r} = \left| \frac{dt_2}{ds^r} \right|$. Similarly, given that $c_1^d = c_2^d$, (2.16) and (2.17) imply that $\frac{dt_1}{dk^r} = \left| \frac{dt_2}{dk^r} \right|$ for $f_k(k) = 1$. The donor chooses t_1 and t_2 in such a way that the positive incentive effect of t_1 on the recipient's capital investment and financial savings exactly offsets the negative incentive effect of t_2 .

Since $\lim_{k \rightarrow 0} f_k(k) = \infty$ and $\frac{dt_1}{ds^r} = \left| \frac{dt_2}{ds^r} \right|$ and $\frac{dt_1}{dk^r} = \left| \frac{dt_2}{dk^r} \right|$ for $f_k(k) = 1$, (2.19) and (2.20) imply that there is an equilibrium such that the financial savings by the recipient is strictly positive, $s^r > 0$, and the capital investment is at the efficient level

$$f_k(k^r) = 1. \quad (A6)$$

From (2.4-2.7), Lemma 1, (2.19), (2.20) and (A6), it follows that

$$c_1^r = c_2^r = \frac{1}{2}[y_1^r + y_2^r + t_1 + t_2 + f(k^*) - k^*]; \quad (A7)$$

$$k^r = k^* \text{ \& } \quad (A8)$$

$$c_1^d = c_2^d = \frac{1}{2}[y_1^d + y_2^d - t_1 - t_2]; \quad (A9)$$

where the optimal choices of t_1 and t_2 satisfy (2.12) and (2.13) respectively.

Proof of Proposition 5:

The first order condition for the optimal choice of k^d modifies to

$$V_{k_d}^d \equiv V_c(c_1^d) - \delta \lambda V_c(c_2^d) f_k(k) \geq 0; \quad k^d \geq 0 \text{ \& } k^d V_{k_d}^d = 0. \quad (A10)$$

Denote the level of effective capital satisfying the condition that $f_k(k) = \frac{1}{\delta}$ by \tilde{k} . Note that for $\delta \leq 1$, $\tilde{k} \leq k^*$ and for $\delta > 1$, $\tilde{k} = k^{**}$. Also, (2.13) and (A10) imply that if $t_2 > 0$ then $k^d > 0$ for any $0 < k^r < \tilde{k}$.

Further using (2.10), (2.13), and (A10), it is straight-forward to show that for any $0 \leq k^r < \tilde{k}$ when $t_2 > 0$ the donor will choose k^d such that

$$f_k(\tilde{k}) = \frac{1}{\delta}. \quad (A11)$$

(A11) equates the marginal return to the donor from the capital transfer, $\delta f_k(\tilde{k})$, to the marginal return from the second period budgetary transfer, 1. On the other hand, if $t_2 = 0$,

$$f_k(k) > \frac{1}{\delta}. \quad (A12)$$

In addition, for any $k^r \geq \tilde{k}$, the donor will choose $k^d = 0$.

If $\delta < 1$, (A11) and (A12) imply that for any $0 \leq k^r < \tilde{k}$, the donor will choose k^d such that there will be under-investment of capital relative to the efficient level, k^* . On the other hand, if $\delta > 1$ and $t_2 > 0$, the donor will choose k^d such that there will be efficient level of capital investment, k^{**} , for any $0 \leq k^r < \tilde{k}$.¹⁵

Turning to the recipient's optimal choices, the first order conditions of the recipient are given by:

¹⁵If $\delta < 1$, (A10) also implies that the donor is less likely to use capital transfer. On the other hand, if $\delta > 1$, the donor is more likely to use capital transfer.

$$U_{s^r}^r \equiv U_c(c_1^r)(1 - \frac{dt_1}{ds^r}) - U_c(c_2^r) \left[\delta f_k(k) \frac{dk^d}{ds^r} + \frac{dt_2}{ds^r} + 1 \right] \geq 0; s^r \geq 0; \& s^r U_{s^r}^r = 0 \& \quad (A13)$$

$$U_{k^r}^r \equiv U_c(c_1^r)(1 - \frac{dt_1}{dk^r}) - U_c(c_2^r) \left[f_k(k)(1 + \delta \frac{dk^d}{dk^r}) + \frac{dt_2}{dk^r} \right] \geq 0; k^r \geq 0 \& k^r U_{k^r}^r = 0. \quad (A14)$$

Suppose now that $t_2 \& k^d > 0$. Using (A13) and (A14), it is straightforward to show that $k^r = 0$ as $\frac{dk^d}{ds^r} \& \frac{dk^d}{dk^r} < 0$, $|\frac{dk^d}{dk^r}| > |\frac{dk^d}{ds^r}|$ and $|\frac{dk^d}{dk^r}| > |\frac{dt_2}{dk^r}|$.¹⁶

¹⁶The expressions for $\frac{dk^d}{dk^r}$ & $\frac{dk^d}{ds^r}$ are slightly different than in (2.14) and (2.15), but the qualitative properties remain the same.

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