Aid Volatility and Dutch Disease:

Is There a Role for Macroeconomic Policies?

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Abstract

This paper studies how macroeconomic policies can respond to aid volatility and head off unintended consequences of foreign aid such as Dutch disease. First, we study the welfare implications of macroeconomic policies in a general equilibrium model where aid does not only support consumption but can also affect (positively or negatively) productivity growth through externalities. In this setting, monetary policy has permanent real effects. We find that the less productive aid is the more aggressive monetary and fiscal policies should be in containing the impact of aid on the trade balance. Conversely, if aid has large immediate consumption and productivity benefits but donors' disbursements are back-loaded, macroeconomic policies should be expansionary and allow the trade balance to deteriorate. Second, we present evidence consistent with the presence of Dutch disease effects of aid in certain conditions, and show that recipient countries can smooth aid-driven fluctuations of the trade balance and support export levels by adjusting the net domestic assets of the central bank—a variable that reflects both monetary and fiscal policy decisions.

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I. INTRODUCTION

At the G8 meeting in Scotland in July 2005, world leaders announced a $50 billion increase in official development assistance to poor countries. This surge in aid—aimed at achieving the Millennium Development Goals (MDGs)[2]—is focusing policymakers' and researchers' attention on the macroeconomic challenges associated with absorbing large aid inflows.[3]

Our paper contributes to this debate by studying how, if at all, macroeconomic policies should respond to foreign aid inflows. Specifically, we develop a model showing that in aid receiving countries monetary and fiscal policies can help achieve the optimal spending path, and have persistent effects on real variables in the presence of externalities. We also present empirical evidence consistent with the predictions of this model.

In a recent paper, Rajan and Subramanian (2005b) argue that systematic adverse effects of foreign aid on competitiveness of the recipient country's exports may explain the lack of any robust positive correlation between aid and growth.[4] The evidence supporting their argument is that the share of labor intensive and tradable industries in the manufacturing sector declines as foreign aid increases. This is consistent with a Dutch disease mechanism whereby real exchange rate overvaluation hurts export industries and overall productivity growth. A key question this evidence leaves us with is: are there any macroeconomic policies that could dampen the Dutch disease effects associated with large aid inflows?

There is also broad agreement that the volatility of foreign aid has high welfare costs. Bulir and Hamann (2002) document such volatility and Arellano et al. (2005) find that volatile aid flows result in substantial welfare losses.[5] This is in line with Pallage and Robe's (2003) estimate of a median welfare cost of business cycles in developing countries between

[2] Tripling ODA is viewed as a necessary step to achieve the Millennium Development Goals by 2015 (Heller and Gupta, 2002). The Millennium Development Goals (MDGs), which emerged from the September 2000 Millennium Declaration at the United Nations, are a set of measurable targets for halving world poverty between 1990 and 2015.

[3] See for instance Heller (2005) and International Monetary Fund (2005a).

[4] There is surprisingly little agreement about the impact of foreign aid on growth. An influential paper by Burnside and Dollar (2000) found that aid fosters growth in countries with good policies and institutions, but Easterly, Levine, and Roodman (2004), among others, have raised doubts on the robustness of their results. Two recent papers reach opposite conclusions. Clemens et al. (2004) find a large and positive effect of aid on growth after distinguishing between short-impact aid and long-impact aid. By contrast, Rajan and Subramanian (2005b) show that aid has not had a significant impact on growth even after controlling for a possible endogeneity bias.

[5] See also Prati and Tressel (2005).

10 and 30 times that of the United States. Other studies—including Ramey and Ramey (1995) and Aghion et al. (2004)—document the negative effect of volatility on long-term growth. This literature leaves open the question of whether macroeconomic policies could reduce the transmission of aid volatility to the trade balance, consumption, and growth.

To understand better how macroeconomic policies can help mitigate potential adverse effects of aid flows related to Dutch disease and aid volatility, we model a two sectors small open economy receiving an exogenously given flow of foreign aid that is either consumed or invested in productivity-enhancing public goods. As in standard Dutch disease models,[6] the source of growth is learning-by-doing (LBD) located in the export sector so that a temporary aid inflow can have long-term effects on growth and welfare by causing real appreciation and a reallocation of resources away from tradable sectors (see for instance Sachs and Warner (1995)). We add to this model a monetary sector under the assumption that the capital account is closed and government bonds are the only interest-bearing financial instruments in the economy. We show that, under these conditions, changes in the net domestic assets of the central bank—a variable that reflects both monetary and fiscal policy decisions[7]—affect real variables, by modifying relative prices. This implies that macroeconomic policies can target the trade balance or the real exchange rate even though prices of non-tradable goods are fully flexible.[8] Moreover, our model shows that, in the presence of externalities, even temporary monetary policy actions have permanent real effects.

We characterize the macroeconomic policy response that maximizes welfare for any distribution of a *given* net present value of aid over time. Specifically, we show that the authorities can undo some of the money supply expansion associated with foreign aid inflows by reducing net domestic assets, thereby preventing real appreciation, preserving the competitiveness of the tradable sector, and raising international reserves and national savings. This policy amounts to postponing spending of aid and it is welfare-improving only if the economy is better off saving part of the aid for later use. This is the case when aid flows that support domestic consumption are expected to drop in the future or the net effect of current aid on productivity growth is low (or negative) because of Dutch disease.

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[6] Models of Dutch disease include Van Wijnbergen (1984), Krugman (1987), Matsuyama (1992), Sachs and Warner (1995), Torvik (2001), and Gylfason et al. (1999).

[7] The central bank can control net domestic assets through sales or purchases of government bonds while the government can regulate its deposits at the central bank by modifying the fiscal balance (e.g., by spending larger or smaller fractions of the aid that donors disburse). On monetary policy implementation in low-income countries, see International Monetary Fund (2005b)

[8] We assume flexible prices of nontradable goods in view of the evidence—presented in Reinhart and Rogoff (2004)—that several aid-receiving African countries have experienced long and repeated periods of *deflation*. This is also consistent with the fact that informal sectors where prices are flexible typically represent a large share of aid receiving countries' GDP.

In our model, expansionary macroeconomic policies can improve welfare. This is the case when the optimal allocation requires bringing aid forward because the immediate consumption and productivity benefits of aid are large but donors' disbursements are back-loaded. Under these circumstances, an expansionary monetary policy could realize the same resource allocation achievable by front-loading aid as long as the stock of international reserves is sufficiently large.

Next, we present evidence based on a *panel* of aid-receiving countries that foreign aid tends to deteriorate the trade balance. [9] This evidence is consistent with the presence of Dutch disease but could also reflect the impact of aid on the external balance constraint (i.e., as foreign aid rises, recipient countries can finance higher levels of imports and larger trade deficits). Our second result is, instead, consistent with the presence of Dutch disease: foreign aid inflows tend to depress exports in "normal" years (i.e., years that are not post-conflict and not affected by natural disasters or large negative commodity export price shocks). Finally, we find that tighter macroeconomic policies improve the trade balance and raise exports, while expansionary policies deteriorate the trade balance and lower exports (provided there are enough international reserves to finance a larger trade gap). These results are consistent with the predictions of our model.

An important *caveat* is that, in years of negative shocks, which account for 44 percent of the observations in the sample, foreign aid may have a *positive* effect on exports. This suggests that foreign aid might help buffer exports from negative shocks and that, under these circumstances, tightening of macroeconomic policies in response to a surge in aid would be unnecessary and inappropriate.

We also present empirical evidence based on a *cross-section* of aid-receiving countries that macro policies are effective in mitigating trade balance volatility. Specifically, we show that, controlling for openness to trade, countries where the central bank's net domestic assets fall in response to a surge in aid flows—a practice dubbed "sterilization"—experience a significantly smaller volatility of their trade balance. This result holds when we control for (i) country-specific commodity export price shocks and (ii) the endogeneity bias that donors' response to volatile exports and imports might generate.

The key assumptions of our model do not only deliver results consistent with the empirical evidence but they also match key characteristics of aid-receiving countries. Prati and Tressel (2006) show that the typical aid-receiving country is a small open economy and has a closed capital account (both *de jure* and *de facto*). There is also substantial

[9] Difficulties in measuring real exchange rates makes it easier to test the effectiveness of monetary policy on the trade balance than on real exchange rates data. Prati, Sahay, and Tressel (2003) present evidence consistent with that presented in this paper using black market exchange rate data to overcome some of the measurement problems, but these data are not available after 1998. Adam and Bevan's (2003) calibrate their model on Uganda data and find that the impact of aid on the real exchange rate is complex and might not be large.

microeconomic evidence supporting the assumption of LBD externalities in the export sector of developing countries. For example, Van Biesebroeck (2005) finds that productivity of manufacturing plants in African countries increases after entering export markets. Blalock and Gertler (2004) show that Indonesian manufacturing firms become more productive by learning through exporting. Fernandes and Isgut (2005) present evidence of "learning by exporting" by young Colombian manufacturing plants between 1981 and 1991.

The main point of our paper is that, in aid-receiving countries, monetary and fiscal policies help achieve optimal spending and current account paths and have persistent effects on real variables in the presence of externalities. While few other papers focus on this issue,[10] there are several related to ours. Matsen and Torvik (2005) are interested in the optimal management of exogenous transfers.[11] They derive an optimal spending path of natural resource wealth in the presence of Dutch disease. However, their model does not have a monetary sector and individuals' consumption decisions are constrained by an exogenously set current account, which instead we endogenize. They also do not consider the question of whether and how macroeconomic policies might replicate the optimal spending path,[12] whereas we focus on those that can help countries achieve the optimal current account path.

Krugman (1987) argues that, in the presence of LBD externalities, temporary monetary policies can have permanent real effects on competitiveness. His model predicts, however, that monetary tightening would *reduce* exports in contrast with the predictions of our model and the empirical evidence of this paper. In Krugman's model, domestic wages are sticky. As a consequence, monetary tightening causes real *appreciation* because exports need to fall in line with the lower imports that monetary contraction brings about. In this model, tightening monetary policy in response to aid inflows would then amplify real appreciation and the export reduction caused by aid rather than muffling it as our evidence suggests.

The literature on sterilization of capital inflows is also closely related to our paper (see, for example, Calvo et al. (1995)). In this literature, monetary policy is non-neutral in the short-run even though *nontradable* goods prices are fully-flexible.[13] This effectiveness

[10] In a related paper, Buffie et al. (2004) calibrate a theoretical model to study the issue of money and exchange rate targets and look at the impact on inflation, current account and real exchange rate volatilities in aid-receiving countries. However, they do not derive welfare and real output is exogenous.

[11] To our knowledge, Van Wijnbergen (1984) is the only other paper in the Dutch disease literature doing some normative analysis. Van Wijnbergen, however, does not discuss the optimal management of a transfer but the optimal design of subsidies.

[12] In the case of natural resources wealth, the country can set up a special fund – such as oil reserve funds in oil rich countries. In the case of aid, such an option is unlikely to be available.

[13] See also Edwards (1988) for a model of low-income countries with limited capital flows.

reflects the stickiness of *tradable* goods prices, which remain unchanged in international markets (because the supply of tradable goods is perfectly elastic) as domestic monetary policy varies. Our model differs, however, from this class of models in predicting that the temporary effects of sterilization on the real exchange rate translate into *permanent* effects on growth through LBD externalities originating in the tradable sector.

The paper is organized as follows. Section II lays down the structure of the model. Section III describes the partial and general equilibrium effects of foreign aid and macroeconomic policies. Section IV presents the results of the welfare analysis. Section V provides empirical evidence confirming the model's prediction that responding to aid fluctuations by adjusting the central bank's net domestic assets allows recipient countries to limit adverse effects on export levels and trade balance volatility. Section VI concludes.

II. THE MODEL

A. Consumers and Prices

We consider a three-goods (exportable, importable, and non-tradable) small open economy lasting two periods where a continuum of identical individuals consume an importable good (c_T) and a non-tradable good (c_N). They also value real money balances of domestic currencies as in standard money-in-the-utility-function models. The representative agent *i* maximizes[14]:

$$V^i = U^i{}_1 + U^i{}_2 = \log C_1{}^i + \chi \log\left(\frac{M_1{}^i}{P_1}\right) + \log C_2{}^i$$

where C_t^i is an index of consumption in period t, M_1^i denotes nominal money balances held between period 1 and period 2 in domestic currencies, and χ is small. We assume that agents have perfect foresight and know the structure of the economy. The real exchange rate e_t is: $e_t = \dfrac{p_{N,t}}{p_{T,t}}$ and the terms of trade q_t are defined as: $q_t = \dfrac{p_{X,t}}{p_{T,t}}$.

Agents have Cobb-Douglas preferences with respect to tradable and non-tradable goods:

$$C_t{}^i = \left(c_{T,t}{}^i\right)^{\gamma} \cdot \left(c_{N,t}{}^i\right)^{1-\gamma} \qquad \text{t} = 1,2$$

The consumer price index P_t is defined as the minimum cost of one unit of the consumption index C_t^i: $P_t = p_{T,t}^{\gamma} \cdot p_{N,t}^{1-\gamma}$ (t=1,2), where p_T is the price in local currency of one unit of the tradable good and p_N is the price of one unit of the non-tradable good. The law of one price holds for the imported and the exported good: $p_{T,t} = E_t \cdot p_{T,t}^*$ and $p_{X,t} = E_t \cdot p_{X,t}^*$ where $p_T{}^*$ and $p_x{}^*$ are respectively the price of the imported good and the price of the exported good in dollars and E_t is the nominal exchange rate in period *t=1,2* (domestic

[14] For simplicity, and without loss of any generality, the discount rate is set to 1.

currency per dollar). Hence, the consumer price index P_t (t=1,2) is a function of the nominal exchange rate, the real exchange rate, and the international price of imports:

$$P_t = E_t \cdot e_t^{1-\gamma} \cdot p_{T,t}^* \qquad \text{(1-1) and (1-2)}$$

Individual *i*'s budget constraints for periods one and two in domestic currency are:

$$\begin{aligned} P_1 C_1^i + M_1^i + B^i &= I_1^i + TR_1^i \\ P_2 C_2^i &= I_2^i + (1+r)B^i + TR_2^i + M_1^i \end{aligned} \qquad \text{(2-1) and (2-2)}$$

where B^i are the domestic bond holdings between period one and two, *r* is the nominal interest rate on domestic bonds, I_1^i and I_2^i are respectively nominal income in period one and two, TR_1^i and TR_2^i are lump-sum net government transfers. The nominal exchange rates E_1 and E_2 are predetermined in a fixed exchange rate regime. Without loss of generality, we normalize the nominal exchange rates: $E_1 = E_2 = E$.

B. Production

The exportable (y_X) and the non-tradable goods (y_N) are produced according to production functions with decreasing returns to scale ($0 < \alpha < 1$), as in the standard specific-factors model with one mobile factor:

$$y_{X,t} = a_{X,t} \cdot L_{X,t}{}^{\alpha} \qquad \text{(3-1) and (3-2)}$$

$$y_{N,t} = a_{N,t} \cdot L_{N,t}{}^{\alpha} \qquad \text{(4-1) and (4-2)}$$

where $L_{i,t}$ (*i=X,N*) are labor inputs in the exportable and non-tradable sectors, and. $L_t = L_{X,t} + L_{N,t}$, the aggregate supply of labor, is fixed. The productivity parameters are $a_{X,t}$ and $a_{N,t}$ respectively in the exportable and non-tradable sectors. In the following, we assume that $a_{N,1} = a_{X,1} = a_1$.

Foreign aid and productivity growth

We augment the model by allowing foreign aid to affect productivity growth, either positively or negatively. To capture productivity-enhancing effects of aid, we introduce an aid-financed public good x_P produced in period one that raises period-two productivity in both sectors. To capture the negative productivity effects of Dutch disease, we allow for LBD in the export sector, as in models of Dutch Disease. We follow Sachs and Warner (1995) by assuming that LBD is generated only in the traded sector and there is a perfect learning spillover to the non-traded sector, and that the size of the export sector *in period one*, $L_{X,1}$, raises *period-two* productivity *in both sectors*:

$$\begin{cases} a_{X,2} = h_X(x_P) \cdot a_{X,1} \cdot (1 + z \cdot L_{X,1}) \\ a_{N,2} = h_N(x_P) \cdot a_{N,1} \cdot (1 + z \cdot L_{X,1}) \end{cases} \quad \text{(5) and (6)}$$

where z is a parameter and h is a function that embodies the decreasing marginal productivity returns of the aid-financed public good, x_P. For simplicity, we assume $h_X = h_N = h$, with $h' > 0, h'' < 0$. In view of our assumption $a_{N,1} = a_{X,1} = a_1$, this implies that $a_{N,2} = a_{X,2} = a_2$ as well.

C. The Public Sector

The public sector is highly stylized. The government receives foreign aid $\overline{A}$, uses part of it ($\widetilde{A} < \overline{A}$) to produce a public good x_P, and transfers the rest to consumers (A_1 in period one and A_2 in period two). The government also issues domestic debt B_0 in period one that then repays with interest in period two by levying lump-sum taxes. In period one the budget deficit is financed by public debt B_0:

$$B_0 = TR_1 + c(x_p) - \widetilde{A} - A_1$$

where $c(x_P)$ is the cost of producing the public good x_P.

