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by Carlos de Resende

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Abstract

The author studies the welfare implications of adjustment programs supported by the International Monetary Fund (IMF). He uses a model where an endogenous borrowing constraint, set up by international lenders who will never lend more than a debt ceiling, forces the borrowing economy to always choose repayment over default. The immediate potential welfare cost of joining a program is driven by *IMF conditionality*: to be able to borrow from the IMF, the country has to submit to limits on the consumption of public goods. The benefits derive from the additional borrowing from the IMF (at a lower interest rate) and/or through a "catalytic effect" on private loans, which facilitates consumption smoothing over time. Simulations of the dynamic model in two institutional environments—with and without the IMF—are compared. Results indicate that when conditionality forces the country to save more, at a cost that does not prevent it from joining an IMF program, the resulting lower probability of default can induce private lenders to relax their borrowing constraints. Based on a calibration of the model for the Brazilian economy, the overall welfare gains associated with IMF programs are relatively small.

JEL classification: F32, F33, F34, F41
Bank classification: International topics

Résumé

L'auteur étudie les incidences sur le bien-être des programmes d'ajustement financés par le Fonds monétaire international (FMI). Il élabore pour ce faire un modèle doté d'une contrainte endogène de crédit correspondant au plafond d'emprunt que fixent les prêteurs internationaux et obligeant le pays emprunteur à toujours préférer le remboursement à la défaillance. En termes de bien-être, le coût potentiel immédiat de l'adhésion à un programme d'ajustement découle de la *conditionnalité des prêts du FMI* : pour recevoir un prêt de cette institution, un pays doit restreindre sa consommation de biens publics. Les bénéfices qu'il en tire consistent dans l'accès élargi aux crédits du FMI (assortis d'un taux d'intérêt moindre) et/ou dans l'effet catalyseur que produit sur les bailleurs de fonds privés cette facilité de prêt, qui permet de mieux lisser la consommation au fil du temps. L'auteur compare les simulations effectuées à l'aide de son modèle dynamique dans deux cadres institutionnels différenciés par la présence et l'absence du FMI. Ainsi, lorsque la conditionnalité force un pays à épargner davantage, mais sans que ce coût l'empêche de s'engager dans un programme du FMI, la réduction de la probabilité de défaillance qui en résulte peut pousser les prêteurs privés à assouplir leurs contraintes de crédit. D'après les résultats obtenus au moyen d'un modèle calibré en fonction des caractéristiques de l'économie brésilienne, les gains de bien-être attribuables aux programmes du FMI sont, dans l'ensemble, plutôt minces.

Classification JEL : F32, F33, F34, F41
Classification de la Banque : Questions internationales

1 Introduction

This paper is a quantitative study of the welfare implications of adjustment programs supported by the International Monetary Fund (IMF). More specifically, it investigates whether IMF-supported programs help countries improve their access to international capital markets, and quantifies the associated welfare gains.

It is reasonable to argue that IMF programs have been responsible for a large part of the economic policy carried out by transition and/or emerging economies. In some periods, these programs have been "*the* critical element in macroeconomic policy" (Fischer 1997, 23) in those economies. The question of whether IMF programs actually help the countries that adopt them is central to the evaluation of the Fund's performance.

The literature on the evaluation of IMF-supported programs is extensive and largely based on reduced-form econometric models applied to cross-country samples (Haque and Khan 1998; Barro and Lee 2002; Mody and Saravia 2003; Joyce 2004; and Bordo, Mody, and Oomes 2004). In general, these cross-country studiesexamine estimated coefficients from the regressions of selected macroeconomic variables (current account, overall balance of payments, inflation, growth, private capital flows, etc.) interacted with an IMF program dummy. This approach may not provide the appropriate metric to evaluate the success of these programs, because there is no clear mapping between welfare measures and the regression coefficients.

This paper takes a different approach to evaluating IMF programs. It considers a model in the tradition of Eaton and Gersovitz (1981) and Kletzer (1984), where an endogenous borrowing constraint limits the ability of a small open economy to smooth consumption. The economy optimally decides whether it will repay or default on its external debt. The benefit of default (a higher level of consumption today) is balanced against the costs (an output loss associated with indirect costs of default plus the exclusion from international capital markets in the future). Foreign lenders impose a debt ceiling such that the country never chooses to default. This type of borrowing constraint prevents full consumption smoothing and thus helps explain part of the excess consumption volatility (normalized by output volatility) experienced by emerging economies, in comparison with more developed ones (Resende 2006). Any increase in the relative benefits of default vis-à-vis repayment induces the lenders to lower the level of the borrowing constraint, generating even more consumption volatility. In this context, IMF programs can be welfare improving if they help ease the constraint and reduce volatility.

In the model, agents derive utility from the consumption of tradable and non-tradable goods, which can be consumed either as private or public goods. The economy can borrow abroad from private agents or from the IMF, upon formally adopting an adjustment program. The decision to adopt an IMF program is endogenous. The immediate cost of a program is *IMF conditionality*: the country must submit to restrictions on the consumption of public goods in order to borrow from the IMF. The benefits are twofold: (i) the interest rate on IMF loans is lower than that charged by private agents, and (ii) there may be additional consumption smoothing if IMF lending positively affects the total amount of available funds for the country to borrow.

The borrowing constraints related to the two components of total external debt are set up differently. While IMF loans are subject to an exogenous institutional limit, there is an endogenous constraint on the borrowing from private agents, given the ceiling for IMF loans. The IMF can relax the borrowing constraint on total debt in two ways. First, there is the direct effect of a higher level of IMF lending for a given level of (maximal) debt from private lenders. Second, IMF-supported programs may have an indirect, general-equilibrium *positive catalytic effect* on private lending, by inducing a relaxation of the endogenous borrowing constraint. The main driving force behind positive catalysis of private lending is the reduction of the likelihood of default induced by the incentives and punishments associated with IMF programs. If they reduce the ex ante relative incentives to default, then private lenders may relax their borrowing constraint.

