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INTERNATIONAL CREDIT AND WELFARE
Some Paradoxical Results with Implications for the Organization of International Lending

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Abstract

This paper models a developing nation that faces a foreign exchange shortage and hence its demand for foreign goods is limited both by its income and its foreign exchange balance. Availability of international credit relaxes the second constraint. It is shown that in this setting the availability of international credit at concessionary rates can leave the borrowing nation worse off than if it had to borrow money at higher market rates. This 'paradox of benevolence' is then used to motivate a discussion of policies pertaining to international lending and the Southern government's method of rationing out foreign exchange to the importers.

Keywords : International credit, foreign exchange, foreign aid.

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1. Introduction

There is a small literature that argues that the benefits of international credit do not accrue to the recipient developing country, ending up, instead, benefiting the donors or in the coffers of large corporations that sell goods to the developing country.[1] The aim of this paper is to subject this claim to careful theoretical scrutiny. What we find is that, while there is no reason to believe that this hypothesis is always or even generally true, there do exist parametric configurations under which it is valid. This is interesting enough because of its paradoxical nature. At first sight it seems that the availability of credit (or, more generally, availability of credit at better terms) cannot make the recipient nation worse off because the recipient has the option not to take the credit or to pay a higher interest than what the donors demand (by, for instance, burning money). However, such simple logic runs into difficulty in the domain of strategic international finance.

We construct a formal model and show that when a nation buys goods from large corporations with monopolistic power, the availability of cheaper international credit may actually leave the recipient worse off. In particular, a poor developing country that is currently borrowing money from a profit-maximizing international bank or financial institution may become worse off if some ‘benevolent’ organization steps in, in place of the profit-maximizing bank, and begins to lend hard currency at a zero or subsidized interest rate.

[1] For works that either defend this proposition or debate it, see Winkler (1929), Hyson and Strout (1968), Bhagwati (1970), Gwyne (1983), Taylor (1985), Darity and Horn (1988), Basu (1991), and Deshpande (1999).

The reason, roughly speaking, is that the lowered interest rate for borrowing foreign exchange changes the strategic environment in which the developing country buys goods from large corporations in such a manner that the benefits of the lower interest rate, and more, flow out of the country.

Our model has important implications for the organization of international lending by multilateral organizations, such as the World Bank and, more pertinently, the IMF, that give subsidized credit. The model in this paper alerts such lending agencies that there are situations where the benefits of cheap money may flow out entirely (and then some more) from the recipient nation. In such environments a lowered interest is no longer the best way to give relief to nations facing foreign exchange shortages. Hence, this paper, by making international lending organizations aware of this risk of an adverse effect of international credit, urges them to be extra careful in designing their international lending programs.

The model also highlights the crucial role of the *mechanism* through which the limited foreign exchange is released to the importers in the borrower country by the borrower government (or the Central Bank). The allocation rules followed by the government can make a crucial difference in determining what effect international credit or aid has on the well-being of the recipient nation. Hence the model, despite its use of a rather stylized framework, depicts theoretically the general idea explored empirically by Burnside and Dollar (2000) on how the nature of governance in the borrowing nation can critically determine whether aid (or subsidized international lending) will work to its advantage or not.[2]

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[2] See also Collier (1997) and Hansen and Tarp (2001).

In constructing our model we try to steer a path between using strong assumptions in order to keep the algebra tractable and building in enough features of reality so as to make our model relevant to at least some particular realities.

Before proceeding to build the model we should warn that the purpose of a theoretical model is to show that certain phenomena are possible. In this paper we show this for the 'paradox of benevolence'. To determine how plausible this *theoretically* possible phenomenon is in reality, we need empirical work. In that sense what this paper tries to establish is the need for empirical work in a certain direction.

2. The Model

In this model there is a developing country – henceforth *South*, and an industrialized country – henceforth *North.* These countries have their own currencies but for all inter-country trade and exchange the only acceptable currency is the North's currency. This is the 'hard' currency. We shall refer to the South's currency as the 'soft' currency. The South, in our model, has a shortage of 'hard currency'. This is so in the sense that if it could buy more hard currency at the going exchange rate it would do so and use it to buy more foreign goods. The fact of a country facing a shortage of hard currency suggests some rigidity in the exchange rate. For reasons of simplicity we treat the exchange rate as fixed and, without loss of generality, we treat it as fixed at 1. That is, one unit of the hard currency changes for one unit of the soft currency. This is not as strong an assumption as appears at first sight. The fact that many Third World nations *do* face a shortage of hard currency, suggests that exchange rates are at least partially rigid in reality. We suspect that there are innate factors in the structure of international economic relations which cause this. How else can one explain why, even after developing country governments go for a free float and allow the exchange rate to be market driven, shortages of hard currency persist.

The stronger assumption in this paper concerns the modeling of the developing country government. We treat the government not as a strategic agent, nimbly maximizing some payoff, but as a somewhat mechanical bureaucracy which has some rigid rules, to which it adheres. In particular, we model m ($\geq$2) licensed importers in the South, to which the government (or the Central Bank) allocates its limited foreign exchange balance; and they are given the right to buy goods abroad and sell them in the South. One reason why we treat the government as not a strategic agent is for simplicity; the model has a surfeit of strategic agents. However, we also believe that this description is fairly realistic in the case of many developing and transition economies.