In period two, lump-sum taxes are levied to repay with interest the domestic debt B_0.

$$(1+r)B_0 = TR_2 - A_2$$

We assume that the public good can only be financed with aid: $c(x_P) = \widetilde{A}$.

Foreign aid

Donors set exogenously the total dollar net present value $\overline{A}$ of aid over the two periods as well as its allocation in each period. A fraction

$$\widetilde{A} = \lambda \overline{A} \quad (\lambda < 1) \tag{7-1}$$

goes to the period one budget to finance the production of a public good x_P (for example, infrastructure, health, or education expenditure), which augments period two productivity. The remainder

$$(1-\lambda)\overline{A} = A_1 + A_2 \tag{7-2}$$

is directly transferred to consumers or equivalently spent on public sector wages.[15]

[15] Endogenizing $\overline{A}$, as well as A_1, A_2, and $\widetilde{A}$, is beyond the scope of this paper. In practice, donors may decide how much aid to disburse by taking other donors' aid into account or simply by pursuing their own interest. Alesina and Dollar (2000) show that colonial history and political closeness are significant determinants of bilateral aid. Cordella and Dell'Ariccia (continued)

Public good production

In the first period, the government produces the public good x_P with tradable goods (x_T) and nontradable goods (x_N) according to a Cobb-Douglas production function. We assume that the elasticity of substitution in the production function is the same as in consumers' preferences:

$$x_P = x_N^{1-\gamma} \cdot x_T^{\gamma} \tag{8}$$

This implies that non-tradable and tradable goods are used as inputs in the proportion implied by consumers' preferences, $\frac{p_N x_N}{1-\gamma} = \frac{p_T x_T}{\gamma}$, so that the *share* of public consumption in total consumption does not affect the aggregate demand for tradable and nontradable goods. We also assume that the public good is financed only with foreign aid:

$$c(x_P) = p_{N,1}x_N + p_{T,1}x_T = \widetilde{A} \tag{9}$$

This implies that the government does not use any of the proceeds of domestic debt issuance B_0 to finance the production of the public good x_P.

Central bank

In period one, the government issues domestic debt $B_0 > 0$ and uses the proceeds to finance a transfer to period one consumers ($B_0 + A_1 = TR_1$). The central bank purchases a fraction $B_0 - B$ of the domestic debt by printing money and leaves B to be bought by consumers. The balance sheet of the central bank at the end of period one is:[16]

$$M_1 = (B_0 - B) + E \cdot R \tag{10}$$

where M_1 is the stock of money between period one and period two, $B_0 - B$ is the face value of domestic public debt held by the central bank between period one and two ("net domestic assets"), and R is the dollar value of international reserves accumulated by the central bank between period one and two ("net foreign assets"). International reserves increase as exporters and aid recipients exchange foreign currency for domestic currency, and are invested in foreign assets that yield zero nominal interest between period one and two.

(2003) show that agency and asymmetric information problems between the donor and the recipient may determine aid composition.

[16] A general formulation would allow for an initial stock of money M_{-1}, bonds B_{-1} held by the central bank (and repaid in period one or two) and reserves R_{-1}, so that changes in stocks can be computed. Our formulation is adopted for notational simplicity and has no impact on the results.

The debt B held by the private sector is the critical policy variable of our model. The central bank controls net domestic assets $B_0 - B$ to achieve a level of aggregate demand consistent with a targeted real exchange rate and net foreign assets (or equivalently, the current account, see below). The central bank can affect the nominal interest rate r because the capital account is closed.

The central bank and the private sector can be seen as purchasing $B_0 - B$ and B directly in the primary market. However, the existence of a liquid secondary market for government bonds to conduct open market operations is not strictly necessary to implement the monetary policy described in this model (see Prati and Tressel (2006)).

Consolidated public sector budget constraint

Net income of the central bank is transferred back to the private sector.[17] In period one, net transfers from the public sector to private agents (excluding aid) are *positive* and equal to government debt B_0 issued in that period plus foreign aid A_1 transferred to consumers:

$$TR_1 = \left[M_1 - \left((B_0 - B) + E \cdot R\right)\right] + B_0 + A_1 = M_1 + B - E \cdot R = B_0 + A_1 \tag{11-1}$$

In period two, net transfers are equal to second period aid A_2, net of the taxes that are levied to pay back both the stock of debt B_0 and interest payments on private sector debt rB:

$$\begin{aligned} TR_2 &= \left[(1+r)\cdot(B_0 - B) + E \cdot R - M_1\right] - (1+r)\cdot B_0 + A_2 \\ &= E \cdot R - (1+r)B - M_1 + A_2 = A_2 - (B_0 + rB) \end{aligned} \tag{11-2}$$

Thus, the government redistributes the international reserves accumulated and raises taxes to repay the domestic debt and guarantee the nominal value of the stock of money.[18]

D. The Aggregate Resource Constraint and the Current Account

The consumption path is constrained by the inter-temporal budget constraint. We assume that the economy has no access to international capital markets and that the only foreign financial asset available to the public sector is foreign currency. The current account balances, CA_t, expressed in foreign currency, are:

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[17] Note that each agent takes the transfer from/to the government as given.

[18] Note that, in this model, sterilization has no *direct* welfare costs: no matter how high is rB, it will be financed with lump-sum taxes levied on the same consumers that will benefit from interest payments. By contrast, sterilization is costly in models where taxes are distortionary as it is often assumed in the literature (see for instance Calvo, 1991). We could easily introduce these costs in our model without affecting our main results.

$$
\begin{cases} CA_1 = R = TB_1 + \widetilde{A} + A_1 = \left(p_{X,1}\right)^* \cdot y_{X,1} + \widetilde{A} + A_1 - \left(p_{T,1}\right)^* \cdot c_{T,1} - \left(p_{T,1}\right)^* x_{T,1} \\ CA_2 = -R = TB_2 + A_2 = \left(p_{X,2}\right)^* \cdot y_{X,2} + A_2 - \left(p_{T,2}\right)^* c_{T,2} \end{cases} \quad \text{(12-1) and (12-2)}
$$

where a star corresponds to dollar prices, and TB_t is the trade balance in period t. The inter-temporal budget constraint implies that: $CA_1 + CA_2 = 0$.

By combining the private sector and public sector budget constraint, one obtains the budget constraints of the economy in period one and period two:

$$
\begin{cases} P_1 C_1 + R = I_1 + A_1 \\ P_2 C_2 = I_2 + A_2 + R \end{cases} \quad \text{(13-1) and (13-2)}
$$

These budget constraints show clearly that the intertemporal transfer of resources (national savings) is achieved through the accumulation of international reserves by the Central Bank, which constitute the main policy target in our model, and is achieved by changes in net domestic assets, which is the policy instrument in our model. As we show in the next section, this policy objective can be achieved by adjusting either monetary or fiscal policy.

E. Equivalence Between Monetary and Fiscal Policy

Note that in our simplified framework with flexible wages and prices for non-traded goods, as well as lump sum taxes and transfers, fiscal policy cannot be distinguished from monetary policy. This can be easily seen by combining the balance sheet of the Central Bank with the government budget constraint (11):

$$
M_1 = TR_1 - A_1 - B + ER \quad \text{(10')}
$$

In the central bank's balance sheet (10'), the net domestic assets of the central bank are equal to $B_0 - B = TR_1 - A_1 - B$, reflecting both fiscal and monetary policy decisions. In the rest of the paper, we shall simply denote net domestic assets with $B_0 - B$ and we will interchangeably refer to monetary policy and macroeconomic policy decisions. It is worth keeping in mind, however, that any given level of net domestic assets could be achieved either through monetary policy actions affecting B (e.g., net central bank's purchases of government bonds at issuance or on the open market) while keeping fiscal policy unchanged or through fiscal policy actions affecting TR_1 while keeping B unchanged. In this framework monetary and fiscal policy are perfect substitutes. Imperfect substitutability could be achieved for example by assuming that taxes and transfers are distortionary.

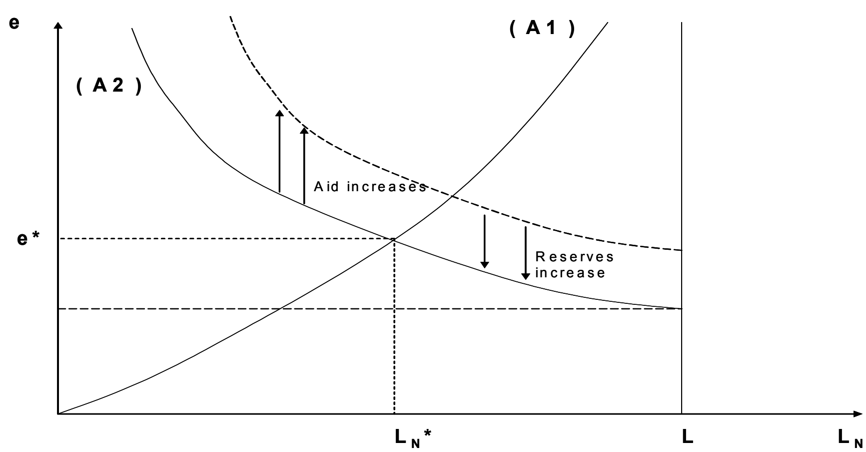
III. PARTIAL AND GENERAL EQUILIBRIUM EFFECTS OF FOREIGN AID AND MACROECONOMIC POLICY

In this section we characterize the partial and general equilibrium effects of *front-loading* foreign aid, keeping the net present value of total aid unchanged. We also illustrate the general equilibrium effects of modifying the macroeconomic policy stance in response to aid flows in a fixed exchange rate regime. A more detailed discussion can be found in Appendix II-b. In Appendix II-a, we discuss how these results can be generalized to a managed float and to a fully flexible exchange rate regime.

A. Partial equilibrium effects of aid and macroeconomic policy

Figure 1 illustrates the partial equilibrium effects of aid inflows and monetary policy on the real exchange rate in period one.[19] The upward sloping locus (A-1) reflects labor market equilibrium. Perfect labor mobility requires the marginal product of labor in the non-tradable and export sectors to be equalized. To maintain this equality, the price of non-tradable goods (and, thus, the real exchange rate) needs to increase as employment in the non-tradable sector increases and its marginal productivity declines. The downward sloping locus (A-2) reflects the equilibrium in the goods market. Higher prices of non-tradable goods imply a lower demand for non-tradable goods and, therefore, lower employment in the non-tradable sector.

Figure 1: Partial Equilibrium Effects of Aid Inflows and Macroeconomic Policy



As part of foreign aid is spent on non-tradable goods, demand for non-tradable goods rises, shifting the locus (A-2) up and resulting in real exchange rate appreciation. Monetary policy can, however, undo such appreciation by reducing aggregate demand and shifting the locus (A-2) back.

[19] Section A of Appendix I derives the equations underlying the loci (A-1) and (A-2).

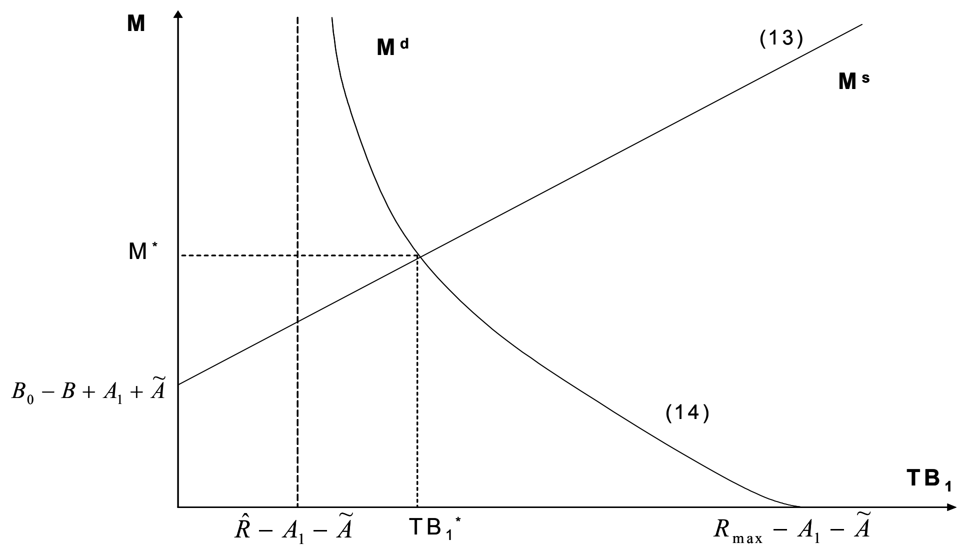
These are only partial equilibrium effects. By reducing aggregate demand, monetary policy reduces also imports, leading to an improvement in the current account balance and an accumulation of international reserves that will increase back money supply and have an upward feedback effect on non-tradable prices.

B. General equilibrium effects of aid and macroeconomic policy

Effects of front-loading foreign aid

Figure 2 illustrates the general equilibrium level of money balances (vertical axis) as a function of the trade balance in period one (horizontal axis).

Figure 2: General Equilibrium



The upward-sloping line (13) captures the positive relationship (derived from the central bank's balance sheet (10) and the current account balances (12)) between *money supply* and its three counterparts: *i)* the domestic currency value of the trade balance, $E \cdot TB_1$ *ii)* the first-period aid inflows expressed in domestic currency, $E \cdot (A_1 + \widetilde{A})$; and *iii*) the net domestic assets of the Central Bank $B_0 - B$:[20]

$$M^s = E \cdot TB_1 + (B_0 - B) + E \cdot (A_1 + \widetilde{A}) \tag{13}$$

The downward-sloping curve (14) shows how *money demand* declines as the trade balance improves. The intuition is that, for a given income, a higher trade balance in period

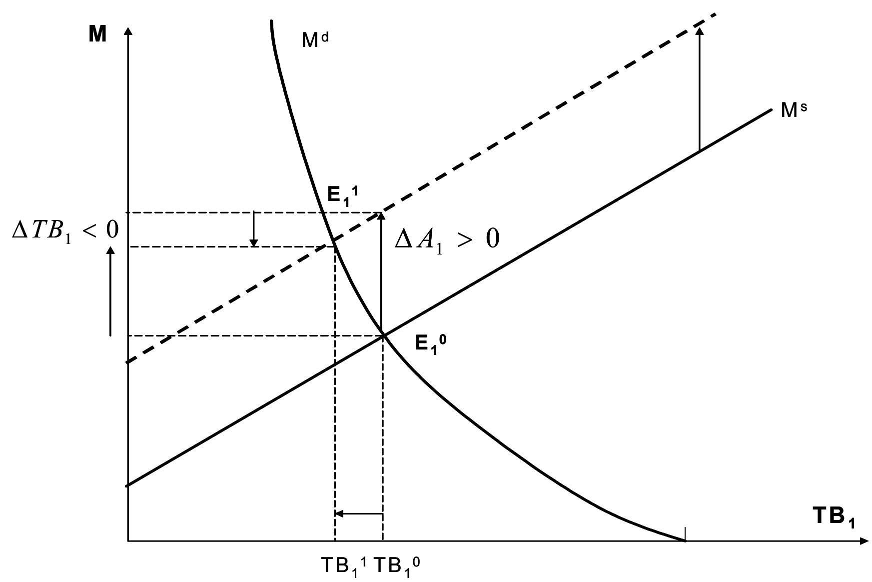
[20] For notational simplicity, the nominal exchange rate E is assumed to be equal to 1 in the figures.

one is associated with higher savings, smaller consumption, and, therefore, lower money demand:[21]

$$M^d = \chi \cdot \frac{1}{\frac{1}{I_1 - TB_1 - \widetilde{A}} - \frac{1}{I_2 + TB_1 + \overline{A}}} \tag{14}$$

Appendix I derives equations (13)-(14), establishes existence and unicity of an equilibrium, and derives the two boundaries of the money demand function.

Figure 3: Front-loading Consumption Aid *without* LBD Externalities



In the absence of LBD externalities, front-loading consumption aid (i.e., increasing A_1 while keeping $\overline{A}$ constant) shifts period one money supply up (Figure 3). Initially, the higher money supply puts downward pressure on interest rates and induces agents to increase period one consumption and reduce period two consumption. Higher period one consumption of tradables deteriorates the trade balance and causes a *partial* reduction of the initial increase in money supply. This offset is only partial and leaves interest rates below the initial level because part of the higher consumption is spent on nontradables. Given that the trade balance deteriorates less than the initial increase in period one aid, the current account (which includes aid flows) improves.The new equilibrium will be associated with a lower trade balance and higher money balances.

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[21] The curve (14) is defined when the trade balance is: *i)* above the threshold $\hat{R} - A_1 - \widetilde{A}$ that ensures nominal interest rates above the zero lower bound and *ii)* below the threshold $R_{\max} - A_1 - \widetilde{A}$ that ensures positive consumption in period one.

The impact of front-loading aid *in the presence of externalities* follows the same logic and is described in Appendix II-b where the impact of productivity-enhancing aid is also discussed.

The following proposition summarizes the general equilibrium effects of front-loading aid.