The likelihood of default is affected by IMF programs when they induce a higher ex ante propensity to save through conditionality. It is shown numerically that this mechanism does not work when the consumption of public goods is optimally chosen: when conditionality is too strong, the economy avoids IMF programs, since the forced savings are too costly with regards to suboptimal levels of public goods consumption. In that case, the country does not increase savings. When conditionality is less strict, IMF program participation is positive, but there are no additional savings either, because the economy is already optimizing at a level of public goods consumption that is lower than that required by conditionality.

In an alternative set-up, the economy cannot commit to a low level of public goods consumption unless it signs an IMF program. In this case, when the IMF acts as a "commitment device," conditionality can simultaneously force a higher propensity to save while driving the economy closer to the optimal allocation. As a result, IMF program participation is positive and has a positive catalytic effect on private lending.

The model is calibrated to the Brazilian economy. Two relevant questions regarding IMF-supported programs can be answered based on the results. First, can conditionality, in the form of restrictions on domestic absorption (in the model, limits on the consumption of public goods), help relax the borrowing constraint imposed by private foreign lenders? That is, can conditionality produce a positive catalytic effect on the country's access to international private capital markets? Second, for reasonable values of the structural parameters, what are the welfare gains associated with a less stringent constraint on international borrowing?

The rest of this paper is organized as follows. The theoretical model is described in section 2 and a quantitative exercise is presented in section 3. Section 4 offers some conclusions.

2 The Model

This section extends a model in the tradition of Eaton and Gersovitz (1981) and Kletzer (1984) by incorporating an endogenous decision to adopt an IMF program. Specific components of the model are discussed, such as preferences, stochastic endowments, the characterization of international capital markets, the resource constraints, the endogenous borrowing constraint on external debt, and the IMF.

2.1 Preferences

Consider a small open economy, where a central planner seeks to maximize the lifetime utility of a representative agent. The agent enjoys utility from the consumption of both private and public goods, summarized by the indexes c_t and g_t, respectively. The planner's objective function is:

$$V_0 = \mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t u\left(c_t, g_t\right), \tag{1}$$

where $\beta \in (0,1)$ is the subjective discount factor, and the function u is strictly concave and strictly increasing in both arguments, twice continuously differentiable, and satisfies the Inada conditions with respect to both arguments.

Indexes c_t and g_t are constant elasticity of substitution (CES) aggregators of the consumption of tradable and non-tradable goods:

$$c_t = \left[\omega_c \left(c_t^T\right)^{-\mu_c} + (1-\omega_c)\left(c_t^N\right)^{-\mu_c}\right]^{-\frac{1}{\mu_c}}, \tag{2}$$

$$g_t = \left[\omega_g \left(g_t^T\right)^{-\mu_g} + (1-\omega_g)\left(g_t^N\right)^{-\mu_g}\right]^{-\frac{1}{\mu_g}}, \tag{3}$$

where c_t^T and c_t^N denote consumption of tradable and non-tradable goods as private goods, respectively, and g_t^T and g_t^N have similar denotations for public goods. The parameters μ_c and μ_g determine the elasticities of substitution between tradable and non-tradable goods within the indexes c_t and g_t, given by $1/\left(1+\mu_i\right) > 0$, $i = c, g$, respectively. The weights of tradables in the respective indexes are ω_c and ω_g, both in the $[0,1]$ interval.[1]

2.2 Endowments

The supply side of the economy is characterized by:

$$y_t^N = y^N, \tag{4}$$

$$y_t^T = y^T + z_t. \tag{5}$$

[1] It is common to associate public goods with services, which are non-tradable goods. One interpretation of (3) is that the planner takes part of the endowments of both tradable and non-tradable goods, produces g_t according to the CES technology, and then allocates the "output" to the representative consumer.

Equations (4) and (5) represent the constant flow of non-tradable goods $\left(y^N > 0\right)$ and the stochastic endowment of tradable goods $\left(y_t^T > 0\right)$, received by the representative agent, respectively. The only source of uncertainty in the model is the shock to the tradable endowment, $z_t \in \Omega_Z$, which is assumed to follow a first-order Markov chain with transition probabilities given by $\pi\left(z_t|z_{t-1}\right)$ over the compact set Ω_Z.

The introduction of tradable and non-tradable goods is not crucial. However, it adds some interesting dynamics through movements in the real exchange rate (p_t) as defined by the relative price of non-tradables in terms of tradables. In particular, the volatility of any aggregate variable $X_t = x_t^T + p_t x_t^N$, for $X = C, G, Y$ and $x = c, g, y$, will depend not only on the exogenous underlying volatility associated with the stochastic process for z_t, but also on the *endogenous* volatility of p_t.[2]

2.3 External debt

It is assumed that international asset/capital markets are incomplete and that no contingent contracts are available.[3] The economy can always borrow $d_t \in \boldsymbol{D} \subseteq \mathcal{R}$ from private lenders (or "banks"). It can also borrow $f_t \in \boldsymbol{F} \subseteq \mathcal{R}^+$ from the IMF *only* if it agrees to sign an adjustment program and comply with the conditions imposed by the Fund, as discussed in section 2.6 and Appendix A. Both types of loans[4] are expressed in units of the tradable good, and are contracted at time $t-1$, to be paid at time t. Loans from banks charge the constant interest rate, r, while Fund loans are signed at a lower interest rate, $r^* < r$.

The assumption of lower interest rates on IMF loans has both theoretical and technical/computational implications (section 2.6). On the one hand, it affects the relative incentives to default and, as a consequence, the possibility of positive catalysis of private loans by IMF lending. On the other hand, it helps to substantially reduce the computational cost of the model's numerical solution,[5] while being representative of actual IMF lending.[6]

The total external debt, $d_t^* \in \boldsymbol{D}$, observed at the end of every period t, is:

$$d_t^* = d_t + IMF_t f_t, \tag{6}$$

where the discrete-choice variable IMF_t takes the value of 1, if the country optimally decides to adopt an IMF program, or 0 otherwise.

[2] Arellano (2005) notes an interrelated reason for having tradable and non-tradable goods in this type of model. The relative size of the tradable sector has a negative effect on the probability of default, *ceteris paribus*.