We shall in this paper focus on one good, which the South likes to consume but it does not produce. The good is in fact produced by a firm based in the North, which sells the good (may be in the North but also) in the South through the licensed importers. The Northern firm produces the good at a constant marginal cost c, faces no fixed cost, and chooses the price p at which it sells to the South. Though in our formal model we work with one such firm, our qualitative results would be unchanged under n oligopolistic firms.

On the demand side we assume, without loss of generality, that the South has one consumer, who is a price taker. If the consumer has free access to the hard currency at the going exchange rate, which is 1, then the consumer's inverse demand function for the good sold by the North is given by:

$$p = a - bx, \tag{1}$$

where a > c, b > 0, p is the price of the product and x the amount demanded. This will be called the *unconstrained demand curve.* Without a shortage in hard currency and in the absence of licensed importers (that is, assuming that the consumers buy directly from the Northern producers), standard monopoly analysis shows the equilibrium price and quantity to be:

$$p^* = \frac{a+c}{2}, \text{ and } x^* = \frac{a-c}{2b}.$$

This point is illustrated in Figure 1 by the point E^*.

We assume that the Southern government has only R (> 0) units of foreign exchange reserves; and this is 'insufficient' for what the South wants to import. In other words, we assume that the following condition holds:

Assumption 1: $0 < R < \dfrac{a^2 - c^2}{4b}$.

This assumption says that point E* in Figure 1 is not feasible due to the shortage of hard currency in the South. In other words, the shortage of hard currency is such that the Northern firm cannot fully capture the monopoly rent associated with the unconstrained demand curve.

It is being assumed here that, what the South suffers from is not a problem of insolvency but illiquidity. In other words, it expects to have adequate access to foreign exchange in the future. The simplest way to make this formal is to suppose that the South's currency becomes convertible in the future. So in the future its demand is not constrained by its foreign exchange reserves. We will assume that this foreign-exchange constrained position lasts for one period (which can of course be very long) and it is this one period that our model studies.

So the Southern government has a reserve of R units of hard currency. How does the government use this? We will assume that the government sets a quota for each of the $m\,(\geq 2)$ importers. That is, each importer is given the right to acquire foreign exchange up to this quota limit by giving up an equivalent amount of soft currency. With this foreign exchange the importers use the hard currency to buy goods from the North which they then sell to the Southern consumers. While a slew of different methods for rationing out limited foreign exchange have been used by different developing countries and transition economies, the structure that we are using is not unrealistic, and, in the case of, for instance, Pakistan and India, especially through the seventies and eighties, fits reality quite well.[3] We shall, for simplicity, assume that all importers are treated identically, and so each importer has access to R/m units of the hard currency. It will be assumed that the importers take the international price of the product as given and constitute a Bertrand oligopoly in the domestic market.

It will be shown later (in Section 4) that, for the purpose of our analysis, such a model works the same way as a model in which the Southern government gives consumers direct access to a fixed amount of foreign exchange. Though this is unrealistic, its mathematical equivalence to the above more realistic specification (to be demonstrated formally later in Section 4) implies that we can develop our model by

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[3] Writing in the very early nineties on Pakistan, Baysan (1992, p. 468) observed, "Distinct from import bans and restrictions, value limits on individual licenses against cash for imports of machinery and

assuming that the Southern government gives its citizens direct access to a certain amount of foreign exchange in order to buy foreign goods. That is the route that we take here.

Given this, we suppose that the Southern government announces that the consumer can acquire up to R units of hard currency. In other words, the amount of foreign good, x, that the consumer buys must satisfy

$$x \leq R/p \tag{2}$$

Keeping in mind that (1) implies that the demand function (with no foreign exchange constraint) is given by x = (a-p)/b, and combining this with (2) we see that the *actual* demand function of the South is given by:

$$x = \min\left\{\frac{a-p}{b}, \frac{R}{p}\right\} \tag{3}$$

This is demonstrated by the thick line in Figure 1.

[Figure 1 somewhere here]

We now incorporate international lending into our model; we will consider the following two cases:

Case I: There is a non-profit 'international organization' that lends hard currency credit to the South at a subsidized interest rate.

Case II: There is a profit-maximizing international bank (based in the North) that gives credit to the South.

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millwork have been (and still are being) maintained … . These ceilings … function as nontariff barriers …

We shall, throughout, assume, without loss of generality, that the interest rate prevailing in the North is zero. The Southern consumer and government do not have direct access to the Northern credit market, but the international organization and the Northern bank have access to it. So to these latter agents the opportunity (interest) cost of lending money to the South is zero. It will also be assumed throughout that the borrowing country never defaults. Though default (or the threat of default) is important in reality and there is a substantial literature that investigates this (for surveys see Sachs, 1984; Kletzer, 1988; and Eaton and Fernandez, 1995), to introduce default would be a distraction, given present focus.

The analysis of Case I is straightforward. Let us suppose that the international organization lends to the South at the opportunity cost interest, that is, an interest rate of zero. Once South has access to such credit, the foreign exchange constraint of R becomes immaterial. South's demand for the product is given by equation (1) and the equilibrium price and quantity are given by p^* and x^*, which are represented by point E^* in Figure 1.

Case II is the interesting case, and what we go on to show, later, is that the Southern country may be better off in this case than under Case I. But first we need to depict the equilibrium that will arise in Case II.