Proposition 1
For a constant net present value of total aid:

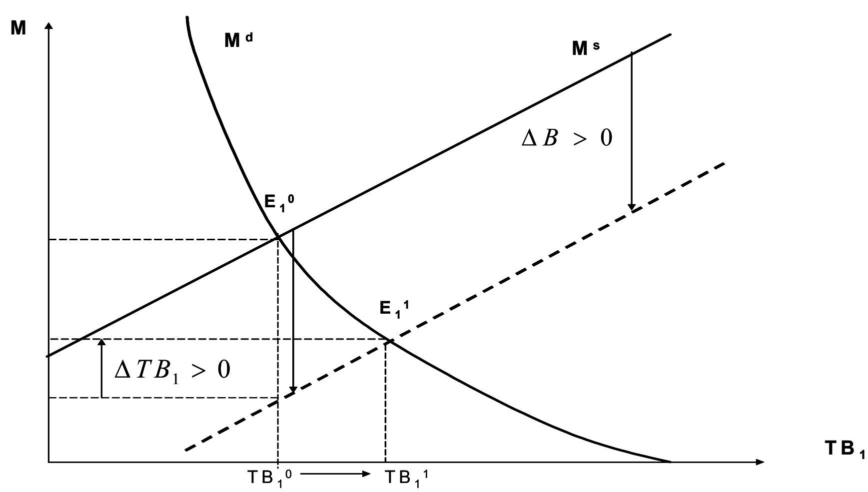
- *Increasing period one consumption aid deteriorates the trade balance but improves the current account and, therefore, raises the stock of international reserves. The larger LBD externalities are, the smaller is the deterioration in the trade balance and the larger is the accumulation of international reserves.*
- *Increasing period one productivity-enhancing aid leads to a greater deterioration of the trade balance and a smaller accumulation of international reserves. The more productive public investment is, the greater is the deterioration of the trade balance and the smaller is the accumulation of international reserves. The larger LBD externalities are, the smaller is the deterioration in the trade balance.*

Proof: see Appendix I.

C. General equilibrium effects of macroeconomic policy

Figure 4 shows how sterilization can offset the effects of front-loading consumption aid. As interest rates increase to absorb the additional supply of bonds, private agents postpone consumption, nontradable prices fall in relation to tradable prices, and the trade balance improves. In the limit, monetary policy can fully undo the effects of an increase of consumption aid on the trade balance. Similar temporary effects of monetary policy can be found in Edwards (1988) and Calvo et al. (1995), where a temporary depreciation of the real exchange rate is associated with higher real domestic interest rates.

Figure 4: Sterilization *without* LBD Externalities



In the presence of LBD externalities, the money demand is steeper, hence the same reduction in net domestic assets leads to a smaller improvement of the trade balance but the latter would have deteriorated less in the first place (see Appendix II-b). With LBD externalities, however, monetary policy *permanently* affects the productive structure of the economy. A monetary tightening temporarily depreciates the real exchange rate and leads to an expansion of the export sector, which, in turn, leads to greater LBD and higher productivity in the future. As previously mentioned, Krugman (1987) also argues that monetary policy has permanent effects in the presence of externalities but, in his model, tight monetary policy has opposite effects because he assumes balanced trade and sticky domestic wages.

Sterilizing the money supply effects of front-loading *productivity-enhancing aid* will also reduce period one private sector consumption, improve the trade balance, and raise international reserves and national savings, while allowing the higher aid-financed public expenditure. With reference to Figure 5, this implies that full sterilization would only shift back the money supply line to its original position while the money demand curve will remain shifted down, so the current account and international reserves would remain below their initial level.

In the presence of LBD externalities, sterilization raises productivity and future consumption by reducing current private consumption, partially offsetting the Dutch disease effects of an increase in first period aid (ΔA_1 or $\Delta\tilde{A}$). In particular, associating sterilization policy with an increase in aid-financed productivity-enhancing public expenditure $\Delta\tilde{A}$ would maximize the productivity benefits of aid. These benefits would always need to be traded off against the costs in term of postponed consumption, which could be large if the country is facing a negative output shock.

Proposition 2 summarizes the general equilibrium effects of monetary policy.

Proposition 2

- *The deterioration in the trade balance associated with front-loading <u>consumption aid</u> can be fully offset by a reduction in net domestic assets ("sterilization") of the same size of the aid increase no matter whether there are or not LBD externalities.*
- *The deterioration in the trade balance associated with front-loading <u>productivity-enhancing aid</u> can be offset by a greater reduction in net domestic assets ("sterilization") than the size of the aid increase.*
- *In the presence of LBD externalities, sterilization raises productivity and future consumption by reducing current private consumption.*

<u>Proof</u>: see Appendix I.

IV. THE OPTIMAL TIMING OF AID AND MACROECONOMIC POLICY

In the previous section, we showed that monetary policy can affect the real exchange rate and the external balance but we have not discussed under which conditions monetary policy improves (or worsens) welfare, and what should be the target of the central bank. To address this question, we proceed in two steps. First, we define the welfare maximization program of a social planner who chooses an optimal distribution of consumption aid over time given the net present value of aid inflows $\overline{A}$. Second, we show that, given an arbitrary distribution of aid over time, agents may not necessarily achieve the welfare-maximizing allocation in the decentralized equilibrium and discuss how monetary policy can improve welfare in such case.

A. Social planner's problem and optimal timing of aid

We assume that both the net present value of aid $\overline{A}$ and the aid for public investment $\widetilde{A}$ are exogenously fixed so that the social planner's problem reduces to choosing optimally A_1 and A_2, given a real interest rate equal to the subjective discount rate of the representative agent. The formal maximization program of the social planner is:

$$Max_{(A_1,A_2)} W = \left\{ \log C_1 + \log C_2 + \chi \log\left(\frac{M}{P}\right) \right\}$$

subject to:

(1) $\overline{A} = A_1 + A_2 + \widetilde{A}$, where $\widetilde{A}$ and $\overline{A}$ are exogenous;

(2) $\frac{C_2}{C_1} = \frac{1+r^*}{P_2 / P_1} = \frac{1}{\beta}$, where $\beta \le 1$ is the subjective discount factor of the representative agent[22] and r^* is the nominal interest rate that, in equilibrium, determines a real interest rate equal to $\frac{1}{\beta} - 1$.[23] This is also the real interest rate that would prevail under perfect capital mobility *if the rest of the world had the same discount factor* β.

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[22] We have for simplicity set $\beta = 1$ so that agents do not discount the future. Our welfare results hold for a generic $\beta \le 1$, which implies a non-negative real interest rate (i.e., $1+r \ge \frac{P_2}{P_1}$).

[23] As explained below, the central bank can target any nominal interest rate *r* by adjusting its net domestic assets in response to aid flows. Given that monetary policy in our model has real effects, there will be a different real interest rate associated with each nominal interest rate targeted by the central bank.

Appendix I derives a sufficient condition for a solution to this problem to exist. Our approach is to solve it by allowing the social planner to choose optimally fictitious aid flows F_1 and F_2 with $F_1 + F_2 = \overline{A}$ such that the current account is balanced in every period (i.e., $F_1 = -TB_1$ and $F_2 = -TB_2$). This gives us an optimal consumption (or trade balance) path, characterized by $TB_1^{opt} = -F_1^{opt}$ and $TB_2^{opt} = -F_2^{opt}$, along which donors distribute aid over time so that private sector agents can implement the consumption plan associated with the subjective discount factor β without any need to save or dissave in aggregate because the current account is balanced.

When aid flows are not distributed optimally over time (i.e., $A_1 + \widetilde{A} \neq F_1^{opt}$ and $A_2 \neq F_2^{opt}$), the same level of welfare could be achieved through accumulation or decumulation of international reserves and corresponding current account deficits and surpluses. Specifically, the welfare-maximizing accumulation of reserves needs to be $R^{opt} = A_1 + \widetilde{A} - F_1^{opt}$ with an associated optimal trade balance $TB_1^{opt} = R^{opt} - A_1 - \widetilde{A}$. This provides an optimal path for the real exchange rate $\left(e_1^{opt}, e_2^{opt}\right)$.

B. Decentralized equilibrium and macroeconomic policy

We now discuss whether, given an arbitrary initial distribution of aid over time, agents can achieve, through a decentralized equilibrium, the optimal reserve accumulation and trade balance. Given that, in our model, monetary policy affects the real interest rate and therefore agents' decisions, we also need to characterize the monetary policy stance that would make this optimal decentralized allocation feasible. We characterize such optimal monetary stance with the nominal interest rate r^{opt} as an intermediate target, chosen to target the optimal trade balance path $\left(TB_1^{opt}, TB_2^{opt}\right)$, *or equivalently the real exchange rate path* $\left(e_1^{opt}, e_2^{opt}\right)$.

We denote with TB_1^* the trade balance associated with the *unconstrained* decentralized allocation that agents would achieve if they could borrow and lend *at the interest rate* r^*—associated with the subjective discount factor β—without limit given their *total* incomes and aid flows over the two periods. This unconstrained decentralized allocation coincides with the optimal allocation (i.e., $TB_1^* = TB_1^{opt}$) *in the absence of LBD externalities*, while it is associated with over-consumption in period one and it is not optimal (i.e., $TB_1^* < TB_1^{opt}$) *in the presence of LBD externalities*.

We also denote with TB_1^0 the lowest possible period one trade balance that could be financed given the stock of international reserves and period one consumption aid, A_1. There are instances in which the optimal trade balance TB_1^{opt} is not feasible because reserves or first period aid are insufficient. This is the case in which the external financing constraint is binding and $TB_1^{opt} < TB_1^0$. Intuitively, the larger is A_1, the lower is the constrained trade balance TB_1^0. This means that front-loading aid (i.e., raising A_1) can lower TB_1^0 up to the point where the optimal allocation can be implemented through a decentralized equilibrium.

Proposition 3

- *In the absence of LBD externalities,*

- *when $TB_1^0 < TB_1^{opt}$, monetary policy can make private agents achieve the optimal allocation through an unconstrained decentralized equilibrium (i.e., $TB_1^* = TB_1^{opt}$) by maintaining a nominal interest $r_1^{opt} = r_1^*$ such that, in equilibrium, the real exchange rate is $\left(e_1^{opt}, e_2^{opt}\right)$.*
- *when $TB_1^0 > TB_1^{opt}$, monetary policy cannot improve welfare, and only front-loading aid can make agents achieve the optimal allocation.*

- *In the presence of LBD externalities,*

- *the unconstrained decentralized allocation always leads to overconsumption (i.e., $TB_1^* < TB_1^{opt}$ and $e_1^* > e_1^{opt}$);*
- *when $TB_1^0 < TB_1^{opt}$, monetary policy can make private agents achieve the optimal allocation through a decentralized equilibrium by targeting an interest rate $r^{opt} > r^*$. (Alternatively, donors can back-load aid to induce a binding external constraint so that $TB_1^* < TB_1^0 = TB_1^{opt}$).*
- *when $TB_1^0 > TB_1^{opt}$, monetary policy cannot improve welfare and only front-loading aid can implement the optimal allocation. (However, the external balance constraint must remain binding in equilibrium so that $TB_1^* < TB_1^0 = TB_1^{opt}$).*

Proof: see Appendix I.

The key implication of Proposition 3 is that, when aid is not distributed optimally over time, monetary policy needs to be set appropriately to allow agents to achieve an equivalent welfare-maximizing allocation through a decentralized equilibrium. Proposition 3 also indicates that the monetary policy stance needs to be tighter when there are LBD externalities so as to target the optimal path for the real exchange rate. Finally, Proposition 3 specifies that there are instances in which monetary policy is powerless because of lack of international reserves and where the welfare-maximizing allocation can be achieved only if donors front-load aid. We now describe the intuition underlying Proposition 3 in detail.

Timing of aid and macroeconomic policy without LBD externalities

Consider first the case in which, at the interest rate r^*, *first period aid is too front-loaded* to maximize welfare. In this case, agents would like to save part of first-period aid to raise future consumption and would increase their demand for government bonds bidding down interest rates. The monetary authority will prevent interest rates from falling by raising the supply of bonds (i.e., reducing net domestic assets), thereby allowing private sector agents to increase their savings and smooth consumption (see section V for a precise description of this mechanism). As private agents reduce consumption, the trade balance will improve, the real exchange rate will depreciate and international reserves increase. This increase in international reserves will be a measure of the increase in national savings needed to maximize welfare. Given that, in our model, there is no limit to the reduction in net domestic assets (if necessary they can become negative with the central bank issuing its own bonds) and to the accumulation of international reserves, private sector agents can always achieve the optimal allocation through a decentralized equilibrium, and raise savings in response to an excessive front-loading of aid, as long as the central bank targets the interest rate r^*.

Consider now the case in which at the interest rate r^*, *first period aid is too back-loaded* to maximize welfare. In this case, agents would like to borrow against future aid (or income) to raise period one consumption and they would sell government bonds bidding up interest rates. In aggregate, the private sector will be able to dissave only if the monetary authorities buy bonds and prevent interest rates from rising (i.e., they increase net domestic assets). As private agents increase consumption, the trade balance deteriorates and international reserves fall. In this case, when the stock of international reserves reaches zero, monetary policy cannot help any longer private sector agents improve on an excessively back-loaded distribution of aid. This happens when the reduction in national savings required to maximize welfare exceeds the stock of international reserves and makes the external balance constraint binding.

Timing of aid and macroeconomic policy with LBD externalities

As already discussed, in the presence of LBD externalities, an unconstrained decentralized outcome always leads to over-consumption relative to the optimal allocation. In this case, to improve welfare, monetary policy can modify the decentralized allocation by raising the interest rate above r^*, thereby reducing current consumption and real exchange rate appreciation, so as to align the real exchange rate with its optimal path $\left(e_1^{opt}, e_2^{opt}\right)$.

However, when the decentralized allocation at the interest rate r^* makes the external constraint binding (i.e., $TB_1^* < TB_1^0$), monetary policy may or may not be sufficient to implement the optimal allocation. If the optimal allocation is feasible and the external constraint is binding only because there is overconsumption (i.e., $TB_1^* < TB_1^0 < TB_1^{opt}$), monetary policy can implement the optimal allocation by raising the interest rate to $r^{opt} > r^*$. Instead, when the optimal allocation is not feasible because the external constraint would remain binding even after correcting the overconsumption (i.e., $TB_1^* < TB_1^{opt} < TB_1^0$), the only way to achieve the optimal allocation is to front-load aid and reduce TB_1^0 until it becomes equal to TB_1^{opt}. Note that, however, in this case, the external constraint must remain binding in equilibrium (i.e., $TB_1^* < TB_1^0 = TB_1^{opt}$).

V. The Effectiveness of Macroeconomic Policies in Aid-Receiving Countries

This section presents evidence—based on both a panel database and a cross-section of aid-receiving countries—of stylized facts consistent with the predictions of the theoretical model of this paper.

A. Panel Estimates

The evidence in this section is based on an unbalanced panel dataset of 58 aid-receiving countries whose median aid-to-GDP ratio is greater than 2 percent and population is above 1 million, over the period 1960-2003.[24] We report both OLS and System GMM (SGMM) estimates using the latter to address not only the well-known bias of dynamic panels but also the potential endogeneity of foreign aid and macro policies.[25]

We estimate the following *fixed effect* dynamic panel specification:

$$Y_{i,t} = \zeta_i + \alpha \cdot Y_{i,t-1} + \beta \cdot AID_{i,t} + \gamma \cdot NDA\_dif_{i,t} + \delta \cdot X_{i,t} + \varepsilon_{i,t}$$

where $Y_{i,t}$ is alternatively the trade-balance-to-GDP ratio (Table 1) and the exports-to-GDP ratio (Table 2), ζ_i are country dummies, $AID_{i,t}$ is the foreign aid-to-GDP ratio, $NDA\_dif_{i,t}$ is the annual change in the central bank's net domestic assets-to-GDP ratio, and $X_{i,t}$ is a vector of controls.

All specifications include the *index of real commodity export prices* and the logarithm of the *import demand by trading partners* to control for exogenous country-specific external shocks.[26] In some specifications, we include *a "negative shock" dummy* for years of droughts, windstorms, earthquakes, or large drops in commodity export prices,[27] *a post-conflict dummy* for the three years after the end of a war or civil war, and *a trade liberalization dummy* for the year of trade liberalization[28] We also interact some of these dummies with the *AID* variable to verify whether the effect of foreign aid is significantly

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[24] Given that many countries in the sample have aid-to-GDP ratios much higher than 2 percent, the mean and median aid-to-GDP ratios for the entire sample are respectively 8.5 and 7.3 percent.

[25] A pseudo first stage of SGMM estimates is discussed in the Appendix III.

[26] These variables should capture shocks to export prices and export demand. The index of commodity export prices is a weighted average of international commodity prices computed using country-specific commodity export shares in the 1990s. The import demand measure is computed by applying the same weights to real imports of trading partners.

[27] A large drop in commodity export prices is defined as a year-on-year change that is in the lowest quartile of the sample distribution.

[28] The trade liberalization date is from Wacziarg and Welch (2003)

different in years of negative shocks or post-conflict. In interpreting the results, it is important to keep in mind that “negative-shock” years represent about 44 percent of the sample and that post-conflict years are another 21 percent; as a consequence, the truly “normal” years—for which we estimate the largest negative effects of aid on the trade balance and exports—account for only one third of the sample.