[3] This differs from Kehoe and Levine (1993), who discuss endogenous borrowing constraints with complete markets. The assumption of incomplete markets used in this paper seems to better reproduce the evidence that countries tend to default during hard times. See Arellano (2005).

[4] We refer to loans, but the analysis is equally valid for debt in the form of bonds.

[5] For instance, when combined with an upper limit on f_t imposed by the IMF (see section 2.6), the planner's problem is well defined, and the economy will always borrow up to that limit when it decides to borrow from the IMF. In that case, the state-space for f_t can be discretized into only two points, consisting of zero and that upper limit.

[6] From 1981 to 2005, the average annual "rate of charge" (the interest rate on IMF loans) was about 5.3 per cent a year, while sovereign bond yields from IMF borrowing countries, such as Brazil, paid more than 12 per cent a year.

Following Eaton and Gersovitz (1981), there is no commitment technology that forces the country to repay its external debt. The choice between defaulting or repaying the debt is endogenous. Should the planner optimally choose to default at time t, it is assumed that: (i) default would occur in both types of loans (i.e., countries cannot default on IMF loans and repay private loans, and vice versa), and (ii) international lenders, both private banks and the IMF, would exclude the country from intertemporal asset trading forever.[7] That is, the country not only faces a discrete choice of joining an IMF program, but must also choose between default ($DEF_t = 1$) or repayment ($DEF_t = 0$). The discrete choices involving both IMF_t and DEF_t are explained in section 2.6.

2.4 Resource constraints

The economy is subject to two resource constraints. For the non-tradable good, the constraint is:

$$c_t^N + g_t^N = DEF_t \lambda y^N + (1 - DEF_t)\, y^N, \tag{7}$$

where $\lambda \in (0, 1)$.

The $(1 - \lambda)$ reduction in y^N, when $DEF_t = 1$, is a reduced-form way of introducing an "output loss" due to indirect costs associated with the default state.[8] The factor λ is effective as long as the economy remains in the default state. Given the assumption of permanent exclusion from international capital markets in case of default, this cost is permanent.[9]

In terms of the tradable good, the resource constraint is:

$$c_t^T + g_t^T = DEF_t \lambda y_t^T + (1 - DEF_t) \left[y_t^T + d_t^* - (1 + r)\, d_{t-1}^* + (r - r^*)\, IMF_{t-1} f_{t-1} \right]. \tag{8}$$

Notice that, in case of full repayment, the available resources for consumption, after servicing the outstanding debt, come from the endowment and/or new loans. The last term in (8) accounts for the fact that part of d_{t-1}^*(i.e., $IMF_{t-1} f_{t-1}$) is contracted at the lower interest rate, r^*. In case of default, the country does not pay the debt services, cannot contract d_t^*, and must consume the endowment reduced by the factor λ.

[7] In reality, defaulting countries are able to borrow again after some renegotiation of their debts. In terms of the model presented in this paper, the penalty for defaulting countries is higher than what actually occurs. Arellano (2005) introduces an exogenous probability of leaving the default state at each period. Yue (2004) endogenizes the renegotiation process as a Nash bargaining game between the sovereign and the creditors.

[8] These costs may include disruption in the countries' ability to engage in international trade, sanctions imposed by foreign creditors, or damages caused to the financial system (Cole and Kehoe 1998). For instance, Chuhan and Sturzenegger (2003) find that the per cent contraction in output in Latin America, following the default episodes in the 1990s, was about 2 per cent.

[9] As in other empirical studies that rely on real business cycle models based on Eaton and Gersovitz's (1981) framework (Arellano 2005; Aguiar and Gopinath 2004), λ is necessary for calibration purposes. For reasonable values of the structural parameters, the threat of financial autarky alone cannot generate the debt-to-output ratios observed in actual indebted economies.

2.5 The borrowing constraint

The lack of commitment to repay the external debt introduces another imperfection to the international capital markets, in addition to the fact that they are incomplete. The possibility of choosing optimal default is reflected in the following endogenous borrowing constraint faced by the planner:

$$d_t^* \leq \overline{d}_t^* = \min_{\Omega_Z} \left\{ \overline{d}_t^* \left(S_t \right) : V_t^R \left(\overline{d}^* \left(S_t \right), S_t \right) = V_t^D \left(z_t \right) \right\}, \tag{9}$$

where V_t^R and V_t^D are the time-t values of the indirect utility obtained by the representative agent in the states of repayment and default, respectively, and $S_t = \{z_t, f_{t-1}, IMF_{t-1}\}$ is a partition of the state of the economy, given by $\left\langle d_{t-1}^*, S_t \right\rangle \in \boldsymbol{S} = [\boldsymbol{D} \times \Omega_Z \times \boldsymbol{F} \times \{0,1\}]$.

The constraint (9) differs from others used in the literature, often specified arbitrarily outside economic models.[10] It captures the notion that borrowers face credit limits that depend not only on their characteristics, but also on their income streams and the endogenous current state of the economy. Notice that $\overline{d}_t^*$ is the maximal amount of funds that the domestic economy can borrow, including private and IMF loans, without triggering the strategy of optimal default. As implied by the constraints (7) and (8), there are two costs associated with the default option. First, there is the output loss given by $(1 - \lambda)$. Second, since it must stay in financial autarky forever once it chooses to default, the country loses the ability to use international borrowing to smooth consumption in the future. More consumption volatility is welfare-reducing, because of the concavity of the agent's utility function. On the other hand, the benefit of default is the possibility of higher consumption at t. In terms of default, costs are intertemporal, and benefits are immediate. The planner balances the costs against the benefit to choose the value of DEF_t, and decides to default at t whenever $V_t^R < V_t^D$. Repayment takes place whenever $V_t^R \geq V_t^D$.