Since the central issue in the analysis of Case II is the strategic interaction between the firm and the bank, we derive the reaction functions (more precisely '*implicit* reaction functions') of the firm and the bank and then characterize Nash equilibria. Let

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and serve as a nonprice rationing mechanism for the allocation of foreign exchange."

us start with the firm. Consider first the case where R = 0, that is, for whatever the South buys from the North it has to first borrow money from the bank.

[Figure 2 somewhere here]

In Figure 2, aF is the South's unconstrained demand curve (given by equation (1)). Suppose the bank charges an interest rate of i. Then if the firm charges a price of p, the effective price to the Southern consumer is (1 + i)p. Hence the effective demand curve is given by the line a'F where Oa = (1 + i)Oa'. Standard monopoly analysis implies that the firm's best response is to choose a price that is represented by the midpoint of line segment a'H', shown by point E'. By considering different interest rates, i, and plotting the mid-point that represents the firm's best response for each i, we obtain the firm's best response curve. This is represented by the broken line E*E'C. We call it the firm's 'implicit reaction function.'[4] The reader should also check that, if c were 0, the firm's implicit reaction function would be a vertical line from E* down to the horizontal axis. The reason why we call this an 'implicit' reaction function is because, unlike in a conventional reaction function where the two variables chosen by the two players are represented on the two axis, here the interest rate i, chosen by the bank, is not represented on any axis, but is implicit in the effective demand curve.

[Figure 3 somewhere here]

Now let us bring in the fact that R > 0, as shown in Figure 3. If the interest rate, i, charged by the bank is such that the effective demand curve is a'F, then the actual demand curve (the one which takes into account the fact that up to R units, the South does not *need* to borrow money) is given by the thick line, going through points B and D.

The firm’s implicit reaction function is E*K’ and point B, where E*K is a truncated segment of the E*E'C curve in Figure 2. To see this, gradually increase the value of i, starting from i = 0. The firm’s best response is represented by point E* when i=0, and by point E’ (see Figure 2) when i is positive but sufficiently small. Then, as i rises E’ moves in the southwest direction. But before E’ reaches point K (in Figure 3), the firm’s best response point will jump to point B. Let us denote by K’ the point where the jump occurs. To see that this will happen, suppose that i is such that the line, a’F, passes through point K in Figure 3. Clearly, the firm is strictly better off by choosing the price that corresponds to point B rather than point K; since at both prices revenue is the same and the total cost is smaller at point B. Hence, there exists point K’, where the firm is indifferent between choosing point K’ and point B.

Now we turn to the bank’s reaction function. First suppose that the firm has fixed a price, p, such that $\frac{R}{p} \geq \frac{a-p}{b}$ holds. In this case, the South does not borrow hard currency because the consumer’s demand given by the unconstrained demand curve (i.e., p = a-bx) is feasible without borrowing any hard currency. Then, any value of i is the bank’s best response, because the bank cannot make any profits from lending to the South for all $i \geq 0$.

Next suppose that the firm has fixed a price, p, such that $\frac{R}{p} < \frac{a-p}{b}$ holds. This condition means that, under the price, the consumer’s demand given by the unconstrained demand curve is not feasible without borrowing hard currency because the Southern

[4] The mathematical properties of the implicit reaction function are spelled out in Anant, Basu and Mukherji (1995).

government has only R (> 0) units of hard currency. Graphically, the price is strictly between the prices represented by point B and D in Figure 3. Given such price, the bank can make a profit from lending hard currency to the South, which is given by

$$\pi_B(i) \equiv i\left\{p\left[\frac{a - p(1+i)}{b}\right] - R\right\}.$$

[Figure 4 somewhere here]

Graphically, the bank's profit is represented by area QRST in Figure 4, where the firm has fixed a price at p=p' and the bank has chosen i represented by a'F. Given p', the bank chooses i so that the area QRST is maximized. The maximization implies that the bank chooses i such that point R in Figure 4 becomes the midpoint of QZ. Then, for any given p', the bank's best response is to choose i such that corresponding a'F line goes through the midpoint of QZ. Plotting such midpoints for different values of p', we obtain the broken line in Figure 5. We call it the bank's 'implicit reaction function.'

[Figure 5 somewhere here]

We are now ready to identify Nash equilibria. Superimpose the firm's implicit reaction function (E*K' in Figure 3) here. A Nash equilibrium is then depicted by the point of intersection of the two reaction functions, shown here by point N, where the equilibrium price is given by $\hat{p}$ and the interest rate is the one implicit in the effective demand curve $\hat{a}F$. This is an equilibrium in which a positive amount is borrowed. We call this the N-equilibrium. Note that the N-equilibrium does not always exist because the broken line does not necessarily intersect with E*K'. Note also that there exists another Nash equilibrium, where the firm chooses the price that corresponds to point B and the bank chooses a very high interest rate. This is an equilibrium in which no lending occurs.

3. The Paradox of Benevolence

We now demonstrate that the paradox of benevolence can happen in the N-equilibrium. The aggregate welfare earned by the South in the N-equilibrium is shown in Figure 6 as the area STQ$\hat{p}$a.