Our model predicts that expansionary macroeconomic policies affect the trade balance and exports only if international reserves are large enough to finance the widening of the trade gap. To test this prediction, we estimate separate coefficients for positive and negative changes in $NDA\_dif_{i,t}$ and interact positive $NDA\_dif_{i,t}$ with the level of international reserves scaled by GDP at the end of year *t-1*. Finally, to try to separate the effects of monetary policy from those of fiscal policy, we consider a specification with the government balance-to-GDP ratio (including grants) among the controls.

Trade balance, exports, and foreign aid

Tables 1a and 1b present evidence that *foreign aid deteriorates the trade balance in “normal” years but has no effect, or even improves the trade balance in one specification, in years of a negative shocks*. The negative effect of aid on the trade balance is consistent with our and others’ theoretical models. In fact, foreign aid allows countries to finance a wider trade gap due to higher imports and, possibly, lower exports. In the event of a negative shock, foreign aid may, instead, help support economic activity and exports offsetting the direct negative effect of the shock on the trade balance.

When we do not distinguish between normal and negative-shock subsamples (columns 1, 2, 5, 6, 9, 10, 13 and 14), the impact of aid is predominantly negative and strongly significant across specifications and estimation techniques. In a sample where the median aid-to-GDP ratio is 7.3 percent, a one-percent-of-GDP increase in aid is estimated to worsen the trade balance by 0.16-0.17 percent of GDP in the OLS regressions and by 0.24-0.29 percent of GDP in the SGMM regressions.

In the specifications where we include an intercept dummy for negative shocks and estimate separate aid coefficients for the two sub-samples (columns 3, 4, 7, 8, 11 and 15), we find that in normal years the negative impact of aid on the trade balance remains significant and becomes larger. In these years, a one-percent-of-GDP increase in foreign aid worsens the trade balance by as much as 0.54 percent of GDP. By contrast, in years of negative shocks, SGMM estimates show that aid has either no effect on the trade balance or has a *positive* effect (columns 7 and 8). Estimating separate coefficients for post-conflict years does not affect these conclusions nor reveals these years to be different from normal years.[29]

[29] Note that war years are part of these“normal” years. In a subsample without *WAR* years, OLS estimates confirm previous results while SGMM estimates appear somewhat weaker (results available upon request). This may be due, however, to the difficulties inherent in instrumenting the aid variable with its lags in post-conflict years when conflict years are dropped from the sample.

Tables 2a and 2b present export regressions. The different effect of aid in the two subsamples is related to the different response of exports. SGMM export regressions show that, *in "normal" years, aid significantly depresses exports* (columns 5-8 and 13-16 in Table 2). The impact of foreign aid on exports rises becomes more negative as we exclude post-conflict years from the normal subsample. This evidence is consistent with the presence of substantial *Dutch disease* effects or other negative effects of aid on exports in "normal" years. In such years, the estimated impact of aid is large with a one-percent-of-GDP increase reducing exports by as much as 0.57 percent of GDP. By contrast, foreign aid has no effects or tends to improve exports in years of negative shocks (years of negative shocks represent 44 percent of the observations).

Measuring the effect of foreign aid on the trade balance and exports is not a trivial endeavor in view of several omitted variables that can bias the coefficient estimates in different directions. In the estimates presented in Tables 1 and 2, we try to address these problems by using (i) regressors that proxy the omitted variables and (ii) SGMM estimation techniques that treat aid flows as endogenous.

If we did not control for events that simultaneously disrupt the productive capacity of the economy, lower living conditions, and trigger a surge in foreign aid, we would risk attributing erroneously to foreign aid a deterioration in the trade balance and export performance. Our controls for export prices and demand, negative natural shocks (such as droughts, earthquakes, and windstorms), and post-conflict periods aim at reducing this risk.[30]

But there are also several factors that might lead, if neglected, to attenuate the impact of aid on the trade balance and exports. As donors disburse aid, recipient countries may not spend all of it or may tighten monetary and fiscal policy to smooth the impact of aid on the economy (and the trade balance) over time. Under these circumstances, if we did not control for policy intervention, the aid coefficient would measure the impact of aid net of the effect of offsetting government's policies with a risk of underestimating the true effect of aid. We include changes in the net domestic assets of the central bank and government balances among the regressors to obviate part of this underestimation problem.

Another source of attenuation bias could be structural reforms that simultaneously raise exports, improve the trade balance, and trigger higher aid disbursements from donors keen to reward countries that reform. This donors' response to reform efforts might generate a positive correlation between aid and exports in the trade liberalization year that would be spurious and no indication that aid stimulates exports. To the contrary, trade reform would be the source of higher exports. This bias may contribute to explain the positive aid coefficient we estimate in the OLS exports regressions. Indeed, when we include the trade liberalization dummy (which is sometimes weakly significant), the OLS coefficient of aid for normal periods remains positive but becomes significant only at the 10 percent level (columns 2 and

[30] According to specification (1) of Table 2a, a 10 percent increase in the export commodity price index from its sample average would lead to an increase of 0.13 percentage points of the export-to-GDP ratio at impact.

10 in Tables 2). Nonetheless, the difficulties associated with measuring reliably the effects of trade liberalization make SGMM techniques a better way to address this possible source of underestimation bias.

In SGMM regressions, we consider aid endogenous. This means that aid at time *t* is instrumented with lags of aid dated *t-2 and t-3*.[31] The corresponding identifying assumption is that first-differences of the error term of our trade balance and export regressions be orthogonal to aid levels two periods earlier. Using trade reform as an example of omitted variable, this identifying assumption implies that donors would raise foreign aid one year before trade reform translates into higher exports but not two or more years before. In the instrument set, we also include 3-year lags of the index of commodity export prices and of the negative shock dummy. The exclusion restriction—accepted by the J-test—is that long lags of these exogenous variables can contribute to explain current aid inflows and lagged exports but do not affect current exports directly.

Trade balance, exports, and net domestic assets

The annual change in the ratio of the central bank's net domestic assets to GDP (*NDA_dif*) captures the macroeconomic policy response to foreign aid inflows. *NDA_dif* measures changes in the monetary policy stance but it can also reflect fiscal policy decisions (see equation (10') of the model).[32] If aid-receiving countries "sterilize" the monetary impact of aid inflows, *NDA_dif* will take negative values with reductions of net domestic assets offsetting the aid-driven rise in net foreign assets. Conversely, expansionary macroeconomic policies would be associated with positive values of *NDA_dif*.

In both the trade balance and export regressions (OLS and SGMM), the estimated coefficient of *NDA_dif* is strongly significant and has the expected negative sign (columns 1-8 in Tables 1a and 2a). These estimates suggest that sterilization policy would improve the trade balance and maintain export levels in the face of aid inflows. A reduction in net domestic assets of 1 percent of GDP is estimated to improve the trade balance by 0.18 percent of GDP at impact, with exports rising—according to SGMM estimates—by 0.13 percent of GDP.

Given that, in economies with a closed capital account, expansionary macroeconomic policies cannot lead to a deterioration in the trade balance unless there are enough foreign reserves to finance it, we expect positive *NDA_dif* to have a smaller impact on the trade balance and exports than negative *NDA_dif*. We also expect the coefficient on positive

[31] See Bond (2000) for the appropriate choice of instruments in SGMM estimation.

[32] The central bank can control net domestic assets through sales or purchases of government bonds while the government can regulate its deposits at the central bank by modifying the fiscal balance (e.g., by spending larger or smaller fractions of the aid that donors disburse), thereby influencing the net domestic assets of the Central Bank.

NDA_dif to vary with the level of international reserves in the previous period. International reserves can also be seen as allowing central banks to limit nominal depreciation in the face of a monetary expansion so that domestic prices rise, the real exchange rate appreciates, and exports fall. By contrast, without international reserves, the nominal exchange rate would depreciate in line with the higher domestic prices, leaving the real exchange rate and exports unchanged. Our estimates broadly confirm these predictions (columns 12-16 in Tables 1 and 2) with the interaction between *NDA_dif* and initial reserves being statistically significant in two out of four specifications.

When we try to separate the effects of monetary policy from those of fiscal policy by including the government balance (columns 11 and 15 in Tables 1 and 2), we find that the effectiveness of monetary policy is confirmed (with a small tendency of the coefficients for *NDA_dif* to rise). The government balance has the expected positive sign but is statistically significant only in the export regressions.

The finding that monetary tightening does not only improve the trade balance but also raises exports confirms a key prediction of our theoretical model that distinguishes it from sticky-price models à la Krugman (1987). In the latter, a monetary contraction reduces domestic demand and imports but does not spur exports because domestic wages are sticky. In the long run, the new steady state actually requires exports to fall in line with lower imports as the real exchange rate appreciates to restore trade balance equilibrium. By contrast, in our model, domestic prices are flexible and a monetary contraction makes exports more competitive by depreciating the real exchange rate.

In all SGMM regressions, we consider *NDA_dif* and the government balance as *predetermined* variables to control for the possibility that some omitted variables might enter the central bank's and the government's reaction functions but not our econometric specification. While we include proxies for the most likely export shocks (commodity export prices, demand by trading partners, and natural disasters), there might still be some shocks that the monetary authority observes but the econometrician does not. In this case, the error term of the export regression might be correlated with *NDA_dif* if the monetary authority responds to the omitted shock by modifying net domestic assets. Our identifying assumption is that lags of *NDA_dif* dated *t-1 or earlier* be orthogonal to first-differences of the error term in the export and trade balance SGMM regressions (see pseudo first stage regressions reported in Appendix III).[33] This means that the central bank is expected to react to contemporaneous (or past) innovations of the export equation but not to future innovations. In other words, the information advantage that the central bank has in observing current

[33] Specifically, the identifying assumptions are: $E(NDA\_dif_{it-1}, \Delta\varepsilon_{it}) = 0$ in the difference equation, and $E(\Delta NDA\_dif_{it-1}, \varepsilon_{it}) = 0$ in the level equation.

shocks does not translate into a greater ability to predict future export shocks or into adjusting current monetary policy based on such prediction. [34]

Finally, Sargan tests support the validity of our instrumentation strategy. Morevoer, the pseudo first stage of system GMM regressions suggests that these specification tests are unlikely to be distorted by problems of weak instruments (see Appendix III).

B. Cross-Section Estimates

The panel regressions of the previous section show that, in aid-receiving countries, macroeconomic policies can be used not only to limit the Dutch disease effects of foreign aid on exports (if any) but also to smooth over time undesired fluctuations of trade balance and exports caused by aid volatility. In this section, we present further evidence on this second possible role of macroeconomic policies in aid-receiving countries based on cross-country regressions. This evidence is consistent with that of the panel regressions but is somewhat weaker (i.e., results are statistically significant only when we restrict the sample to countries with median aid-to-GDP ratios greater than 4 or 5 percent).[35]

In Tables 3, the dependent variable is the standard deviation of the trade-balance-to-GDP ratio. In columns 1 and 6, the explanatory variables are the standard deviation of the aid-to-GDP ratio (Std_AID), the standard deviation of a country-specific (trade-weighted) real commodity export price index (Std_COMM), and a scaling variable for trade openness (Mean_MX), measured as the average ratio of the sum of exports and imports over GDP. All variables have been detrended using a linear trend.[36] This first set of estimates shows that a higher volatility of aid flows is significantly associated with a higher volatility of the trade balance.

In columns 2 and 7, we add as an additional regressor Std_AID multiplied by a dummy equal to one whenever the country follows a sterilization policy (i.e., the correlation between aid flows and changes in net domestic assets is negative). The estimated coefficient

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[34] The serial correlation tests of the system GMM regressions support the assumption that the error term of the level equation is not serially correlated.

[35] With lareger samples (corresponding to median aid-to-GDP ratios of 2 or 3 percent), the estimated coefficients have the same sign of those in the restricted sample but are significant only in few specifications. (The results are available from the authors upon request). A difficulty associated with estimating the cross-section specification, and that might explain the weaker results relative to the panel specification, is that we cannot control for the effect of natural disasters such as droughts, earthquakes, and windstorms.

[36] Countries with less than 1 million inhabitants are dropped from the sample. We also dropped outliers identified by a standard procedure. If outliers were included, our results would be stronger and would hold also in the larger samples corresponding to median aid-to-GDP ratios greater than 2 or 3 percent

of this variable (Std_AID_Cn) is negative and significant, indicating that the link between aid volatility and trade balance volatility is significantly weaker in countries that sterilize the monetary impact of aid inflows.

The remaining columns in Table 3 confirm the robustness of our results when we control for possible endogeneity biases, caused either by omitted variables or by reverse causality. Indeed, some exogenous factors other than aid inflows (such as weather fluctuations or wars) might increase trade balance volatility and, in turn, induce more volatile aid inflows as donors modify their policies to respond to these shocks. In this case, causality would go from the volatility of the trade balance to that of aid inflows.

For this reason, we need instruments that are unrelated to trade balance developments. In columns 3 and 8, we use Rajan and Subramanian's (2005a) instrument for aid levels (i.e., the predicted value of aid based on exogenous determinants of donors' aid policies such as colonial relationships and donors' budgetary cycles), which happens to be correlated not only with aid levels but also with their standard deviations. In columns 4 and 9, we add as a second instrument a measure of the dispersion in individual donors' aid policies which is positively correlated with aid volatility.[37] In columns 5 and 10, we show that our results remain broadly unchanged when we also instrument Mean_MX with Frankel and Romer's instrument for trade openness.

Standard tests suggest that most instruments are valid. The over-identifying restriction tests are always passed (J-Statistics for columns 4, 5, 9 and 10. We also check whether our first stage regressions pass Stock and Yogo's (2005) tests of the null hypothesis of weak instruments. In the first of these tests, the null hypothesis is that the bias of the IV is more than 10 percent of the bias of the OLS. For two endogenous variables and four instruments, the critical value for this F-test is 7.56. In the second (more stringent) Stock and Yogo's test, the null is that the true significance level is 10 percent when the nominal level is 5 percent. For two endogenous variables and four instruments, the critical value for this F-test is 16.87. The specifications of columns 4 and 9 pass both tests rejecting the null of weak

[37] The identifying assumption on which the validity of this instrument depends is that donors are more likely to change their disbursements from one year to the next in a coordinated fashion when they are responding to shocks. As a consequence, a high dispersion of annual changes in aid disbursements across donors would be an indication of volatility in donors' policies unrelated to shocks. To construct this instrument, we first compute, for each country and year, the year-on-year change in the aid flow from each donor. We then compute the absolute difference between that donor-specific change in aid flows and the average change across donors for that country and year. Finally, we compute the average of this measure across years for each country. This instrument would take a value of zero if all donors increased or reduced their aid to a given country from year to year in the same amount. The greater the dispersion of the donor-specific changes around the average annual change of the aid flow, the higher is the value taken by this instrument. All aid flows are measured in percent of the recipient's GDP.

instruments. Frankel and Romer's instrument for trade openness is, instead, confirmed to be a weak instrument as already pointed out in the literature.

VI. CONCLUSIONS

While there is a vast literature on foreign aid, few contributions have tried to identify macroeconomic policies that enhance its benefits and limit its undesirable consequences. This paper provides a framework that can be used to understand whether macroeconomic policy can play this role in countries that receive aid flows that tend to worsen export competitiveness or are excessively volatile. Specifically, we study how monetary and fiscal policy can help harness the full growth potential of aid by limiting the associated real appreciation and, thereby, smoothing consumption over time. We show that, in the presence of learning-by-doing externalities, temporary monetary policies can have persistent effects on productivity and, therefore, contribute to augment the real resources available to recipient countries. Our paper can be seen as analyzing the role of macroeconomic policies given the structural characteristics of the economies. Structural reforms are of course key to improve the growth potential of aid receiving countries, and would complement macroeconomic policies analyzed in this paper.[38]

Our theoretical analysis yields the following taxonomy. When aid flows are excessively front-loaded, monetary and fiscal policy can improve welfare by increasing national savings in the form of higher international reserves. When aid flows are excessively back-loaded, an expansionary monetary or fiscal policy can improve welfare if the stock of international reserves is large enough. The empirical evidence presented in this paper is consistent with these effects of macroeconomic policies.

There are, however, limits to what extent such policies can correct the effects of an inappropriate distribution of aid over time. When aid flows are deemed excessively back-loaded, insufficient international reserves can prevent macroeconomic policy from bringing resources forward. Conversely, when aid flows are excessively front-loaded, sterilization costs may reduce the benefits of reserve accumulation. These costs can be large in practice. If the taxes needed to finance the differential between the interest rates on sterilization bonds and international reserves are distortionary or costly to be levied, sterilization would have welfare costs that should be weighed against the benefits of smaller Dutch disease effects. These costs would be even larger if high interest rates depressed interest-sensitive *private* investment that might enhance productivity. In such cases, saving part of aid for latter use, for instance through government deposits at the Central Bank, might be a better alternative. But this latter policy may also be costly. If fiscal surpluses are achieved by postponing the very public investment that is supposed to be financed with the aid increase, the trade balance and Dutch disease effects of aid would be undone but any related productivity benefit would be lost as well.

[38] For example, our model takes the LBD externality and spillover effects as a given. These parameters of the model would typically depend on structural characteristics of the economy considered.