To force the country to pay back its debt in all possible dates and states, fully informed international lenders will set up and enforce the rule formally defined in (9), and will not lend any amount of funds that makes the planner choose default over repayment. That is, lenders will define the credit limit for the borrowing country, $\overline{d}_t^*$, such that its representative agent's expected lifetime utility from participating in the asset market is at least as high as that of staying in financial autarky. The approach used for the identification of $\overline{d}_t^*$, proposed by Zhang (1997), is based on the worst-case scenario given by the minimal value of z_t in Ω_Z.

2.6 The IMF

To introduce the IMF is introduced into the model, let $\theta_t \in \Theta = \left\{ \theta^0, \theta^1 \right\}$ be a set of restrictions on $\left\langle DEF_t, d_t, f_t, g_t^N, g_t^T \right\rangle$, which characterize the *IMF conditionality rule.* The country must satisfy a different rule depending on its choice of wheter to adopt an IMF program. The collection Θ

[10] For example, see Aiyagari and Gertler (1991), Telmer (1993), and Lucas (1994). In the international macroeconomics literature, examples include papers in the "sudden stop" literature, such as Mendoza (2001).

contains two types of conditionality sets:

$$\text{if } IMF_t = 0 : \theta_t = \theta^0 = \left\{ DEF_t \in \{0,1\} ; d_t \in \boldsymbol{D};\ f_t = 0;\ 0 \leq g_t^i,\ i = T, N \right\}, \tag{10}$$

$$\text{if } IMF_t = 1 : \theta_t = \theta^1 = \left\{ DEF_t = 0;\ d_t \geq 0;\ 0 \leq f_t \leq \overline{f} < \infty;\ 0 \leq g_t^i \leq \overline{g}^i,\ i = T, N \right\}. \tag{11}$$

IMF conditionality is "turned on" when the country chooses to adopt an IMF program. Whenever $IMF_t = 1$, the economy is subject to $\theta_t = \theta^1$, indicating additional restrictions regarding the default choice, the level of debt from private banks and from the IMF, and the consumption of public goods. For instance, embedded in the conditionality rules above, there are four assumptions about the behaviour of the IMF:

(i) the IMF will not lend to a country that chooses to default or does not need to borrow;

(ii) there is an upper bound, $\overline{g}^i$, for $i = T, N$, to the consumption of public goods when $IMF_t = 1$;

(iii) countries cannot lend to the IMF; and

(iv) the IMF does not have "deep pockets," being limited to lend up to $\overline{f}$.

The way the IMF is characterized, as represented by assumptions (i) to (iv), is exogenous and not a result of any optimizing behaviour. From a *positive* perspective, the Fund's behaviour is modelled based on what seems to occur in actual IMF adjustment programs: whenever a country requires financial assistance, the IMF follows its mandate to lend, conditional upon the borrowing country accepting some (potentially) costly conditions in terms of economic policy. These policies typically include restrictions to the domestic absorption, often in the form of caps on government spending, here represented by limits on the consumption of public goods.

The part of assumption (i) that deals with default, which requires $DEF_t = 0$ whenever $IMF_t = 1$, simply restates the previous assumption that, once a country defaults, it cannot borrow abroad from t onwards. The remaining part of assumption (i) is required to prevent a country from borrowing from the IMF at a lower interest rate and lending to private banks at the market rate. This is consistent with the Fund's concern about lending only when there is a "balance of payments need" and when countries "cannot find sufficient financing on affordable terms to meet its net international payments."[11] Given its public nature as an international organization, it is hard to justify providing subsidized loans to countries that are not in need.[12]

Assumption (ii) is motivated by the fact that restraint on central government expenditure (a proxy for the consumption of public goods) is indeed a key element for the Fund to approve an

[11] See the "factsheet" on IMF lending at http://www.imf.org/external/np/exr/facts/howlend.htm.

[12] Corsetti, Guimarães, and Roubini (2004) develop a static model of IMF optimal lending in which the issue of no subsidized loans by the IMF−when there is no expected gain in terms of improving a borrowing country's external payments position−is explicitly taken into account.

arrangement (Mussa and Savastano 1999). Whenever the constraint $g_t^i \leq \overline{g}^i$, $i = T, N$, is binding, the consumption of public goods will be set at suboptimal levels and IMF conditionality will be a cost, at least in the short run.

At least two findings in the empirical literature indicate that restrictions on the consumption of public goods are implemented by countries borrowing from the IMF, and that those restrictions would not take place, or not to the same extent, without the Fund's support. First, countries that seek the IMF's assistance tend to follow more expansionary fiscal policies (Table A.1, in Appendix A, shows that six out of eight empirical studies find that government spending, or a government deficit, increases the likelihood that a country will adopt an IMF program). Second, there is a negative relationship between the adoption of an IMF program and the rate of growth of government consumption (Conway 1994; Killick, Malik, and Manuel 1995; Marchesi 2003).

Regarding assumption (iii), most resources for IMF loans are provided by member countries, primarily through their quota payments, which is not the same as lending to the IMF. Although concessionary lending and debt relief to low-income countries are financed through separate contribution-based trust funds, this is not the case for the adjustment programs.[13]

Assumption (iv) implies an asymmetry in how private and IMF lending are limited by credit suppliers. The latter is exogenously limited by $\overline{f}$, while the former has the endogenous limit $\overline{d}_t = \overline{d}_t^* - \overline{f}$, as implied by (9). Because of the difference in interest rates charged in private and Fund loans, an upper bound on f_t is needed for a well-defined problem: the lower interest rate on IMF loans favours the substitution of debt from private agents by IMF loans and, if there is no limit on f_t, the economy can borrow a large (infinity) amount from the IMF and then default on both types of debt.[14] However, the overall effect of different interest rates on the likelihood of default is ambiguous, since lower interest rates from the IMF may also imply a higher intertemporal cost of default: defaulting countries will not only be prevented from borrowing abroad in the future, but will also lose access to cheaper loans from the IMF. The former (substitution) effect will increase the likelihood of default and force private lenders to be more strict when they set up their borrowing constraint, while the latter (intertemporal effect) will increase the cost of default and allow lenders to relax their borrowing constraint.