[Figure 6 somewhere here]

Let us call this, in brief, W^{π}, where the π is a reminder that this is the welfare of the South when the lender of credit is a profit-maximizer. Let us denote South's aggregate welfare when the Northern lender is benevolent (and charges no interest) by W^{b}, where b is for benevolence. Our claim is that there are parameters of the model where

$$W^{b} < W^{\pi}.$$

We will say that the 'paradox of benevolence' occurs if this inequality is true.

To prove this we need to first depict W^b. Recall that when the South can freely borrow from a benevolent lender (Case I, above) equilibrium occurs at point E^{*} and the price of the Northern good is given by p^{*}. Hence W^b is the area of $aE^{*}p^{*}$. By examining Figure 6 it is clear that *a priori* we cannot say which is larger W^b or W^{π}.

Now, we are able to state the central result of the paper.

Proposition (The Paradox of Benevolence): For any parameter values that satisfy Assumption 1, there exists a value $\tilde{c}$ (>0) such that, holding all parameter values except c fixed, the model exhibits the following property for all $c \in [0, \tilde{c}]$:

The N-equilibrium exists and the paradox of benevolence occurs in that equilibrium.

[Proof] See Appendix.

To understand the result graphically, consider the case where the marginal cost of producing the good, c, is zero. As we have already seen, when this happens, the firm's implicit reaction function is a vertical line from E^*. Hence, the N-equilibrium point, N, is vertically below E^* (see Figure 5). In that case the area depicting W^b sits properly inside the area depicting W^{π}, which implies that we have $W^b < W^{\pi}$ when c=0. Continuity of the demand function implies that $W^b < W^{\pi}$ holds for all small enough c (>0).

Just as the proposition establishes the kinds of value of the cost of production that is likely to give rise to the paradox of benevolence, it is interesting to inquire into what levels of foreign exchange reserves are likely to give rise to the paradox. It is easy to verify that the paradox cannot arise if R were equal to zero or it is very large (for instance, it is so large that the point E* is achievable with the existing foreign exchange balance). This suggests that the paradox may be more likely to arise for countries with 'intermediate' foreign exchange reserves. We conducted numerical simulations to compute the zones of paradox in the (R, c)-space, in particular, a space in which the horizontal axis represents R and the vertical axis represents c. For each value of R we have computed the maximum value of c, denoted c^{max}, such that the paradox occurs for all non-negative values of c less than c^{max}. The computation is made for the case where a = 10 and b = 0.4 or 0.5 and the results are displayed in Table 1.

The table tells that, for instance, with b = 0.4, we have c^{max} = 2.23, 6.06, or 3.00, when R = 10, 20, or 40, respectively. Namely, the Paradox of Benevolence occurs for all $c \in [0, 6.06]$ when a = 10, b = 0.4 and R = 20. Note that c < a (= 10 in these examples) must hold for the Northern firm to sell a positive amount of goods to the South. The numerical examples therefore seem to indicate that the Paradox of Benevolence occurs in non-trivial ranges of parameter values.

Table 1. Numerical examples for the Paradox of Benevolence

(The value of c^{max} when a = 10).

	b = 0.4	b = 0.5
R = 5	0.94	1.22
R = 10	2.23	3.22
R = 15	7.00	6.29
R = 20	6.06	5.16
R = 25	5.16	4.16
R = 30	4.35	3.31
R = 35	3.63	2.57
R = 40	3.00	1.91
R = 45	2.44	1.23
R = 50	1.91	-
R = 55	1.37	-
R = 60	0.73	-
R = 65	-	-

It is interesting to note the table exhibits an "inverted-U" shape in the (R, c)-space. That is, holding other parameter values fixed, the value of c^{max} is increasing in R when the value of R is relatively small, and it is decreasing in R when the value of R is relatively large. Although we have worked out a number of examples and identified this property in all of them, we have been unable to prove that this is the general property.

4. Competition Among Licensed Importers

In Section 2 we began with the realistic assumption that, in the South, the government gives some designated importers the right to acquire hard currency from the central bank in order to import goods for domestic sale. We then pointed out that, if these importers took the international price, p, of the good and the interest rate, i, as given, and chose the domestic sale price (that is, they played a Bertrand game), we could ignore these importers for the purpose of our analysis. Given this, we derived our result under the assumption that government allocated foreign exchange directly to the consumers rather than to the designated importers. In this section we show that we can indeed ignore the importers in order to derive out results.

As before, the Southern demand for the Northern good is given by:

$$x = \frac{a - r}{b},$$

where r is the price that the consumers have to pay. There are now m identical importers. They can buy the good (subject to having the requisite foreign exchange) from a Northern producer at a price, p, chosen by the Northern producer. It is assumed that the Southern importers take this price as given. Each of these importers is given access to R/m units of foreign exchange by the Southern government. If they want more foreign exchange they have to borrow this from a Northern bank at an interest rate of i. Hence, if an importer wants to buy x units of this good from the North it has to incur a total cost, TC(x), given by:

$$TC(x) = \begin{cases} px, \ if \ \ px \le \dfrac{R}{m}. \\ \dfrac{R}{m} + (1+i)\,p(x - \dfrac{R}{mp}), \ if \ \ px > \dfrac{R}{m} \end{cases} \tag{4}$$

Now, each of these m importers have to choose a price at which it offers to sell the product to the Southern consumers. If r_i denotes the price offered by importer i, then we may denote the strategy n-tuple of the m importers by

$$(r_1, \ldots., r_m)$$

The profit earned by importer i may then be denoted by $\pi_i(r_1, \ldots, r_m)$.