Finally, the idea that there are circumstances in which some aid is better saved owes nothing to the notion that foreign aid might be too generous. Our results do not provide any indication that an increase in the *overall* net present value of aid can reduce welfare. They pertain, instead, to the welfare implications of the *distribution* of a given net present value of aid over time. Indeed, our empirical results suggest that the impact of aid on exports depends upon the circumstances in the country. During periods of large negative shocks, or of reconstruction efforts such as after a war or civil war, aid flows could in fact have positive effects on exports. From this perspective, the declared objective of the donor community to raise ODA to 0.7 percent of industrial countries' GDP from a level that is currently only about one third of that target can only be welcome.

Table 1a. The Impact of Aid and Macroeconomic Policies on the Trade Balance

	Panel A: OLS regressions				Panel B: System GMM regressions			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Trade Balance / GDP (t-1)	0.689	0.635	0.689	0.685	0.602	0.554	0.62	0.623
	[20.56]***	[19.02]***	[20.56]***	[20.66]***	[8.96]***	[10.40]***	[8.61]***	[8.30]***
Aid / GDP (t)	-0.166	-0.169			-0.237	-0.225		
	[4.15]***	[4.11]***			[2.72]***	[2.73]***		
Aid / GDP, no negative shock (t)			-0.164				-0.543	
			[3.63]***				[2.78]***	
Aid / GDP, no post conflict (t)				-0.156				-0.594
				[3.10]***				[2.85]***
Aid / GDP, negative shock (t)			-0.17	-0.01			0.363	0.902
			[3.47]***	[0.21]			[0.85]	[2.18]**
Aid / GDP, post conflict (t)				-0.178				-0.47
				[3.19]***				[3.88]***
Change in Net Domestic Assets (t)	-0.174	-0.182	-0.175	-0.177	-0.17	-0.191	-0.176	-0.18
	[4.44]***	[4.46]***	[4.46]***	[4.50]***	[2.58]**	[2.61]**	[2.80]***	[2.99]***
Government Balance (t)								
Real Exports Commodity Price Index (t)	9.2E-05	9.90E-05	8.7E-05	9.6E-05	1.0E-04	1.10E-04	1.1E-04	1.1E-04
	[2.16]**	[2.33]**	[2.03]**	[2.25]**	[2.42]**	[2.34]**	[2.39]**	[2.53]**
Log of Import Demand from Trading Partners (t)	0.018	0.019	0.019	0.018	0.003	0.002	0.007	0.006
	[1.59]	[1.33]	[1.63]	[1.55]	[0.78]	[0.37]	[1.36]	[1.21]
Dummy for Negative Shocks (t)			-0.008	-0.007			-0.085	-0.085
			[1.63]	[1.48]			[1.60]	[2.25]**
Dummy for Post-Conflict (t)				0.011				-0.01
				[2.00]**				[0.58]
Dummy for Trade Liberalization (t)		0.004				0		
		[0.47]				[0.05]		
Observations	1362	1288	1362	1362	1329	1255	1329	1329
country fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
R-squared	0.81	0.8	0.81	0.81				
F Test					32.6	38.5	20.0	19.8
Sargan test (p value)					0.62	0.49	0.54	0.66
Serial correlation test (p value)								
order 1	0.07	0.05	0.06	0.06	0.00	0.00	0.00	0.00
order 2	0.25	0.09	0.21	0.22	0.57	0.44	0.96	0.91
order 3	0.68	0.93	0.66	0.72	0.22	0.83	0.09	0.07

Robust t statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Note: Two step system GMM with finite sample correction to the covariance matrix (Windmeijer, 2005) with a maximum of three lags for instruments

Table 1b. The Impact of Aid and Macroeconomic Policies on the Trade Balance

	Panel A: OLS regressions				Panel B: System GMM regressions			
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Trade Balance / GDP (t-1)	0.689	0.636	0.642	0.691	0.575	0.555	0.564	0.559
	[20.54]***	[18.98]***	[18.48]***	[20.16]***	[8.74]***	[11.35]***	[10.69]***	[7.60]***
Aid / GDP (t)	-0.168	-0.17		-0.164	-0.281	-0.244		-0.286
	[4.21]***	[4.15]***		[4.01]***	[3.19]***	[2.97]***		[3.42]***
Aid / GDP, no negative shock (t)			-0.166				-0.301	
			[3.59]***				[2.79]***	
Aid / GDP, negative shock (t)			-0.169				-0.194	
			[3.38]***				[0.85]	
Positive Change in Net Domestic Assets (t)	-0.126	-0.149	-0.155	-0.006	-0.188	-0.171	-0.213	-0.143
	[1.81]*	[2.03]**	[2.02]**	[0.08]	[2.23]**	[1.46]	[1.83]*	[1.28]
Negative Change in Net Domestic Assets (t)	-0.225	-0.217	-0.212	-0.25	-0.216	-0.246	-0.26	-0.267
	[3.47]***	[3.21]***	[3.11]***	[3.71]***	[2.35]**	[2.67]**	[2.96]***	[2.91]***
Reserves * Change in Net Domestic Assets (t)				-1.742				-0.868
				[2.20]**				[0.97]
Government Balance (t)			0.024				-0.018	
			[1.04]				[0.22]	
Real Exports Commodity Price Index (t)	9.1E-05	9.8E-05	8.4E-05	9.1E-05	9.8E-05	9.8E-05	6.7E-05	9.2E-05
	[2.14]**	[2.32]**	[1.95]*	[2.16]**	[2.30]**	[2.24]**	[1.38]	[2.12]**
Log of Import Demand from Trading Partners (t)	0.018	0.019	0.02	0.014	0.004	0.002	0.001	0.003
	[1.60]	[1.34]	[1.41]	[1.19]	[1.04]	[0.40]	[0.26]	[0.60]
Dummy for Negative Shocks (t)			-0.007				-0.018	
			[1.53]				[0.72]	
Dummy for Trade Liberalization (t)		0.003	0.002			-0.001	-0.005	
		[0.41]	[0.26]			[0.16]	[0.61]	
Observations	1362	1288	1239	1347	1329	1255	1208	1317
country fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
R-squared	0.81	0.8	0.81	0.82				
F Test					28.2	56.2	48.7	17.2
Sargan test (p value)					0.68	0.70	0.81	0.34
Serial correlation test (p value)								
order 1	0.07	0.05	0.06	0.08	0.00	0.00	0.00	0.00
order 2	0.23	0.09	0.09	0.29	0.53	0.50	0.38	0.61
order 3	0.69	0.94	0.81	0.60	0.27	0.57	0.84	0.17

Robust t statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Note: Two step system GMM with finite sample correction to the covariance matrix (Windmeijer, 2005) with a maximum of three lags for instruments

Table 2a. The Impact of Aid and Macroeconomic Policies on Exports

	Panel A: OLS regressions				Panel B: System GMM regressions			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Exports / GDP (t-1)	0.832	0.829	0.833	0.832	0.826	0.81	0.819	0.836
	[43.04]***	[41.80]***	[43.34]***	[43.55]***	[10.13]***	[9.60]***	[9.14]***	[9.38]***
Aid / GDP (t)	0.06	0.047			-0.156	-0.13		
	[2.28]**	[1.79]*			[2.79]***	[2.70]***		
Aid / GDP, no negative shock (t)			0.053				-0.379	
			[1.80]*				[2.11]**	
Aid / GDP, no post conflict (t)				0.062				-0.57
				[1.86]*				[2.69]***
Aid / GDP, negative shock (t)			0.067	0.012			0.306	0.884
			[2.06]**	[0.37]			[0.78]	[1.77]*
Aid / GDP, post conflict (t)				0.039				-0.271
				[1.09]				[1.61]
Change in Net Domestic Assets (t)	-0.049	-0.068	-0.051	-0.052	-0.125	-0.159	-0.132	-0.142
	[1.79]*	[2.39]**	[1.87]*	[1.89]*	[2.53]**	[3.13]***	[2.32]**	[2.46]**
Government Balance (t)								
Real Exports Commodity Price Index (t)	1.0E-04	9.9E-05	9.9E-05	5.4E-03	1.5E-04	1.5E-02	1.5E-04	1.5E-04
	[3.72]***	[3.62]***	[3.63]***	[3.76]***	[5.22]***	[5.51]***	[4.31]***	[4.42]***
Log of Import Demand from Trading Partners (t)	0.025	0.029	0.026	0.026	0.017	0.015	0.021	0.02
	[3.88]***	[4.02]***	[4.00]***	[3.92]***	[3.92]***	[3.63]***	[4.15]***	[4.55]***
Dummy for Negative Shocks (t)			-0.007	-0.006			-0.067	-0.084
			[2.09]**	[1.98]**			[1.32]	[1.90]*
Dummy for Post-Conflict (t)				0.005				-0.03
				[1.43]				[2.49]**
Dummy for Trade Liberalization (t)		0.016				0.007		
		[1.66]*				[0.86]		
Observations	1391	1324	1391	1391	1357	1292	1357	1357
country fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
R-squared	0.93	0.93	0.93	0.93				
F Test					132.7	93.0	72.6	86.5
Sargan test (p value)					0.34	0.27	0.12	0.16
Serial correlation test (p value)								
order 1	0.50	0.35	0.58	0.59	0.00	0.00	0.00	0.00
order 2	0.96	0.71	0.93	0.94	0.81	0.79	0.54	0.49
order 3	0.34	0.24	0.35	0.38	0.22	0.31	0.18	0.17

Robust t statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Note: Two step system GMM with finite sample correction to the covariance matrix (Windmeijer, 2005) with a maximum of three lags for instruments

Table 2b. The Impact of Aid and Macroeconomic Policies on Exports

	Panel A: OLS regressions				Panel B: System GMM regressions			
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Exports / GDP (t-1)	0.833	0.829	0.837	0.829	0.767	0.775	0.827	0.844
	[43.24]***	[42.05]***	[42.25]***	[42.08]***	[9.54]***	[9.99]***	[11.20]***	[13.98]***
Aid / GDP (t)	0.058	0.046		0.055	-0.165	-0.157		-0.19
	[2.23]**	[1.75]*		[2.08]**	[2.69]***	[2.71]***		[2.87]***
Aid / GDP, no negative shock (t)			0.038				-0.296	
			[1.30]				[2.68]**	
Aid / GDP, negative shock (t)			0.059				0.154	
			[1.77]*				[1.05]	
Positive Change in Net Domestic Assets (t)	0.011	0.013	0.022	0.055	0	0	0.06	0.09
	[0.23]	[0.27]	[0.44]	[1.00]	[0.01]	[0.01]	[0.88]	[1.10]
Negative Change in Net Domestic Assets (t)	-0.11	-0.157	-0.161	-0.147	-0.22	-0.271	-0.314	-0.207
	[2.26]**	[3.14]***	[3.22]***	[3.08]***	[2.39]**	[2.71]***	[2.93]***	[1.83]*
Reserves * Change in Net Domestic Assets (t)				-0.496				-0.888
				[1.39]				[4.51]***
Government Balance (t)			0.027				0.106	
			[2.19]**				[1.77]*	
Real Exports Commodity Price Index (t)	1.0E-04	9.6E-05	8.0E-05	9.8E-05	1.4E-04	1.4E-04	1.4E-04	1.3E-04
	[3.66]***	[3.54]***	[2.94]***	[3.58]***	[5.28]***	[5.18]***	[4.68]***	[4.48]***
Log of Import Demand from Trading Partners (t)	0.026	0.03	0.03	0.024	0.019	0.017	0.016	0.017
	[3.87]***	[4.06]***	[4.06]***	[3.60]***	[4.53]***	[4.33]***	[4.23]***	[4.33]***
Dummy for Negative Shocks (t)			-0.008				-0.049	
			[2.45]**				[2.08]**	
Dummy for Trade Liberalization (t)		0.015	0.015			0.008	0.006	
		[1.58]	[1.57]			[0.90]	[0.76]	
Observations	1391	1324	1276	1376	1357	1292	1247	1345
country fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
R-squared	0.93	0.93	0.93	0.93				
F Test					129.5	120.8	43.7	131.1
Sargan test (p value)					0.52	0.35	0.19	0.18
Serial correlation test (p value)								
order 1	0.55	0.38	0.77	0.50	0.00	0.00	0.00	0.00
order 2	0.99	0.65	0.49	0.90	0.82	0.77	0.87	0.70
order 3	0.29	0.19	0.16	0.26	0.21	0.30	0.20	0.19

Robust t statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Note: Two step system GMM with finite sample correction to the covariance matrix (Windmeijer, 2005) with a maximum of three lags for instruments

Table 3: Foreign Aid and Trade Balance Volatility`

(countries with more than 1 million inhabitants)

	Median ODA/GDP > 4%					*Median ODA/GDP > 5%*				
	(1) OLS	**(2) OLS**	**(3) IV**	**(4) IV**	**(5) IV**	**(6) OLS**	**(7) OLS**	**(8) IV**	**(9) IV**	**(10) IV**
Std_AID	0.399	0.571	1.062	0.612	0.508	0.409	0.597	1.349	0.625	0.508
	(2.70)**	(3.41)***	(3.40)***	(4.63)***	(2.96)***	(2.35)**	(3.10)***	(2.90)***	(3.70)***	(2.36)**
Mean_MX	0.127	0.124	0.118	0.124	0.142	0.127	0.124	0.116	0.124	0.147
	(8.77)***	(10.31)***	(8.31)***	(10.15)***	(4.08)***	(8.34)***	(9.87)***	(6.14)***	(9.95)***	(4.36)***
Std_COMM	0.00039	0.00044	0.00035	0.00042	0.00053	0.00039	0.00047	0.00031	0.00044	0.00056
	(2.99)***	(3.37)***	(1.99)**	(3.40)***	(2.79)***	(2.72)**	(3.28)***	(1.37)	(3.48)***	(2.94)***
Std_AID_Cn		-0.272	-0.300	-0.226	-0.222		-0.301	-0.297	-0.257	-0.243
		(2.31)**	(1.79)*	(2.22)**	(1.89)*		(2.46)**	(1.52)	(2.48)**	(1.97)**
Observations	41	41	41	41	38	34	34	34	34	32
R-squared	0.76	0.79	0.71	0.78	0.77	0.76	0.78	0.61	0.78	0.76
F-Test (First Stage)										
Std_AID			5.34	14.77	14.84			2.37	13.61	12.13
Std_AID_Cn			19.33	31.01	27.51			17.74	27.52	21.48
Mean_MX					2.29					2.29
Std_AID_Cor										
J-Statistic (p-value)				0.43	0.20				0.32	0.15

Each regression includes a constant - robust t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4a. First Stage Trade Balance Regressions

Panel A: Difference Equation

Change in:	**Aid / GDP (t)**	**Change in NDA / GDP (t)**	**Trade Balance / GDP (t-1)**
Lagged Levels:			
Aid / GDP (t-2)	**-0.152**	-0.044	-0.102
	[2.87]***	[1.23]	[1.42]
Aid / GDP (t-3)	**0.03**	0.034	0.046
	[0.66]	[0.86]	[0.64]
Trade Balance / GDP (t-2)	0.051	0.037	**-0.401**
	[2.54]**	[1.84]*	**[7.35]*****
Trade Balance / GDP (t-3)	-0.021	-0.017	**0.127**
	[0.92]	[0.76]	**[2.34]****
Change in NDA/GDP (t-1)	0.047	**-0.992**	-0.192
	[1.58]	**[18.38]*****	[4.22]***
Change in NDA/GDP (t-2)	0.029	**-0.099**	0.148
	[1.13]	**[2.13]****	[3.07]***
Change in NDA/GDP (t-3)	0.038	**-0.062**	0.104
	[1.34]	**[1.34]**	[1.94]*
Levels:			
Real Exports Commodity Price Index(t)	-2.03E-06	-1.97E-05	1.04E-04
	[0.12]	[0.85]	[3.67]***
Log of Import Demand from Trading Partners (t)	0.0005	-0.003	0.001
	[0.29]	[1.80]*	[0.45]
Real Exports Commodity Price Index(t-3)	-2.19E-05	1.20E-04	-1.21E-04
	[1.48]	[4.89]***	[3.39]***
Drought Dummy (t-3)	0.005	0.001	0.002
	[1.76]*	[0.47]	[0.47]
Observations	1252	1252	1252
R-squared	0.07	0.5	0.22
F test (lags of dependent variable)	8.52	113.38	35.21