Ideally, one would like to model explicitly the behaviour of the IMF, as well as allow for separate decisions about defaulting only on IMF loans, but not on private loans, or vice versa. This would eliminate the asymmetry, by allowing an endogenous borrowing constraint for the IMF loans similar to $\overline{d}_t$. However, this would considerably increase the state-space of the problem and, as

[13] The assumption is really not necessary, since the country would always prefer to lend to private banks, at a higher interest rate. However, in terms of the numerical method used for the solution of the model, it is always convenient to restrain the state-space for computational purposes.

[14] Thus, a natural upper bound on $\overline{f}$ would be the minimal value such that private banks can avoid default by setting $\overline{d}_t^* - \overline{f} > 0$.

a consequence, the computational cost of the numerical solution.[15] To keep things simple, the approach used here fixes $\overline{f}$ such that $\overline{d}_t$ is determined *given* (that is, as a function of) $\overline{f}$ and the country never defaults.[16] Nevertheless, if $\overline{f}$ is set too high, the country would end up by borrowing only from the IMF.[17]

One way to interpret the exogenous and constant value of $\overline{f}$ is as an institutional rule that ensures that $f_t < \infty$. For instance, countries usually cannot borrow in excess of 300 per cent of their quotas and, although exceptional access criteria do exist, they depend on country-level analysis by the Fund and are ultimately limited by the Fund's budget. The quota that each member of the IMF is assigned to is based broadly on its relative size in the world economy. Quotas are reviewed at least every five years, but revisions are not frequent,[18] implying that $\overline{f}$ is country-specific and changes slowly over time.

Thus, the optimal choice in terms of wheter adopt an IMF program is based on the net effect of conditions (10) and (11). On one hand, the country has more options for borrowing, including cheaper loans from the IMF, but must optimize subject to caps on the consumption of public goods. On the other hand, the country loses the option of borrowing from the IMF, but may freely choose the consumption allocations.

2.7 The planner's problem

Formally, the planner's problem is to maximize the objective function (1) subject to constraints (2) to (11), by choosing the sequence $\{c_t^T, c_t^N, g_t^T, g_t^N, d_t^*, d_t, f_t, IMF_t, DEF_t\}_{t=0}^{\infty}$. The timing of events, shown in Figure 1, is as follows. Once the state $\langle d_{t-1}^*, S_t \rangle$ is known, the central planner decides: (i) whether the outstanding debt (both from private banks and from the IMF), including interest services, is going to be repaid or defaulted, and (ii) whether to sign an agreement with the IMF. Then, international lenders set $\overline{d}_t^*$, given $\overline{f}$. Finally, given expectations about the next realization of the shock, and the endogenous borrowing constraint, the planner chooses the next-period levels of the endogenous state and control variables.

The planner's problem admits a recursive formulation. Recall that, given the definitions of c_t and g_t in (2) and (3), one can write the instantaneous utility function as $u\left(c_t^T, c_t^N, g_t^T, g_t^N\right)$. In addition, let the time subscript t be excluded from the (indirect) utility functions so that V^D and V^R represent time-invariant value functions.

[15] We leave this for future research.

[16] Note that, because $r^* < r$, it would always be in the interest of the economy to first default on the debt from private lenders.

[17] This means that, by changing the value of $\overline{f}$ from zero to a value that is high enough, it is possible to generate different shares of IMF lending on the total debt in the $[0, 1]$ interval. In the calibration exercise for the Brazilian economy discussed in section 3, $\overline{f}$ is calibrated to match a realistic $\overline{f}/\overline{d}_t^*$ ratio.

[18] For instance, in 1998 the quota review led to a 45 per cent increase in IMF quotas, but the review concluded in January 2003 resulted in no change in quotas.

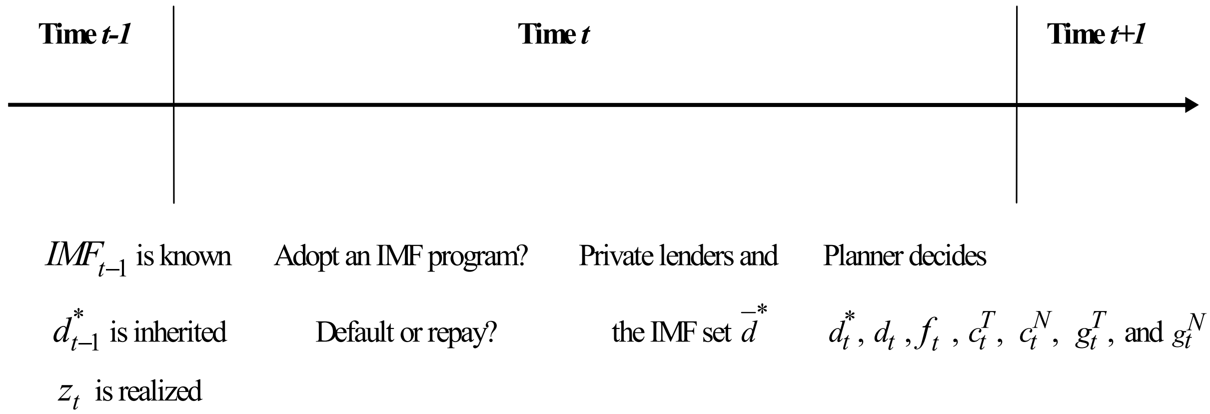

Figure 1: Sequence of Events

In the default case, the country cannot choose the IMF option, which implies that $IMF_t = 0$. The planner has to choose optimal decision rules for c_t^T, c_t^N, g_t^T, and g_t^N in order to solve the following Bellman equation:

$$V^D(z_t) = \max_{\langle c_t^T, c_t^N, g_t^T, g_t^N \rangle} \left\{ u\left(c_t^T, c_t^N, g_t^T, g_t^N\right) + \beta \mathrm{E}_z V^D(z_{t+1}) \right\},$$

subject to:

$$\begin{aligned} c_t^T + g_t^T &= \lambda\left(y^T + z_t\right); \\ c_t^N + g_t^N &= \lambda y^N. \end{aligned}$$