Our aim is to characterize the Nash equilibrium (Bertrand equilibrium in this case) of this game. We will in particular be interested in the symmetric Nash equilibrium. In other words, we define r^* to be an "equilibrium" if, for all $i = 1, \ldots, m$, $\pi_i(r^*, \ldots, r^*) \ge \pi_i(r^*, \ldots, r_i, \ldots, r^*)$, for all r_i.

Fortunately, to characterize such an equilibrium we do not need to fully characterize the π_i function. We will here make the following reasonable assumptions. If every importer charges the same price r, then each importer faces a demand of (a-r)/bm. If all importers, excepting importer i, charges r and importer i charges r_i ($\neq$ r), then the consumers respond as follows. If $r_i < r$, importer i faces a demand equal to $(a-r_i)/b$. All consumers who fail to buy from i, direct their demand at price r to the other importers. If $r_i > r$, all consumers go to the importers other than i. Only those with unmet demand turn to i. These are fairly normal assumptions and one can find a formal statement of these in Basu (1993).

Let us now suppose that the firm has fixed a price, p, such that $\frac{R}{p} < \frac{a-p}{b}$ holds. Also suppose that the bank has fixed an interest rate, i, such that $\frac{R}{p} < \frac{a-p(1+i)}{b}$ holds. This condition means that, if government allocated foreign exchange directly to the consumers, then the consumers' demand given by the unconstrained demand curve is not feasible without borrowing hard currency and so they borrow a positive amount of hard currency from the bank. Under such p and i, the horizontal summation of all importers' marginal cost functions (derived from (4)) is the thick line shown in Figure 7. It is easy to show that in this case $r^* = (1 + i)p$ is an equilibrium. That is, if each importer charges r^* then no one can do better by deviating. To see this note that when everybody charges (1+i)p, the profit earned by each importer is given by iR/mp. Clearly by undercutting this price, an importer can only do worse. If, on the other hand, an importer charges $r_i >$ (1+i)p, no one will buy from him. Hence, his profit will drop to zero.

The analysis in the previous paragraph indicates that, for any p and i that satisfy the conditions described above, the profits of the firm and the bank are identical with or without the designated importers. Also, consumers face the same marginal price and demand the same amount of the good in the two cases. A similar equivalence can be shown for other combinations of p and i. Since we focus on the welfare consequences of the strategic interaction between the firm and the bank, this equivalence allows us to ignore the importers in our analysis.

[Figure 7 somewhere here]

5. Policy Implications

The model and the results described in this paper have important policy implications. First, it cautions aid donor agencies not to presume that subsidized credit, given to a Third World nation, necessarily benefits the recipient. Depending on the structure of the import market, the advantages of subsidized credit may flow into the hands of corporations that sell goods to the recipient nations. In such a situation the donor agency has to think of ways, other than subsidized credit, for reaching benefit to nations. The classical literature on aid-tying used to be concerned with this question. What we have shown in this paper, however, is that the flow-back of benefit to the North can occur even when aid is not tied, but depending on the market structure of imports and the strategic position of the donor.

In trying to reach out to poor nations, most international organizations use the method of lowering interest rates. The IMF uses this method for the most highly indebted and poor nations, while at the same time combining the generous loan terms with 'conditionalities', which pertain to macroeconomic policies such as the need to keep the fiscal deficit under control and money supply growth in check. What our paper alerts us to is the fact that such policies may not be enough to plug the holes through which the benefits of cheap credit get frittered away. The 'market structure' of trade may be the main route through which the immiserization occurs, by causing all the benefits to flow out to the international firms that export goods to the South. Hence, before lending at concessional rates, it is worth examining and advising recipient governments on the channels and structure of trade and methods of releasing limited foreign exchange reserves. And this brings us to the subject of policy from the Southern point of view.

The model suggests (though we have not really gone into this) that there may be advantages to the South of giving the import rights to a single agent. This would empower the importers vis-à-vis the Northern manufacturer and may end up benefiting the Southern consumer. Secondly, the Southern government may stand to gain by being more pro-active in the foreign exchange market. Releasing the foreign exchange as quotas to different agents may not be a good idea.

Let us take up the first point first. In our model the Southern importers do poorly because they compete against one another both in the product market and the international credit market. If they could behave collusively, they could exercise market power. However, collusive behavior is difficult to sustain on its own – a point made persuasively in the context of international borrowing by governments by Fernandez and Glazer (1990). However, in our model since the borrowers are agencies within a nation, the government can enable them to exercise market power. The system of 'canalized' imports used by some nations, for instance, India, could have potentially played this role. In practice, canalized imports have been inefficient and bureaucratically cumbersome. Its potential has not been understood, let alone realized.

Let us now turn to the second subject of *how* to ration the limited foreign exchange reserve. The method analyzed in this paper – namely, one where the foreign exchange is rationed out to the importers – is not the only one. The government could (and they often do) place quantity restrictions on the amount each importer may import. The analysis of this is not trivial since, while each importer will of course take the quantity ration as given, the government should be modeled as choosing that quantity ration, given which the total import *value* equals the amount of foreign exchange the government has (or wants to release). There can be other more sophisticated kinds of rationing, for instance one in which the amount of foreign exchange released to an importer could depend on the terms of trade. Each such ration will change the market outcome and the total benefit generated to the South and may even avert the paradox of benevolence. In the future it will be worth examining formally the welfare effects of different systems of releasing limited foreign exchange and for the Southern government to choose a system consciously to maximize the welfare of its consumers.