Panel B: Level Equation

Level:	**Aid / GDP (t)**	**Change in NDA / GDP (t)**	**Trade Balance / GDP (t-1)**
Lagged Changes in:			
Aid / GDP (t-2)	**0.234**	-0.032	-0.007
	[5.10]***	[0.91]	[0.08]
Aid / GDP (t-3)	**0.212**	0.046	-0.05
	[4.49]***	[1.23]	[0.57]
Trade Balance / GDP (t-2)	-0.018	0.031	**0.371**
	[0.76]	[1.46]	**[5.72]*****
Trade Balance / GDP (t-3)	-0.028	0.001	**0.275**
	[1.08]	[0.06]	**[4.63]*****
Change in NDA/GDP (t-1)	0.004	**0.037**	-0.146
	[0.11]	**[0.83]**	[2.83]***
Change in NDA/GDP (t-2)	0.006	**-0.014**	-0.044
	[0.15]	**[0.26]**	[0.65]
Change in NDA/GDP (t-3)	0.022	**-0.03**	0.026
	[0.63]	**[0.73]**	[0.55]
Levels:			
Real Exports Commodity Price Index(t)	-3.17E-05	-1.27E-05	1.33E-04
	[1.18]	[0.53]	[3.10]***
Log of Import Demand from Trading Partners (t)	0.014	-0.003	-0.009
	[5.97]***	[1.69]*	[1.86]*
Real Exports Commodity Price Index(t-3)	-4.20E-05	1.10E-04	-1.52E-04
	[1.94]*	[4.44]***	[3.37]***
Drought Dummy (t-3)	0.009	0.001	-0.003
	[2.40]**	[0.27]	[0.55]
Observations	1207	1207	1207
R-squared	0.54	0.1	0.63
F test (lags of dependent variable)	20.03	0.65	25.92

Robust t statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4b. First Stage Export Regressions

Panel A: Difference Equation

Change in:	Aid / GDP (t)	Change in NDA / GDP (t)	Exports / GDP (t-1)
Lagged Levels:			
Aid / GDP (t-2)	**-0.176**	-0.069	-0.062
	[3.33]******	[1.92]*	[1.86]*
Aid / GDP (t-3)	**0.027**	0.063	0.001
	[0.63]	[1.66]*	[0.04]
Exports / GDP (t-2)	0.013	0.136	**-0.199**
	[0.44]	[3.60]***	**[6.01]********
Exports / GDP (t-3)	-0.044	-0.11	**0.041**
	[1.67]*	[2.90]***	**[1.06]**
Change in NDA/GDP (t-1)	0.05	**-0.959**	-0.076
	[1.77]*	**[18.75]********	[2.45]**
Change in NDA/GDP (t-2)	0.021	**-0.081**	0.077
	[0.83]	**[1.82]*****	[2.72]***
Change in NDA/GDP (t-3)	0.038	**-0.047**	0.035
	[1.42]	**[1.06]**	[1.30]
Levels:			
Real Exports Commodity Price Index (t)	-4E-06	-2E-05	1E-04
	[0.22]	[0.98]	[5.65]***
Log of Import Demand from Trading Partners (t)	0.001	-0.005	0.011
	[0.66]	[2.46]**	[6.09]***
Real Exports Commodity Price Index (t-3)	-2.0E-05	1.2E-04	-1.1E-04
	[1.36]	[4.88]***	[5.36]***
Drought Dummy (t-3)	0.004	0.001	0.002
	[1.60]	[0.27]	[0.87]
Observations	1279	1279	1279
R-squared	0.07	0.49	0.18
F test (lags of dependent variable)	12.45	118.2	34.23

Panel B: Level Equation

Level:	Aid / GDP (t)	Change in NDA / GDP (t)	Exports / GDP (t-1)
Lagged Changes in:			
Aid / GDP (t-2)	**0.265**	-0.065	-0.09
	[5.55]******	[1.87]*	[1.23]
Aid / GDP (t-3)	**0.229**	0.041	-0.046
	[4.52]******	[1.12]	[0.57]
Exports / GDP (t-2)	0.025	0.132	**0.442**
	[0.73]	[3.75]***	**[5.69]********
Exports / GDP (t-3)	-0.043	0.035	**0.27**
	[1.11]	[1.05]	**[3.81]********
Change in NDA/GDP (t-1)	-0.013	**0.039**	-0.041
	[0.34]	**[0.91]**	[0.88]
Change in NDA/GDP (t-2)	0.007	**-0.009**	0.003
	[0.16]	**[0.19]**	[0.05]
Change in NDA/GDP (t-3)	0.013	**-0.026**	0.026
	[0.37]	**[0.65]**	[0.66]
Levels:			
Real Exports Commodity Price Index (t)	-3.14E-05	-1.92E-05	1.17E-04
	[1.14]	[0.81]	[2.55]**
Log of Import Demand from Trading Partners (t)	0.014	-0.004	0.032
	[5.72]***	[2.28]**	[6.63]***
Real Exports Commodity Price Index (t-3)	-4.63E-05	1.16E-04	6.93E-06
	[2.06]**	[4.77]***	[0.18]
Drought Dummy (t-3)	0.008	0	0.003
	[2.06]**	[0.15]	[0.79]
Observations	1234	1234	1234
R-squared	0.54	0.11	0.76
F test (lags of dependent variable)	22.32	0.68	21.65

Robust t statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Solution Strategy

The static analysis of this model is standard. The static equilibrium relation between the real exchange rate and the allocation of labor in each period is the outcome of equilibrium conditions on the labor market and non-tradable goods markets. First, perfect mobility of labor implies that the marginal productivity of labor is the same in the tradable and non-tradable goods markets:

$$w_t = p_{X,t} \cdot a_{X,t} \cdot F_X{}'\left(L - L_{N,t}\right) = p_{N,t} \cdot a_{N,t} \cdot F_N'\left(L_{N,t}\right), \qquad t=1,2.$$

Hence:

$$e_t = q_t \frac{a_{X,t}}{a_{N,t}} \cdot \frac{F_X{}'}{F_N{}'}, \qquad t=1,2. \tag{A-1}$$

Second, equilibrium on the non traded-goods market implies that:

$$\begin{cases} (1-\gamma)P_1C_1 + p_{N,1}x_{N,1} = p_{N,1}y_{N,1} \\ (1-\gamma)P_2C_2 = p_{N,2}y_{N,2} \end{cases}$$

Combining these conditions with the aggregate budget constraints, we obtain the two following equilibrium relations:

Period 1:

$$e^1 \cdot \left[\gamma \cdot a_N^1 F_N\left(L^1{}_N\right) - x_N^1\right] = (1-\gamma) \cdot \left[q^1 \cdot a_X^1 F_X\left(L - L_N^1\right) + \frac{\left(A_{1`} - R\right)}{\left(p_T^1\right)^*}\right] \tag{A-2a}$$

Period 2:

$$e^2 \cdot \gamma \cdot a_{N,2} F_N\left(L_{N,2}\right) = (1-\gamma) \cdot \left[q_1 \cdot a_{X,2} F_X\left(L - L_{N,2}\right) + \frac{\left(A_{2`} + R\right)}{\left(p_{T,2}\right)^*}\right] \tag{A-2b}$$

The demand for real money balances is the following:

$$\frac{M_1}{\chi} = P_1 C_1 \left(1 + \frac{1}{r}\right) \tag{A-3}$$

By substituting (11-1) and (11-2) into the aggregate private sector constraint, we obtain the following economy-wide resource constraints:

$$P_1 C_1 + R = I_1 + A_1 \tag{A-4a}$$

$$P_2 C_2 = I_2 + A_2 + R \tag{A-4b}$$

Therefore, in this economy with a closed capital account and no accumulated factor of production, national savings are simply reflected in the accumulation of foreign currency by the central bank and by individuals. Monetary policy affects the inter-temporal allocation of resources insofar as it has a (temporary) effect on the current account balance by reducing (or increasing) aggregate demand. As discussed in Section III.C, this happens because changes in money supply affect both nominal and real interest rates and, in turn, private savings decisions through the inter-temporal consumption smoothing condition:

$$\frac{1+r}{P_2 / P_1} = \frac{C_2}{C_1} \tag{A-5}$$

In sum, we have 15 unknown variables: the real exchange rates e_1 and e_2, the equilibrium allocation of labor between non-tradable and tradable production $L_{N,1}$ and $L_{N,2}$, the CPI levels P_1 and P_2, the aggregate consumption indices C_1 and C_2, the nominal interest rate r, the nominal value of domestic currency M_1 and foreign currency M_1^*, the face value of bonds B held by the private agents, the reserves R accumulated during period 1, and the allocation of aid for productive purposes $\widetilde{A}$ between non-tradable x_N and tradable goods x_T. We have 14 equations: the equilibrium on the non-traded good market, the demand for labor in traded and non-traded sectors, the definition of the consumer price index, the aggregate resource constraints, the demand for domestic bonds, the demand for real money balances, the money supply identity, the balanced budget equation and the production technology of the public good.

Thus, the government can use monetary policy (the face value of bonds B sold to private agents, or the nominal interest rate r) to affect macroeconomic outcomes by targeting the current account via the accumulation of reserves.

Finally the real consumption indexes are given by:

$$\begin{cases} C_1 = e_1^{\gamma} \cdot \left[y_{N,1} + \dfrac{q_1}{e_1} \cdot y_{X,1} + \dfrac{A_1 - R}{e_1 \cdot p_{T,1}^*} \right] \\ C_2 = e_2^{\gamma} \cdot \left[y_{N,2} + \dfrac{q_2}{e_2} \cdot y_{X,2} + \dfrac{A_2 + R}{e_2 \cdot p_{T,2}^*} \right] \end{cases}$$

A. Proofs of Propositions

<u>Existence and Unicity of Equilibrium</u>

To keep notations simple, we assume that $\widetilde{A} = 0$. One can easily check that the result holds for $\widetilde{A} \neq 0$.
First, we show that if an equilibrium exists, it is unique.
Second, we establish existence of an equilibrium.

Unicity of equilibrium

Unicity is established in the following way.

First, if an equilibrium exists, aggregate intertemporal decisions are characterized by the current account balance in the first period (or equivalently the accumulation of reserves *R* between period one and period two).

Second, we simply remark that for each current account balance *R* in the first period there exists a unique equilibrium of the real economy characterized by real exchange rates $e_1(R)$ and $e_2(R)$, price levels $P_1(R)$ and $P_2(R)$ (recall price levels are pinned down by equations (1-1) and (1-2)), consumptions $C_1(R)$ and $C_2(R)$ and allocation of labor between the export and non-tradable sectors $L_{N,1}(R)$ and $L_{N,2}(R)$. In other words, there exists a unique correspondence between a level of reserves R and the equilibrium of the economy with an exogenous current account equal to R. Indeed, the real side of the model is a standard Dutch disease model with a learning by doing externality, as in Van Wijnbergen (1984), Krugman (1987), Matsuyama (1992), Sachs and Warner (1995), Gylfason et al. (1997), Torvik (2001), and Matsen and Torvik (2004) among others.

Finally, the accumulation of reserves *R* is pinned down by the money market equilibrium as shown in Figure 2. Since the M^s and M^d locus are well-behaved curves (just note that first period nominal consumption is a decreasing function of *R*, while second period consumption is increasing with *R*), there is at most one level of reserves *R* that guarantees equilibrium on the money market.

Existence of Equilibrium

To establish existence, we must show that the M^s and M^d locus on Figure 2 have a non-empty intersection.

Necessary conditions comes from the M^d locus. Recall that it is derived by combining the money demand (A-3) and the intertemporal consumption smoothing equation:

$$M^d = \chi \cdot \frac{1}{\frac{1}{P_1 C_1} - \frac{1}{P_2 C_2}}$$

Therefore a necessary condition for existence of an equilibrium is: $P_1 C_1 < P_2 C_2$, which translates into a constraint on the admissible equilibrium current accounts (or reserves R).

Indeed $P_1 C_1 < P_2 C_2$ is equivalent to: $2R > \frac{I_1}{E} + A_1 - \left(\frac{I_2}{E} + A_2\right)$

Assuming for simplicity that the international price of the import good is constant ($p^*_{T,1} = p^*_{T,2} = p^*_T$), and using equations derived in Appendix I.A, the condition becomes:

$$2R > q_1 \cdot y_{X,1} + e_1 \cdot y_{N,1} + A_1 - (q_2 \cdot y_{X,2} + e_2 \cdot y_{N,2} + A_2)$$

The right hand side can be interpreted a a function of R, computed at the equilibrium of the economy with an exogenous current account equal to R.

Define $G(R) = \frac{I_1}{E} + A_1 - \left(\frac{I_2}{E} + A_2\right)$.

$$\frac{dG}{dR} = \frac{dI_1}{dR} + \frac{dI_2}{dR} \text{ and: } \frac{dI_i}{dR} = \underbrace{\frac{\partial I_i}{\partial R}}_{=0} + \underbrace{\frac{\partial I_i}{\partial L_{N,i}}}_{=0} \cdot \frac{\partial L_{N,i}}{\partial R} + \frac{\partial I_i}{\partial e_i} \cdot \frac{\partial e_i}{\partial R}, \text{ for i=1,2.}$$

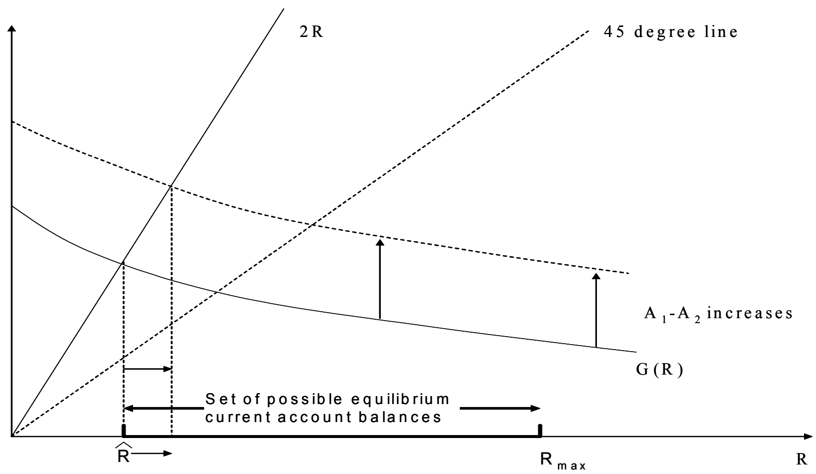
Indeed, $\frac{\partial I_t}{\partial L_{N,t}} = -p_{X,t} \cdot a_{X,t} \cdot F'_X(L - L_{N,t}) + p_{N,t} \cdot a_{N,t} \cdot F'_N(L_{N,t}) = 0$ for t=1,2 in the neighborhoods of the labor market equilibrium for an exogenously set current account.

Moreover, $\frac{\partial I_t}{\partial e_t} = (p^*_{T,t}) \cdot y_{N,t}$, for t=1,2.

Hence $\frac{dG}{dR} = p^*_{T,1} \cdot y_{N,1} \cdot \underbrace{\frac{\partial e_1}{\partial R}}_{<0} - p^*_{T,2} \cdot y_{N,2} \cdot \underbrace{\frac{\partial e_2}{\partial R}}_{>0} < 0$

This implies that for each combinations of parameters, there exists a minimum current account surplus (accumulation of reserves) $\hat{R} \in [0, R_{\max}[$ above which an equilibrium always exists, with $\hat{R}$ defined by the implicit function: $\frac{I_1(\hat{R})}{E} + A_1 - \hat{R} = \frac{I_2(\hat{R})}{E} + A_2 + \hat{R}$ if $G(0) > 0$, and: $\hat{R} = 0$ if $G(0) \leq 0$,

and $R_{\max}$ defined by the implicit function: $P_1 C_1(R_{\max}) = 0$, or: $R_{\max} = \dfrac{I_1(R_{\max})}{E} + A_1 > 0$.
Since the function G is an increasing function of the degree of frontloading of foreign aid ($A_1 - A_2$), this also implies that $\hat{R}$ increases with $A_1 - A_2$, but by less than $A_1 - A_2$ (see figure below), which implies that the corresponding trade balance must deteriorate. It is easy to see that the set of possible current account equilibria is non-empty.
These claims can be visualized on the following figure (it is here assumed that $G(0) > 0$):



These necessary conditions themselves do not guarantee existence. A look at Figure 2 shows that an additional condition must hold to guarantee existence of an equilibrium: $M^d(R=0) \geq M^s(R=0)$. Together with the two constraints on *R*, it is sufficient to establish existence of an equilibrium. This condition is equivalent to:
$\chi \geq \dfrac{B_0 - B}{I_2 + A_2} \cdot \left[\dfrac{I_2 + A_2}{I_1 + A_2} - 1\right] = \dfrac{B_0 - B}{I_2 + A_2} \cdot g$ where g is the growth rate of income including aid between period 1 and 2. Hence, this translates into a condition on the net domestic assets of the Central Bank and the growth rate of the economy.. For instance, if the growth rate is 5 percent, and the net domestic assets of he Central Bank are worth 20 percent of GDP, this implies that $\chi \geq 0.001$, which is small enough to be reasonable..

Proof of Propositions 1 & 2: Real and Monetary Effects of Aid Inflows and Monetary Policy

Let us express the current account balance R as the sum of the trade balance in the first period and first period aid: $R = TB_1 + A_1 + \widetilde{A}$, and $R = -TB_2 - A_2$.
This implies that $-TB_2 = TB_1 + A_1 + A_2 + \widetilde{A} = TB_1 + \overline{A}$ or: $-(TB_2 + TB_1) = A_1 + A_2 + \widetilde{A} = \overline{A}$ so the present value of the trade deficit is equal to the present value of aid inflows.
Thus, the money demand equilibrium locus M^d and money supply M^s are functions of the trade balance and aid inflow in the first period:

$$\begin{cases} M^s = \left(B_0 - B\right) + \left(TB_1 + A_1 + \overline{A}\right) \\ M^d = \chi \cdot \dfrac{1}{\dfrac{1}{I_1 - TB_1 - \widetilde{A}} - \dfrac{1}{I_2 + TB_1 + \overline{A}}} \end{cases} \quad (13 \,\&\, 14)$$

The locus M^d is the equilibrium relation between income, the external balance and the money demand. Hence income and trade balance are those resulting of a given aid inflow and consistent with a given money supply equal to M^d. It is straightforward to check that the locus M^d is a decreasing function of the trade balance in the first period.
We characterize the effects on the money market and the external balance of an increase in first period aid flows (consumption aid or aid for public investment) realized by lowering second period consumption aid, for a given net present value of total aid flows $\overline{A}$.