When $DEF_t = 0$, a set of decision rules for $c_t^T, c_t^N, g_t^T, g_t^N$, IMF_t, f_t, and d_t^* is required for the solution of the following Bellman equation:

$$\begin{aligned} V^R\left(d_{t-1}^*, S_t\right) &\equiv \max_{\langle c_t^T, c_t^N, g_t^T, g_t^N, d_t^*, IMF_t, f_t \rangle} \left\{ u\left(c_t^T, c_t^N, g_t^T, g_t^N\right) + \beta \mathrm{E}_z \max\left[V^R\left(d_t^*, S_{t+1}\right), V^D\left(z_{t+1}\right)\right] \right\}, \\ \text{where } S_t &= \left\{z_t, f_{t-1}, IMF_{t-1}\right\}_t,\ f_t \in \boldsymbol{F} \subseteq \mathcal{R}^+, \text{ and } d_t^* \in \boldsymbol{D} \subseteq \mathcal{R}, \end{aligned}$$

subject to:

$$\begin{aligned} & c_t^N + g_t^N = y^N; \\ & c_t^T + g_t^T = y^T + z_t + d_t^* - (1+r)\, d_{t-1}^* + (r - r^*)\, IMF_{t-1} f_{t-1}; \\ & d_t^* = d_t + IMF_t f_t; \\ & d_t^* \leq \overline{d}_t^* = \min_{\Omega_Z} \left\{ \overline{d}^*(S_t) : V^R\left(\overline{d}^*(S_t), S_t\right) = V^D(z_t) \right\}; \\ & \text{if } IMF_t = 0 : DEF_t \in \{0,1\};\ d_t \in \boldsymbol{D};\ f_t = 0;\ 0 \leq g_t^i,\ i = T, N; \\ & \text{if } IMF_t = 1 : DEF_t = 0;\ d_t \geq 0;\ 0 \leq f_t \leq \overline{f} < \infty;\ 0 \leq g_t^i \leq \overline{g}_t^i,\ i = T, N. \end{aligned}$$

The solution consists of three objects: (i) a set of state-contingent optimal decision rules for the level of next-period debt with private lenders, for the IMF program indicator binary variable, and for the next-period debt with the IMF, $d^*\left(d_{t-1}^*, S_t\right)$, $IMF\left(d_{t-1}^*, S_t\right)$, and $f\left(d_{t-1}^*, S_t\right)$; (ii) two value functions, $V^D(z_t)$ and $V^R\left(d_{t-1}^*, S_t\right)$; and (iii) the state-dependent level of the borrowing constraint, $\overline{d}_t^* = \overline{d}^*(S_t)$. Given the solution, the underlying probability distribution function of the shock, jointly with the decision rules, determines the transition and limiting distributions of all endogenous variables in the model.

Note that, in this set-up, whenever the country chooses $IMF_t = 1$, it will always decide to withdraw the totality of the resources made available by the Fund (i.e , $f_t = \overline{f}$), because there is substitution in borrowing from private banks, at interest rate r, and from the Fund, at a lower (financial) cost. Once the country accepts the cost of conditionality, it will always borrow from the IMF up to the limit, at a lower interest rate, and supplement its borrowing needs from private banks. Also note that, although default is a possible choice for the planner, for any given value of $\overline{f}$, there will be no default at the optimum, since condition (9) will force the planner to always choose $DEF_t = 0$.

In the empirical application of the model, we use a constant relative risk-aversion (CRRA) specification for instantaneous utility function, with a CES aggregator for c_t and g_t:

$$\begin{aligned} u(c_t, g_t) &= \frac{\left\{\left[\delta c_t^{-\nu} + (1-\delta) g_t^{-\nu}\right]^{-\frac{1}{\nu}}\right\}^{1-\gamma} - 1}{1-\gamma}, \text{ if } \gamma \neq 1, \\ &= \log\left\{\left[\delta c_t^{-\nu} + (1-\delta) g_t^{-\nu}\right]^{-\frac{1}{\nu}}\right\}, \text{ if } \gamma = 1, \end{aligned}$$

where $\gamma > 0$ is the reciprocal of the intertemporal elasticity of substitution on the composite CES consumption index (or the risk-aversion parameter), $\delta \in [0,1]$ gives the weight of private consumption in the aggregator, and $1/(1+\nu) > 0$ is the elasticity of substitution between the consumption of private and public goods.

The first-order conditions of the planner's problem imply the following optimal conditions:

$$p_t = \frac{(1-\omega_c)}{\omega_c}\left(\frac{c_t^T}{c_t^N}\right)^{(1+\mu_c)}, \tag{12}$$

$$\begin{aligned} p_t &= \frac{(1-\omega_g)}{\omega_g}\left(\frac{g_t^T}{g_t^N}\right)^{(1+\mu_g)}, \text{ if } IMF_t = 0, \\ &= \frac{\Psi_t (1-\omega_g)\left(g_t^N\right)^{-(1+\mu_g)} - q_t^N}{\Psi_t \omega_g \left(g_t^T\right)^{-(1+\mu_g)} - q_t^T}, \text{ if } IMF_t = 1, \end{aligned} \tag{13}$$

$$P_t^T = \beta(1+r)\,\mathrm{E}_t P_{t+1}^T, \tag{14}$$

where $p_t \equiv P_t^N / P_t^T$ is the equilibrium level of the real exchange rate, as measured by the relative (shadow) price of non-tradable with respect to tradable goods; P_t^N and P_t^T are the Lagrange multipliers associated with the non-tradable and tradable resource constraints, respectively; and q_t^N and q_t^N are the Lagrange multipliers for the conditionality rule $g_t^i \leq \overline{g}^i$, $i = T, N$, and $\Psi_t = (1-\delta) g_t^{(\mu_g - \nu)} \left[\delta c_t^{-\nu} + (1-\delta) g_t^{-\nu}\right]^{(\gamma-\nu-1)/\nu}$. Notice that, when $IMF_t = 1$ and the conditionality rule is binding, there is a wedge between the optimal levels of consumption of public goods with and without the IMF program. This wedge represents the potential cost of conditionality, preventing the shadow prices P_t^N and P_t^T from being equal to the marginal utility of the consumption of public goods as non-tradables and tradables, respectively. Ultimately, it is the net effect of this (suboptimal, welfare reducing) wedge and the reduced consumption volatility when the IMF helps relax the borrowing constraint that will matter in the decision oo whether to adopt an IMF program, and for the welfare implications of those programs, as examined in the next section.