Appendix

Proof of the Proposition:

We first analyze the firm's best response given i (≥0) chosen by the bank.

First consider i that satisfies (A1).

(A1) $$i \geq \frac{a^2 - 4bR}{4bR} .$$

Under (A1), the South does not borrow any hard currency for any p chosen by the Northern firm. To see this, note that (A1) is equivalent to ' $R \geq \frac{p[a-(1+i)p]}{b}$ holds for all p.' Given such i, the firm chooses p such that the South spends R units of hard currency to purchase the good; namely it chooses p such that p[(a-p)/b]=R holds. Hence, the firm's best response is given by (A2).

(A2) $$p = \frac{a + \sqrt{a^2 - 4bR}}{2} \equiv p^B .$$

Any (p, i) such that $p=p^B$ and $i \geq \frac{a^2 - 4bR}{4bR}$ is a Nash equilibrium. Graphically, in this Nash equilibrium the firm chooses the price that corresponds to point B in Figure 3 and the bank chooses high enough i so that a'F does not intersect the rectangular hyperbola twice. In this equilibrium (we call it B-equilibrium), the bank's profit is zero and the firm's profit is given by (A3).

(A3) $$\frac{(p^B - c)(a - p^B)}{b} \equiv \pi^B .$$

Next consider i that satisfies (A4).

(A4) $$i < \frac{a^2 - 4bR}{4bR} .$$

Consider the monopolist who faces the demand curve given by p=(a-bx)/(1+i). It charges the price given by (A5) and the quantity demanded is given by (A6).

(A5) $$p = \frac{a+(1+i)c}{2(1+i)} \equiv \tilde{p}$$

(A6) $$x = \frac{a-(1+i)c}{2b} \equiv \tilde{x}$$

Note that the Northern firm can earn π^B by choosing $p=p^B$ regardless the value of i chosen by the bank. Then, given i, the firm chooses $\tilde{p}$ if and only if $\tilde{\boldsymbol{p}} \equiv (\tilde{p} - c)\,\tilde{x} \geq \pi^B$.

Hence the Northern firm's reaction function is given by (A7).

(A7) $$p(i) = \begin{cases} \dfrac{a+(1+i)c}{2(1+i)} \equiv \tilde{p} & if\ \tilde{\boldsymbol{p}} \geq \boldsymbol{p}^B \\ \dfrac{a+\sqrt{a^2-4bR}}{2} \equiv p^B & otherwise \end{cases}$$

Next we analyze the bank's best response given that the firm chooses p that satisfies (A8).

(A8) $$p[(a-p)/b]>R$$

Given such price, the demand given by the unconstrained demand schedule (which is p=a-bx) is not feasible unless the bank sets i=0. The bank chooses i that maximizes its profit given by (A9).

(A9) $$\Pi(i) \equiv i\left\{ p\left[\frac{a-p(1+i)}{b}\right] - R \right\}$$

Note that, given (A8), the bank can choose i>0 such that $\Pi(i)>0$. The standard maximization exercise then implies that the bank's best response is given by (A10).

(A10) $$i(p) = \frac{pa - p^2 - bR}{2p^2}$$

Now we characterize a Nash equilibrium in which the bank lends a strictly positive amount of hard currency to the South. Insert (A10) into (A5), and we obtain

(A11) $f(p)\equiv 2p^3-cp^2-(2bR+ac)p+bcR=0.$

Note that $f(0)=bcR\geq 0$ and $f(c)=c^2(c-a)-bcR\leq 0$. This means that (A11) has exactly one root that is strictly greater than c. We denote the root by p*. If there exists a Nash equilibrium in which the bank lends a strictly positive amount of hard currency to the South, such equilibrium is characterized by (p, i) = (p*, i(p*)). This constitutes a Nash equilibrium of the game if and only if (p, i) = (p*, i(p*)) satisfies $\tilde{p}\geq\pi^B$ and (A8); or equivalently if (A12) and (A13) hold.

(A12) $$\frac{[a-(1+i(p^*))c]^2}{4b(1+i(p^*))}\geq R-\frac{c(a-\sqrt{a^2-4bR})}{2b}$$

(A13) $p^*[(a-p^*)/b]>R$

Note that p* is continuous in c, which implies that i(p*) is also continuous in c.

Let c=0. Then $f(p)=2p^3-2bRp$, and so $p^*=\sqrt{bR}$ and $i(p^*)=\dfrac{a\sqrt{bR}-2bR}{2bR}$. We find that, when c=0, (A12) is equivalent to $a\geq 2\sqrt{bR}$ and (A13) is equivalent to $a>2\sqrt{bR}$. Note that Assumption 1 implies $a>2\sqrt{bR}$ holds when c=0, and that both p* and i(p*) are continuous in c. This implies that there exists c* (>0) such that both (A12) and (A13) hold for all $c\in[0, c^*]$.