Impact of increased aid flows / monetary policy in absence of externalities

The impact of an increase in first period aid A_1, holding the total amount of aid $\overline{A}$ and the supply of public bonds to the private sector constant, is as follows, and is described in Figure 3 in the main text. The increase in first period consumption aid is obtained by lowering second period aid. This implies that $\widetilde{A}$ and $\overline{A}$ are fixed and that the externality associated with the public good can be assumed away and $h(x_P)$ is simply a parameter. At the initial equilibrium is E_1^0 money supply initially shifts up by the amount of the aid inflow, for a given trade balance. Hence, *at the initial trade balance*, the money supply exceed the money demand, putting downward pressures on interest rates since the supply of bonds remains constant. Agent will reduce their savings and increase their demand for money. Simultaneously, agents will increase their consumption after receiving the aid inflow A_1, for a given income I_1, leading to a deterioration of the trade balance in the first period. This deterioration in the trade balance and the increase in money demand due to higher consumption and lower interest rates appears as a shift to the left *along* the locus M^d.
The new first period equilibrium will be at E_1^1. Since the money supply curve shifts up by A_1 exactly, it is easy to see that the deterioration of the trade balance will be smaller in absolute terms than the increase in first period aid. This happens because par t of the aid received is spent on non-tradable goods. Thus, the equilibrium current account (including aid) will improve by less than the increase in first period aid.

Let us now consider an increase in aid for public investment $\widetilde{A}$ (see Figure 5 in the main text). In this case. the money demand curve will also shift down. Indeed, a larger share of the trade balance will be generated by the public investment, and as money has no liquidity role for the public sector, a given trade balance will be consistent with a smaller money demand. Indeed, if the trade balance remains unchanged, a larger share of first period private income must be saved, which depresses the money demand. As a consequence, no money demand effect that partly offsets the impact of the money supply expansion on the trade balance will be smaller, and the deterioration of the trade balance will be larger. A second mechanism will reinforce this effect. Indeed, as $\widetilde{A}$ increases productivity in the second period, I_2 will be directly affected by $\widetilde{A}$. A positive productivity effect implies that the money demand will have to shift even further down to maintain a given trade balance (as agents will be willing to spend even more in the first period if they expect a higher second period income). In other words, a higher interest rate will be needed to support a given level of savings (or trade balance).
For small values of χ, the money supply effect will dominate the demand effect, and money will increase in equilibrium.

Summary:

This discussion shows that under the assumptions of the model, the same increase in aid will have different implications for the external balance if it is spent on public investment instead of private consumption. The deterioration of the trade balance will be greater in the former case. *It will be even greater the more productive foreign aid is.*

Impact of changes in the monetary policy stance:

The impact of a reduction in the net domestic assets of the Central Bank (sterilization) is simply the opposite shift in the money supply curve without any shift in the money demand curve. It is easy to see that it would lead to a new equilibrium with an improved current account and higher interest rate (Section V.B).

Impact of Dutch disease externalities

Let's consider the impact of an increase in consumption aid in the first period realized by lowering second period aid, in presence of Dutch disease externalities.

With LBD, the money demand schedule is steeper.

To see why, note that the LBD externality implies that $I_2 = I_2\left(R - A_1 \overset{(+)}{=} TB_1 + \widetilde{A} \right)$: an improvement in the equilibrium current account *net of the aid flow* (hence a lower aggregate consumption in the first period) is associated with a lower consumption of the non-traded good in the first period, a larger traded sector, and a higher productivity gain in the second period. Another way to see this is to remark that a lower aggregate consumption in the first period leads to higher productivity growth, and that first period consumption is increasing with aid flows net of reserves: $A_1 - R$. With perfect foresight, agents anticipate this productivity effect for a given aggregate consumption, hence they will reduce their own consumption in the first period, lowering money demand. *However, ,atomistic agents do not internalize the effect of their own consumption pattern on productivity, and savings will remain to low from a welfare point of view.* Since $TB_1 = R - A_1 - \widetilde{A}$, this implies that the money demand in the money-trade balance space schedule will be steeper. This property of the money demand can be formalized as follows from equation (14). For any trade balance $\overline{TB}_1$, the slope of the money demand schedule is given by:

$$\left.\frac{dM^d}{dTB_1}\right|_{TB_1=\overline{TB}_1} = \underbrace{\frac{\partial M^d}{\partial P_1C_1}}_{+} \cdot \underbrace{\frac{\partial P_1C_1}{\partial TB_1}}_{-} + \underbrace{\frac{\partial M^d}{\partial P_2C_2}}_{-} \cdot \left[\underbrace{\frac{\partial P_2C_2}{\partial TB_1}}_{+} + \underbrace{\frac{\partial P_2C_2}{\partial I_2}}_{+} \cdot \underbrace{\frac{\partial I_2}{\partial TB_1}}_{+} \right] < 0$$

Moreover, $\frac{\partial I_2}{\partial TB_1} = 0$ if $z = 0$ and $\frac{d}{dz}\left(\frac{\partial I_2}{\partial TB_1}\right) > 0$. Since the other terms of the derivative do not depend on z , it must be clear that $\frac{d}{dz}\left(\frac{dM^d}{dTB_1}\right) < 0$.

The following results follow from this property of the money demand schedule:

- an increase in first period aid leads to a smaller deterioration of the trade balance the larger the LBD externality ;
- symmetrically, a given reduction in the net domestic assets of the Central Bank leads to a smaller improvement of the trade balance the larger the LBD externality is.

<u>Proposition 3: The Optimal Allocation of Aid</u>

The proof proceeds along the following steps.

First, we define the welfare maximization problem of a social planner.

Second, we derive constraints on the trade balance in the decentralized equilibrium.

Third, we compare the decentralized equilibrium for a given distribution of aid flows to the optimal consumption path chosen by a social planner, and discuss under which conditions a reallocation of aid flows or monetary policy can improve welfare.

In the following, we assume that $\widetilde{A}$ is exogenous, and focus on the time allocation of consumption aid, for a given total net present value of aid flows.

Welfare maximization problem:
The social planner chooses the time allocation of aid maximizes the intertemporal utility function of the representative agent under the following constraints:
(1) the total net present value of aid and aid for public investment are set exogenously;
(2) the interest rate is equal to the rate of time preference of agents: $r = r^* = \dfrac{P_2 C_2}{P_1 C_1} - 1$, where $r^* = \dfrac{1}{\beta} - 1$ ($\beta < 1$) is the subjective discount rate of the representative agent (we have so far assumed that $\beta = 1$).

Formally, for a given net present value of aid $\overline{A}$, the donor objective is to choose a time allocation of consumption, or equivalently a trade balance $TB_1 = R - A_1 - \widetilde{A}$, to maximize:

$Max_{TB_1}\left\{ W = \log C_1 + \dfrac{1}{1+r^*}\log C_2 + \chi \log\left(\dfrac{M}{P_1}\right)\right\}$ where: $\dfrac{M}{P_1} = \chi C_1 \cdot \left(1 + \dfrac{1}{r^*}\right)$ is the demand for money , C_1 and C_2 are the consumption indexes, and productivity parameters depend on the equilibrium trade balance: $a_N^2 = a_X^2 = a^2(R - A_1 - \widetilde{A})$

Thus the maximization problem simplifies to:

$$Max_{TB_1}\left\{ W = (1+\chi)\cdot \log C_1 + \frac{1}{1+r^*}\log C_2 + \chi \log\left(\chi\left(1 + \frac{1}{r^*}\right)\right)\right\}$$

Hence, one simply needs to derive the optimal saving plan for an economy in which the rate of time preference is $\beta = \dfrac{1}{(1+r^*)\cdot(1+\chi)}$. Given the aggregate budget constraints and the definition of the trade balance in each period, this is equivalent to deriving the optimal time allocation of fictitious aid flows F_1 and F_2 in an economy with balanced current account, where $F_1 = A_1 + \widetilde{A} - R$ and $F_2 = A_2 + R$. Indeed, this transformation keeps the total net present value of aid flows unchanged: $F_1 + F_2 = \overline{A}$.

The solution to this problem provides the optimal accumulation of reserves $R^{opt} = A_1 + \widetilde{A} - F_1^{opt}$ and trade balance $TB_1^{opt} = R^{opt} - A_1 - \widetilde{A}$ in the first period for an economy in which we do not impose a balanced current account. These variables can next be compared to the decentralized equilibrium.
The detailed proof is as follows.

The derivative of the welfare function with respect to F_1 and F_2 can be decomposed in the following way:

$$\frac{dW}{dF_1} = \frac{\partial W}{\partial F_1} + \frac{\partial W}{\partial e_1}\cdot\frac{\partial e_1}{\partial F_1} + \frac{\partial W}{\partial L_{N,1}}\cdot\frac{\partial L_{N,1}}{\partial e_1}\cdot\frac{\partial e_1}{\partial F_1} - Z\cdot\left[\frac{\partial W}{\partial a_{x,2}} + \frac{\partial W}{\partial a_{N,2}}\right]\cdot\frac{\partial L_{N,1}}{\partial e_1}\cdot\frac{\partial e_1}{\partial F_1}$$

where $Z = -\dfrac{\partial a_{X,2}}{\partial L_{N,1}} = -\dfrac{\partial a_{N,2}}{\partial L_{N,1}} = z \cdot h\left(x_P\left(\widetilde{A}\right)\right)$, and: $\frac{dW}{dF_2}=\frac{\partial W}{\partial F_2}+\frac{\partial W}{\partial e_2}\cdot\frac{\partial e_2}{\partial F_2}+\frac{\partial W}{\partial L_{N,2}}\cdot\frac{\partial L_{N,2}}{\partial e_2}\cdot\frac{\partial e_2}{\partial F_2}$.

Note that:

(1) $\frac{\partial W}{\partial L_{N,t}}=\frac{\partial I_t}{\partial L_{N,t}}\cdot\frac{\partial W}{\partial I_t}=0$, t=1,2, in equilibrium:

Indeed, from the firms' profit maximization conditions: $\frac{\partial I_t}{\partial L_{N,t}}=p_{N,t}\cdot\frac{\partial y_{N,t}}{\partial L_{N,t}}-p_{X,t}\cdot\frac{\partial y_{X,t}}{\partial L_{X,t}}=0$.

(2) $\frac{\partial C_t}{\partial e_t}=0$, t=1,2.

Indeed :

$$\frac{\partial C_t}{\partial e_t}=\gamma e_1^{\gamma-1}\cdot\left[\frac{q_1}{e_1}\cdot y_{X,1}+y_{N,1}+\frac{1}{e_1}\cdot\frac{F_1}{\left(p_{T,1}^*\right)}\right]-e_1^{\gamma}\cdot\left[\frac{q_1}{e_1{}^2}\cdot y_{X,1}+\frac{1}{e_1{}^2}\frac{F_1}{\left(p_{T,1}^*\right)}\right]$$

$$=\frac{1}{e_t}\frac{p_{T,t}\cdot c_{T,t}-p_{X,t}\cdot y_{X,t}-E_tF_t}{P_t}=\frac{1}{e_t}\cdot\frac{CA_t}{P_t}=0$$

(3) $\frac{\partial W}{\partial e_2}=\frac{\partial W}{\partial C_2}\cdot\frac{\partial C_2}{\partial e_2}=0$

(4) $\frac{\partial W}{\partial e_1}=\frac{\partial W}{\partial C_1}\cdot\frac{\partial C_1}{\partial e_1}=0$

(5) Simple algebra yield:

$\frac{\partial W}{\partial F_t}=\frac{\partial W}{\partial C_t}\cdot\frac{\partial C_t}{\partial F_t}=\frac{1}{I_t^*+F_t}$, t=1,2, with: $I_t^*=\frac{I_t}{E_t}$.

And:

$$\frac{\partial W}{\partial a_{X,2}}+\frac{\partial W}{\partial a_{N,2}}=\frac{1}{a_2}\cdot\frac{I_2}{I_2+E_2F_2}.$$

Therefore the marginal benefit (MB) and marginal cost (MC) of increasing F_1 are respectively:

$$MB(F_1)=\frac{1}{I_1^*+F_1}$$

$$MC\left(F_1\right)=\frac{1}{I_2^*+F_2}+\frac{I_2^*}{I_2^*+F_2}\frac{z}{a_2}\cdot h\cdot\frac{\partial L_{N,1}}{\partial e_1}\frac{\partial e_1}{\partial F_1}\quad\text{where } F_2=\overline{A}-F_1$$

A sufficient condition for the MC curve to be downward sloping is $\frac{zh}{a_2}$ small, which is equivalent to:

$\frac{z}{a_1}<<1+zL_{X,1}$. A sufficient condition is therefore: $\frac{z}{a_1}<<1$

Indeed, $MC'\left(F_1\right)=\frac{\partial MC_1}{\partial F_1}+\frac{\partial MC}{\partial I_2}\cdot\frac{\partial I_2}{\partial F_1}$

Where: $\frac{\partial MC_1}{\partial F_1} = \frac{1}{(I_2+F_2)^2} + \frac{I_2}{(I_2+F_2)^2}\cdot\frac{z}{a_2}\cdot h\cdot\frac{\partial L_{N,1}}{\partial F_1} + \frac{I_2}{I_2+F_2}\cdot\frac{z}{a_2}\cdot h\cdot\frac{\partial}{\partial F_1}\left(\frac{\partial L_{N,1}}{\partial F_1}\right)$

Combining (A-1) and (A-2), the amount of labor allocated to the non-traded sector in period 1 is solution to the following, assuming again that $a_{N,t} = a_{X,t} = a_t$, t=1,2:

$$q\left(\frac{L_{N,1}}{L-L_{N,1}}\right)^{1-\alpha} = \left(\frac{1-\gamma}{\gamma}\right)\cdot q\cdot\left(\frac{L-L_{N,1}}{L_{N,1}}\right)^{\alpha} + \frac{F_1/p_T^*}{\gamma a_1 L_{N,1}}$$

which gives an implicit function: $H(L_{N,1}, F_1) = 0$

Hence, $\frac{\partial^2 L_N^1}{(\partial F_1)^2} = -\frac{\partial}{\partial F_1}\left(\frac{\partial H/\partial F_1}{\partial H/\partial L_N}\right)$. One can show that: $\frac{\partial^2 L_N^1}{(\partial F_1)^2} = \frac{\alpha/p_T^{*2}}{(\gamma a_1 L_N^{\alpha})^2}\cdot\frac{1}{L_N} > 0$

Next $\frac{\partial I_2}{\partial F_1} < 0$ in presence of LDB externality, while $\frac{\partial MC}{\partial I_2} = \frac{-1}{(I_2+F_2)} + \frac{F_2}{(I_2+F_2)^2}\frac{zh}{a}\frac{\partial L_{N,1}}{\partial F_1}$

Therefore a sufficient condition for $\frac{\partial MC}{\partial I_2}$ to be positive is again that $\frac{zh}{a_2}$ is small and $\frac{\partial L_{N,1}}{\partial F_1}$ not too large, which is the case as long as the non-traded sector is large enough.

Indeed, one can show that: $\frac{\partial L_{N,1}}{\partial F_1} = \frac{1/p_T^*}{\gamma a_N L_N^{\alpha}}\cdot Z(L_N)$.

Constraints on the trade balance

Before characterizing the constraints on the trade balance in this model, let us note that the time path of aid does not *always* matter in the decentralized equilibrium despite the fact that the capital account is closed. Indeed, as long as the Central Bank holds enough reserves initially, agents can reduce their holdings of public bonds (this reducing their savings), and increase their consumption. In fact, since there are no ceiling on the issuance of public bonds B_0 and that the income generated by the issuance of bonds is always redistributed to agents, *there is no ceilings on the net domestic assets of the Central Bank even if the amount of bonds held by the private agents B is never negative*. This implies that monetary policy can be arbitrarily expansionary as long as the external balance constraint is met. Since an expansionary monetary policy implies greater private consumption, the decentralized equilibrium mimics the one of an economy with perfect capital market as long as the constraint on international reserves is not binding. In fact, the *equilibrium aggregate* international reserves play the role of the storage technology allowing consumption smoothing. The macroeconomic analogy with an economy with perfect capital markets is clear from the economy-wide budget constraints:

$$\begin{cases} P_1C_1 + p_{T,1}x_{T,1} + p_{N,1}x_{N,1} = I_1 + A_1 + \widetilde{A} - R \\ P_2C_2 = I_2 + A_2 + R \end{cases}$$ with $A_2 = \overline{A} - \widetilde{A} - A_1$ and $p_{T,1}x_{T,1} + p_{N,1}x_{N,1} = \widetilde{A}$

However, if the Central Bank has limited reserves R_0, and first period revenues are low relative to second period revenues, the constraint $-R \le R_0$ on the external balance will be binding, and the distribution of aid will matter. Let us consider an economy in which $R_0 = 0$.