3 A Quantitative Analysis of IMF Programs

In this section, quantitative implications of the model are presented. We calibrate the artificial economy to match Brazilian data during the 1980Q1−2004Q2 period, and then compare the behaviour of the model under two different institutional environments: with and without the IMF.

Table 1: Targeted Average Long-Run Ratios

"Big ratios"	Values
1. Share of tradables in total output	$k_T = 0.4045$
2. Debt-to-output ratio (private lenders)	$k_d = 0.2597$
3. Debt-to-output ratio (IMF loans)	$k_f = 0.0136$
4. Government share in total output	$k_g = 0.2057$
5. Frequency of IMF program participation	$\alpha = 0.5102$

The calibration procedure (see Appendix B for a more detailed description) takes as reference a long-run situation in which $\mathrm{E}(z_t) = 0$ and the values of the tradable endowment and the real exchange rate are normalized to $y^T = p = 1$. Let variables without the time subscript, t, indicate long-run averages and let $Y = \left(y^T + py^N\right)$, the total endowment in units of tradable goods, be the model's proxy for total output. We target five long-run ratios: (1) the average share of the tradable output in total output, $k_T = y^T/Y$; (2) the average debt-to-output ratio from bank loans, $k_d = d/Y$; (3) the average debt-to-output ratio from Fund loans, $k_f = f/Y$; (4) the ratio of government spending (as a proxy for total consumption of public goods) to total output, $k_g = \left(g^T + pg^N\right)/Y$; and (5) the frequency with which the economy participates in an IMF program, α. Table 1 shows the long-run ratios computed from Brazilian data.[19]

[19] Data on GDP, tradable GDP (proxied by the GDP excluding the sum of before-taxes GDP for services and the construction industry, plus a financial dummy), and government spending were obtained from the Instituto Brasileiro de Geografia e Estatística (IBGE). Total external debt corresponds to the net external debt (external debt minus

Exploring the recursive formulation of the central planner's problem, a numerical solution is obtained using the value function iteration method, with discretization of the state-space $\boldsymbol{S}$. The discrete grids used to represent the continuous supports for d_t^*, z_t, and f_t contain 602, 5, and 2 points, respectively. The d_t^* grid implies debt-to-output ratios approximately in the range $[-0.4, 2.83]$, and is appropriately chosen to include the ergodic space. The stochastic process for the production shock mimics a first-order autoregressive process of the type $z_t = \rho z_{t-1} + \varepsilon_t$, with $\varepsilon_t \backsim N(0, \sigma_\varepsilon)$, $\rho = 0.7188$, and $\sigma_\varepsilon = 0.0229$, and it is discretized into a five-point Markov chain using Tauchen's (1986) procedure.[20]

Table 2: Summary of the Calibration Procedure

Exogenous variables	Values	Motivation
1. Interest rate (IMF loans)	$r^* = 0.0081$	U.S. bonds deflated by CPI
2. Interest rate (private loans)	$r = 0.0282$	C Bond spread over U.S. bonds
3. Average tradable output	$y^T = 1.0000$	Normalization
4. Average real exchange rate	$p = 1.0000$	Normalization
5. Non-tradable output	$y^N = 1.4722$	$k_T = y^T / \left(y^T + py^N\right)$
Structural parameters	**Values**	**Motivation/Target**
1. Risk aversion	$\gamma = 1.5000$	Standard
2. Share of c_t in CES aggregator	$\delta = 0.9850$	$k_g \cong \text{avg}\left[G_t / \left(y_t^T + p_t y^N\right)\right]$
3. Subjective discount factor	$\beta = 0.9726$	$\beta(1+r) = 1$
4. Elasticity of substitution between c and g	$\nu = 2.1500$	$1/(1+\nu) = 0.3175$
5. Elasticity of substitution between c^T and c^N	$\mu_c = 4.6600$	$\sigma_y = 2.76\%$
6. Elasticity of substitution between g^T and g^N	$\mu_g = 4.6600$	Symmetry with c
7. Weight of tradables in CES c aggregator	$\omega_c = 0.0893$	$p = \frac{(1-\omega_c)}{\omega_c}\left(\frac{c^T}{c^N}\right)^{(1+\mu_c)} = 1$
8. Weight of tradables in CES g aggregator	$\omega_g = 0.0893$	Symmetry with c
9. Autocorrelation for $z_t = \rho z_{t-1} + \varepsilon_t$	$\rho = 0.7188$	OLS estimation
10. Std. dev. for $z_t = \rho z_{t-1} + \varepsilon_t$	$\sigma_\varepsilon = 0.0229$	OLS estimation
11. Conditionality rule on g^i $\left(\%\ y^i\right)$, $i = T, N$	$\overline{g}^i = 20.9417$	$\alpha = 51.02\%$
12. Standard IMF loan (% Y)	$\overline{f} = 2.6700$	$k_f \cong \text{avg}\left[f_t / \left(y_t^T + p_t y^N\right)\right]$
13. Output loss in state of default	$\lambda = 0.9750$	$k_d \cong \text{avg}\left[d_t / \left(y_t^T + p_t y^N\right)\right]$

As previously noted, the assumption that $r > r^*$ ensures $f_t = \overline{f}$ whenever $IMF_t = 1$, which allows the use of the two-point grid $\{0, \overline{f}\}$ and substantially reduces the dimension of the state-space and the computational cost of the numerical solution. The economy gets $f_t = 0$ when the planner chooses $IMF_t = 0$, and a standard loan, $\overline{f}$, whenever $IMF_t = 1$. The value of $\overline{f}$ is calibrated to match the average value of IMF loans as a proportion of the GDP observed in Brazil.[21] Table 2

international reserves) for the period 1982Q4−2004Q2 and is available from the Banco Central do Brasil. IMF loans and country participation in IMF programs were obtained from the IMF. In computing k_d, "private loans" are simply all outstanding external debt not contracted from the IMF, and may include other sources than private banks, such as loans from the World Bank and other multilateral agencies.