Next, we assume $c\in[0, c^*]$, and let W^π denote South's aggregate welfare in the Nash equilibrium represented by (p*, i(p*)). As stated in the text, the social welfare is represented by the area STQ$\hat{p}a$ in Figure 6, which is given by (A14).

(A14) $W^\pi=(1/2)[a-(1+i(p^*))p^*]x^*+i(p^*)R,$

where $x^* \equiv \dfrac{a-(1+i(p^*))p^*}{b}$. When c=0, we have (A15).

(A15) $$W^p = \frac{a^2}{8b} + \frac{\sqrt{bR}(a-2\sqrt{bR})}{2b} > W^b = \frac{a^2}{8b},$$

where strict inequality holds because a> $2\sqrt{bR}$ by Assumption 1. Note that p*, i(p*) and x* are all continuous in c. This implies that there exists c**>0 such that $W^{\pi}>W^{b}$ holds for all c∈ [0, c**]. Finally, let $\tilde{c}$ ≡Min [c*, c**], and we obtain the desired result. ÿ

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Figure 1

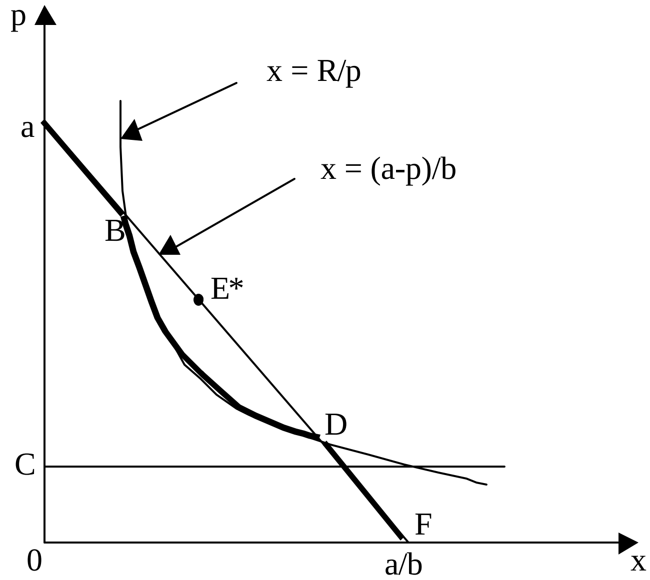


Figure 2

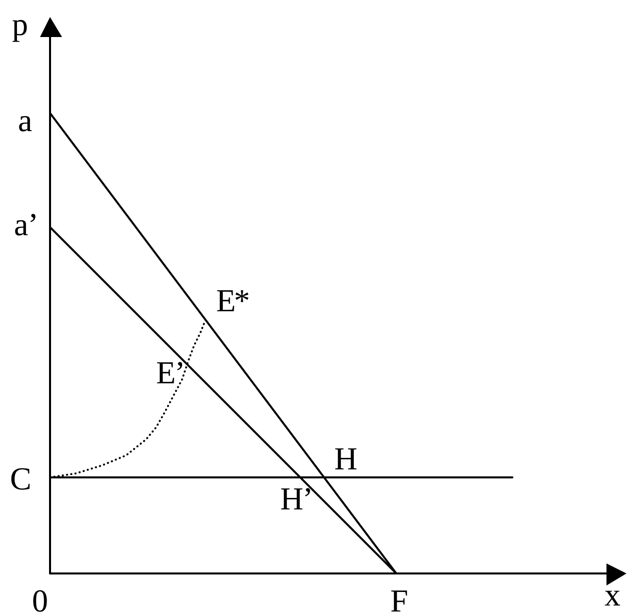


Figure 3

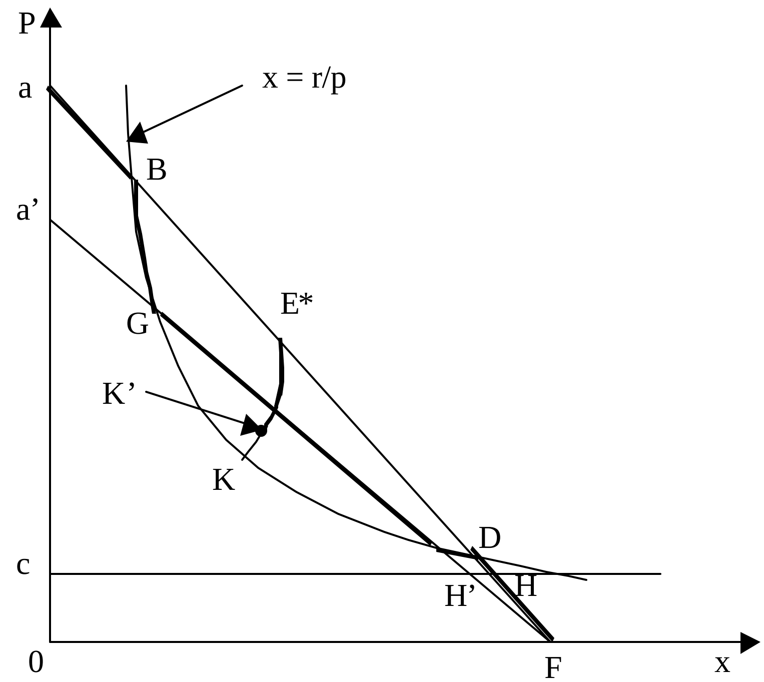
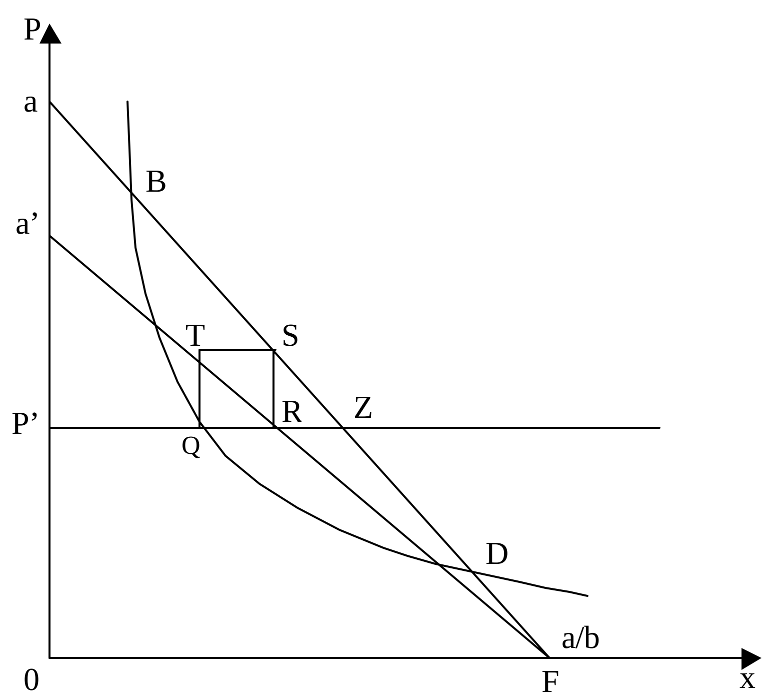