The trade balance for which the external balance' constraint is binding is the following

$$TB_1 = -A_1 - \widetilde{A}$$

indeed $R = 0 \Leftrightarrow TB_1 = -A_1 - \widetilde{A}$.

Thus, it is a decreasing function of first period aid. The constraint $R > \hat{R}$ must also be met. Using the definition of $\hat{R}$ and the trade balance, one obtains the following condition on the trade balance:

$TB_1 > \max\left(-A_1 - \widetilde{A}, \frac{1}{2}\cdot\left(I_1(TB_1) - A_1 - \widetilde{A} - I_2(TB_1) - A_2\right)\right)$. From the proof of the existence of equilibrium, it is easy to see that the RHS of this inequality is a decreasing function of first period aid.

So, the constraint on the trade balance to have an interior decentralized equilibrium is:

$TB_1 > TB_1^0$ where TB_1^0 is defined by the implicit function:

$$TB_1^0 = \max\left(-A_1 - \widetilde{A}, \frac{1}{2}\cdot\left(I_1(TB_1^0) - A_1 - \widetilde{A} - I_2(TB_1^0) - A_2\right)\right)$$

Moreover, in the economy in which $r \approx r^*$, the limit lower bound for the equilibrium trade balance to have a well defined money demand is given by $P_1C_1 = P_2C_2$, or $T\hat{B}_1 = \hat{R} - A_1 - \widetilde{A}$. Therefore, using the definition of $\hat{R}$ one can show that:

$$T\hat{B}_1 \leq TB_1^0 \Leftrightarrow 2(a_1 + \widetilde{a}) \leq (1+g)\cdot(1+\overline{a}) - 1$$

where g is the growth rate of nominal GDP between period 1 and period 2,

and $a_1 = \frac{A_1}{I_1}$, $\widetilde{a} = \frac{\widetilde{A}}{I_1}$, and $\overline{a} = \frac{\overline{A}}{I_2}$.

Decentralized Outcome versus Optimal Outcome: the Role of Redistributing Aid

Define TB_1^* the equilibrium trade balance of an economy in which the Central Bank has unlimited initial reserves.

Hence, a corner equilibrium is more likely to happen ($TB_1^* < TB_1^0$) when (1) total aid flows are large relative to GDP, (2) GDP is expected to grow at a high rate, and (3) aid flows are backloaded.

In such a situation, it is clear that the allocation of aid will affect consumption patterns and welfare.

Consider first the case in which there is no LDB and h=0. In such a case, $TB_1^* = TB_1^{opt}$.

In this case, holding other parameters constant, an increase in A_1 will increase first period consumption, and improve welfare as long as $TB_1^* < TB_1^0$. Conversely, a further increase in A_1 won't affect consumption and welfare if $TB_1^* \geq TB_1^{opt}$, i.e. when A_2 becomes small.

For the same reason, for a given allocation of aid, a negative shock on first period income, holding future growth prospects constant, will make front-loading aid more likely to improve welfare.

Next, in presence of LDB and with h=0, $TB_1^* < TB_1^{opt}$, i.e. agents do not internalize the impact of their first period consumption decision on LDB (However, they do anticipate a lower income if aggregate first period consumption rises, as already discussed). Three cases arise:

(1) $TB_1^* < TB_1^{opt} < TB_1^0$. It is then optimal to *increase* first period aid, but by less than in the previous situation, until $TB_1^{opt} = TB_1^0$,(i.e. the external balance constraint is still binding in equilibrium: $TB_1^* < TB_1^0$) which is the optimal allocation of consumption between period 1 and period 2.

(2) $TB_1^* < TB_1^0 < TB_1^{opt}$: even though agents are constrained in their consumption decisions, and the Central Bank does not accumulate any reserves between period 1 and period 2, it is optimal to *decrease* first period aid until $TB_1^0 = TB_1^{opt}$. In other words, it is optimal to make the external balance *more* constrained.

(3) $TB_1^0 < TB_1^* < TB_1^{opt}$: in this case the economy is not constrained, but it is optimal to make it constrained by reducing first period aid until: $TB_1^* < TB_1^0 = TB_1^{opt}$.

An alternative to back-loading aid in cases (2) and (3) is for the Central Bank to raise the interest rate above r^* to induce a higher saving rate by private agents.

Finally, it is easy to see that in presence of LDB and with $h \neq 0$, the desired decentralized equilibrium trade balance TB_1^* can be either above or below the one for which there is no LDB and h=0, depending on the relative size of the two effects. However, agents will always overconsume in the first period, hence the following inequality will still hold $TB_1^* < TB_1^{opt}$.

MANAGED FLOAT AND FLEXIBLE EXCHANGE RATE REGIMES

In this section, we show that our results on the role of monetary policy can be generalized to countries with a managed float or with a flexible exchange rate regime.

Managed Float

In the case of managed float, the equilibrium real exchange rate adjusts to any given monetary policy and intervention policy through the nominal exchange rate instead of the price level. The CPI levels P_1 and P_2 are the nominal anchors (price level targets) for monetary policy, and the central bank chooses an intervention policy in the foreign exchange market that targets a level of foreign exchange reserves $R = R_0$. The nominal and the real exchange rates adjust to a level consistent with the price and reserve targets.

Formally, the nominal exchange rates in each period are derived from the current account constraints. In the first period the equilibrium nominal exchange rate E_1 equates the supply (exports revenues and aid inflows) and demand of foreign currency (imports, reserves bought by the central bank R_0, and foreign currency held by private agents). In the second period, the supply of foreign currency is the sum of reserves held by the Central Bank, foreign currency held by domestic agents, exports revenues and foreign aid inflows; the demand for foreign currency is simply the demand for imports:

$$\begin{cases} R_0 + M_1^* + \left(p_{T,1}\right)^* \cdot c_{T,1} + \left(p_{T,1}\right)^* \cdot x_{T,1} = \left(p_{X,1}\right)^* \cdot y_{X,1} + \widetilde{A} + A_1 \\ R_0 + M_1^* + \left(p_{X,2}\right)^* y_{X,2} + A_2 = \left(p_{T,2}\right)^* c_{T,2} \end{cases}$$

The central bank chooses net domestic assets $B_0 - B$ to generate a level of aggregate demand consistent with the targeted price levels and international reserves.

The central bank can implement the same allocation of resources of the case with fixed exchange rates. Consider, for instance, an equilibrium with reserves R^*, price levels P_1^* and P_2^*, and bonds held by the private sector B^* that are consistent with fixed exchange rates E_1^* and E_2^*. Note that the price levels P_1^* and P_2^* and the nominal exchange rates E_1^* and E_2^* uniquely characterize the equilibrium real exchange rates e_1^* and e_2^* (see equations (1-1) and (1-2)), which, together with international reserves R^*, determine the allocation of resources and consumption-savings decisions. This resource allocation can be replicated with price targets $\overline{P_1^*}$ and $\overline{P_2^*}$ exogenously set, a target for international reserves $R_0 = R^*$, and net domestic assets $B_0 - B$ such that the private sector holds B^*. These policies would imply different price levels $\overline{P_1^*}$ and $\overline{P_2^*}$ and nominal exchange rates $\overline{E_1^*}$ and $\overline{E_2^*}$ than in the fixed exchange rate regime case but the same real exchange rates:

$$e_1^* = \left(\frac{\overline{P_1^*}}{\overline{E_1^*} \cdot p_{T,1}^*} \right)^{\frac{1}{1-\gamma}} \quad \text{and} \quad e_2^* = \left(\frac{\overline{P_2^*}}{\overline{E_2^*} \cdot p_{T,2}^*} \right)^{\frac{1}{1-\gamma}}$$

Floating exchange rate

In principle, in a country with a purely floating exchange rate, the central bank does not intervene in the foreign exchange market, and therefore does not accumulate foreign exchange reserves. This seems *a priori* to rule out the extension of our model to the case of a pure float.

In reality, however, even in floating exchange rate regimes, aid-receiving governments do not exchange foreign currency for domestic currency on the foreign exchange market, as discussed in Section II.C. Instead, they tend to deposit their foreign-currency aid at the central bank. Initially, this operation raises international reserves and reduces net domestic assets by the same amount. When the government starts drawing on its account at the central bank to finance public expenditure or transfers, money supply grows. The central bank can then undo this monetary expansion through open market sales of bonds or the government can postpone drawing down its account to allow the central bank to achieve its net domestic asset target $B_0 - B$.[39] The central bank may also need to conduct a one-off intervention in the foreign exchange market to bring international reserves in line with the targeted current account and gross national savings.

In a pure float, if the government holds deposits with commercial banks rather than at the central bank, foreign aid inflows will *not* automatically increase base money. To our knowledge, however, the only case among aid-receiving countries of governments holding deposits with commercial banks is that of CFA African countries. Given that these countries have a fixed exchange rate regime, base money still increases in response to aid inflows because commercial banks request domestic currency in exchange of foreign currency when the government needs to spend the aid deposited with them.

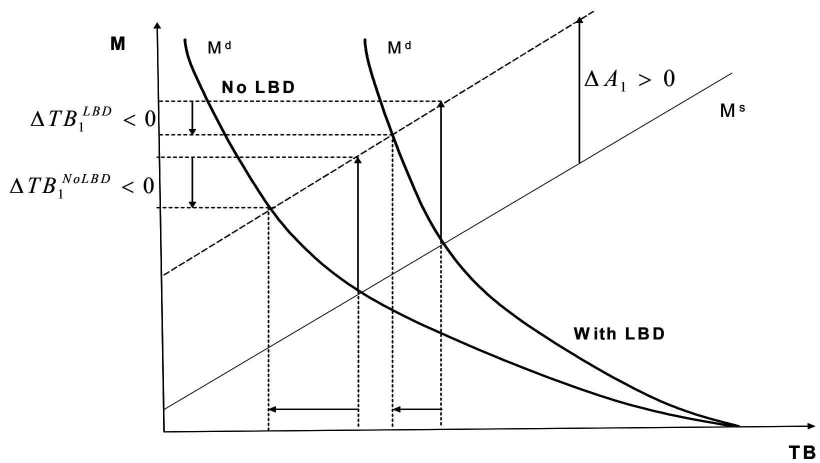
In practice, the case of a flexible exchange rate can be seen as equivalent to the case of a managed float. On the domestic side, monetary expansion does occur as a result of government deposits at the central bank while sterilization policy remains feasible. On the external side, foreign exchange intervention is a one-off action limited to periods of foreign aid inflows, and can be used to target a desired level of foreign exchange reserves.

[39] Such fiscal sterilization of foreign aid inflows was used for instance in Mozambique (see Buffie et al. 2004).

GENERAL EQUILIBRIUM EFFECT OF FRONT-LOADING AID WITH LBD EXTERNALITIES

In the presence of LBD externalities, the money demand schedule is steeper, hence front-loading consumption aid has a smaller effect on the trade balance (Figure 3b, see the formal proof in Appendix I). This happens because, with LBD externalities, the real appreciation caused by an increase in period one aid shrinks the traded sector, reducing period two productivity (equations (5) and (6)) as well as period two income, I_2, in equation (14). Given that agents have perfect foresight, they anticipate the reduction in future consumption and save more in period one at the initial level of the interest rate. For a given supply of bonds, these higher savings demand will put downward pressure on interest rates. Therefore, a given level of savings (or trade balance) will be achieved at a lower interest rate, hence at a higher money demand. Figure 3b shows that the same ΔA_1 will increase equilibrium money balances more with LBD than without LBD externalities. Figure 3b also shows that ΔA_1 has a smaller impact on the trade balance in the presence of LBD, as each individual increases his first period consumption by a smaller amount than without LBD, anticipating lower second period income and consumption. *Note, however, that atomistic individuals do not take into account the impact of their own consumption on productivity growth and, therefore savings remain too low from a welfare point of view.*[40]

Figure 3b: Front-loading Consumption Aid *with* LBD Externalities

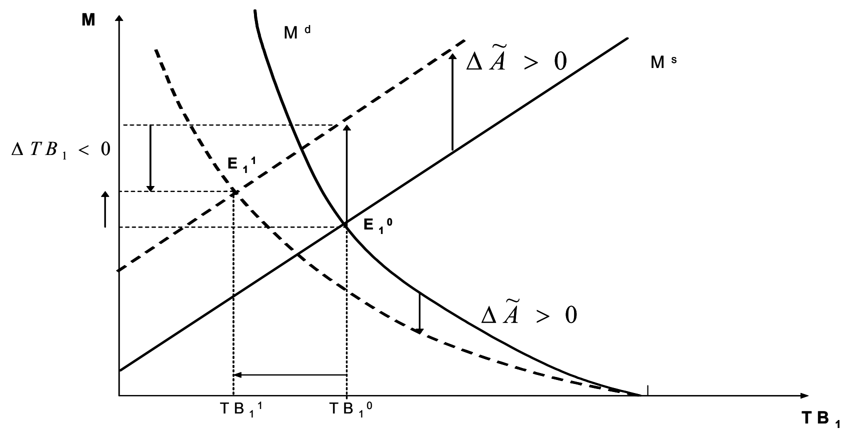


In the absence of LBD externalities, front-loading productivity-enhancing aid for public investment (i.e., increasing $\widetilde{A}$ by reducing A_2 while keeping $\overline{A}$ constant) shifts money supply up and money demand down (Figure 3c). The downward shift in money demand has two components. First, for any given trade balance, the higher productivity (due to a higher $\widetilde{A}$) raises I_2 in equation (14) shifting money demand down. The expectation of higher future consumption makes agents try to save less at the initial level of interest rates. For a given supply of bonds, this reduction in savings demand will put upward pressure on interest rates and shift money demand down (i.e., a given level of savings will be achieved at higher interest rates, hence at a lower money demand). Second, as shown in equation (14), a higher $\widetilde{A}$ further reduces money demand at each

[40] By definition, an externality implies that, while agents predict the effect of the *aggregate* increase in period one consumption on future productivity, they do not internalize the effects of their *individual* consumption on future productivity. This inability to coordinate their actions implies that, in the presence of an externality, the decentralized allocation of resources is not optimal from a welfare point of view, and savings are too low. On this point, see the discussion in Section VI.

level of the trade balance. Indeed, since our model assumes that money has no liquidity role for the public sector, the demand for money will fall at any level of the trade balance because consumption aid is lower when $\widetilde{A}$ is higher. Figure 3c shows that, with productivity-enhancing aid, the trade balance will deteriorate more than in the case of consumption aid,[41] while money balances will increase if χ is small enough (i.e., the drop in money demand is not too large). The more productive is public investment, the higher is the expected future consumption, and the greater is the deterioration of the trade balance.

Figure 3c: Front-loading Productivity-Enhancing Aid



In the presence of LBD, *front-loading productivity-enhancing aid for public investment* will result in a somewhat smaller period two productivity benefit. In fact, given that the shares of tradables and non-tradables in the production of the public good are the same as in consumption (equation (8)), $\Delta\widetilde{A}$ will raise nontradable prices and reduce the recipient country's competitiveness, causing at least as much real appreciation as consumption aid and a greater deterioration of the trade balance.[42]

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[41] Note that this result rests on the assumption that spending for investment or consumption have the same composition of tradable and non-tradable goods. Different composition between tradable and non-tradable goods would be an additional source of differences in the response of the trade balance and real money balances.

[42] This lower trade balance will be associated with a more appreciated real exchange rate in the first period that will make the negative Dutch disease effects on second period productivity larger than in the case of consumption aid.

PSEUDO FIRST STAGE OF SYSTEM GMM PANEL REGRESSIONS

Tables 4a and 4b report pseudo first stage of the system GMM regressions, respectively for the trade balance regression (1) of Table 1a and for the export regression (1) of Table 2a. For each endogenous variable (Aid/GDP, Exports/GDP, and Trade Balance/GDP), instruments include lags of the variable dated t-2 and t-3, in levels or changes depending on the specification. For the pre-determined variable (Change in the Net Domestic Assets/GDP), instruments are the lags dated t-1 to t-3, again in levels or changes. In the difference equations, changes of each of the dependent variables are instrumented on the lags levels of the three variables. In the level equations, levels of each of the dependent variables are instrumented on the lags of the changes of the three variables. Our first stage includes two strictly exogenous variables which also enter the second stage: the contemporaneous Exports Commodity Price Index, and the contemporaneous Real Import Demand from Trading Partners. Finally, two additional strictly exogenous instruments are included in the first stage: a Dummy for Drought and the Exports Commodity Price Index, both dated t-3.

To check for potential weak instruments problems, we report F tests of the joint significance of the lags of each the three variables instrumented. If one excludes the levels equations for the change in net domestic assets, F tests of joint significance are typically above 10 (and above 20 in 8 out of 10 regressions), suggesting that our results (point estimates, standard errors and specification tests) are unlikely to be biased by problems of weak instruments. Note that the low F test in the level regressions for the net domestic asset simply confirm that there is typically no persistence in changes in net domestic assets.

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