Figure 4



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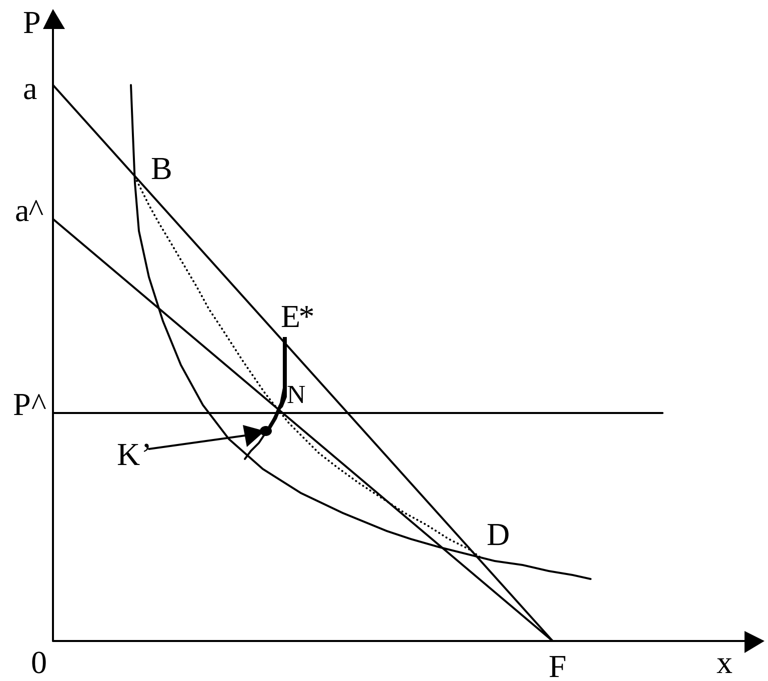

Figure 6

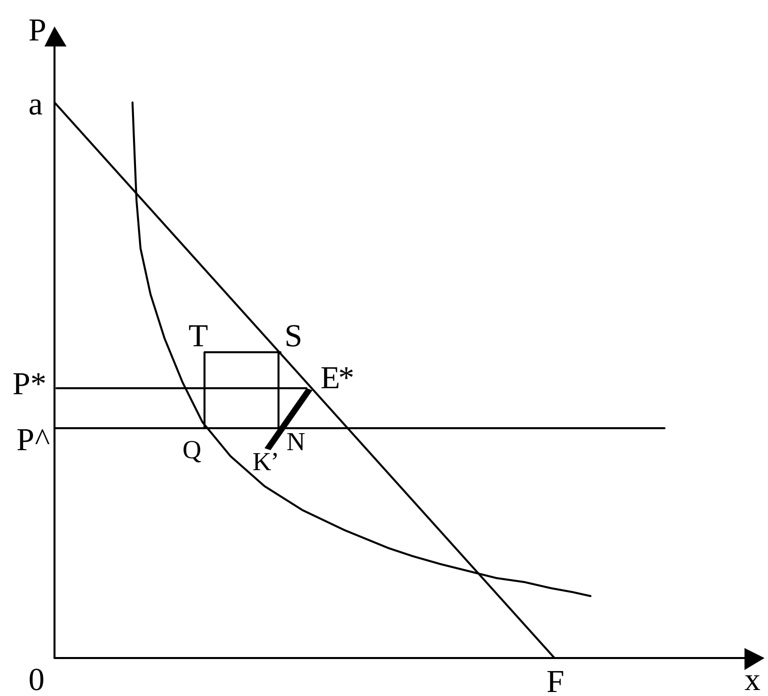

Figure 7