[20] The points in the grid $\widetilde{\Omega}_Z = \{z_1, ..., z_5\}$ are such that $y_t^T > 0$ at all times.

[21] It also satisfies the condition $\overline{d}_t^* - \overline{f} > 0$, as discussed in footnote 14.

displays the calibrated values of the remaining exogenous variables r, r^*, y^N, and $\overline{g}^i$, $i = T, N$, and structural parameters γ, δ, β, ν, μ_c, μ_g, ω_c, ω_g, and λ.

The algorithm used in the numeric solution is the following. For each iteration j, given the discretized state-space and an initial guess for the borrowing constraint, $\overline{d}^{*(j)}$, the unconstrained model (no borrowing constraint) is solved and value functions $V^{D(j)}(z_t)$ and $V^{R(j)}\left(d^*_{t-1}, \widehat{S}_t\right)$, as well as the decision rule $d^{*(j)}\left(d^*_{t-1}, S_t\right)$, are computed through iteration on the Bellman equation.[22] During this step, the borrowing constraint is imposed, meaning that whenever $d^{*(j)}\left(d^*_{t-1}, S_t\right)$ is such that $d^{*(j)} > \overline{d}^{*(j)}$, we set $d^{*(j)} = \overline{d}^{*(j)}$. Updates of the borrowing constraint are obtained using the following:

$$\overline{d}^{*(j+1)} = \min_{\widetilde{\Omega}_Z} \left\{ \overline{d}^*(S_t) : V^{R(j)}\left(\overline{d}^*(S_t), S_t\right) = V^{D(j)}(z_t) \right\}.$$

The procedure is implemented until convergence when $\overline{d}^{*(j+1)} \approx \overline{d}^{*(j)}$.

3.1 Results

Tables 3 and 4 show the average results of 500 simulations of a time series of 98 quarters, corresponding to the 1980Q1−2004Q2 period. The actual Brazilian series for private consumption, government consumption, and GDP, expressed in per capita values at average prices of 1991Q1, are taken from the Instituto de Pesquisa Economica Aplicada (IPEA), available at http://www.ipeadata.gov.br. They are consistent with data from the International Monetary Fund's *International Financial Statistics* when they happen to overlap. Data on external debt and GDP in U.S. dollars, used to compute debt-to-GDP ratios, are obtained from the Banco Central do Brasil. Both the actual and simulated series for consumption and GDP are transformed previous to the computation of their second-moment statistics, as follows. First, all the variables are expressed in logarithms. Second, for the actual series, a seasonal adjustment on the log-variables is implemented using the multiplicative ratio-to-moving-average method. Finally, a smooth trend is subtracted by using the Hodrick-Prescott (HP) filter with a smoothing parameter of 1600.

Table 3: Results I

Variable (%)	Data	Model		
	Brazil (1980Q1−2004Q2)	Unconstrained	Constrained	
		No IMF	IMF	No IMF
σ_c	3.63	1.53	1.99	2.02
σ_y	2.76	2.41	2.76	2.79
G/Y	20.60	20.76	20.79	20.78
d^*/Y	27.33	33.42	27.52	27.38
d/Y	25.97	33.42	26.17	27.38
f/Y	1.36	–	1.34	–
α	51.02	–	56.27	–

[22] This step itself requires initial guesses for the value functions, and the iterations on the Bellman equation are undertaken until convergence.

In general, the baseline model calibration of a borrowing-constrained economy with the option of seeking the IMF's assistance is able to match the data well. Note that the calibration implies good approximations to the debt-to-output ratios (both from private lenders and from the IMF), the consumption of public goods as a proportion of the GDP, and Brazil's participation in IMF programs.

In Table 3, σ_c and σ_y represent the volatility of (the log of) total private goods consumption and total GDP, in units of tradable goods, as given by $C_t = c_t^T + p_t c_t^N$ and $Y_t = y_t^T + p_t y^N$, respectively. Note that the comparison between the constrained and unconstrained economies shows that the borrowing constraint increases consumption and GDP volatility from 1.53 per cent and 2.41 per cent, respectively, in the unconstrained economy (with no IMF), to 1.99 per cent and 2.76 per cent in a constrained economy when the Fund is present, and to 2.02 per cent and 2.79 per cent when it is not. That is, given that the economy faces a borrowing constraint, the IMF means less volatility.

Although the model generates a higher relative consumption volatility (72.1 per cent) in comparison with the unconstrained economy without the IMF option (63.5 per cent), it cannot reproduce the absolute level of consumption volatility observed in the data. This is a shortcoming, because consumption is more volatile than output in emerging economies (Resende 2006), which means that other sources of consumption volatility may be missing from the analysis, such as interest rate shocks (Neumeyer and Perri 2004) or permanent shocks to the growth rate of productivity (Aguiar and Gopinath 2004), as well as commodity-price shocks and the lack of well-developed domestic credit markets for households.[23]

The comparison between the constrained economies with and without the IMF seems to suggest that IMF loans crowd out private loans, having a *negative catalytic effect*. In Table 3, note that, despite the small increase in total debt when the IMF is present, the amount of private loans is higher with no IMF, and the difference is almost totally accounted for by Fund loans. Nevertheless, even though private loans behave as substitutes for Fund loans (rather than as complements to them), the country's access to international capital markets is indeed facilitated by the Fund, because the direct effect of IMF lending makes the borrowing constraint on *total debt* less stringent (Table 4).

Potentially, the increase in available funds for the country to borrow, in the model, may come from two sources. First, there is the direct increase due to the possibility of borrowing from the Fund, given the maximum amount of private loans. Second, there is the possibility that the borrowing constraint $\overline{d}_t^*$ may be positively affected by a general-equilibrium effect of the country's decision to join an IMF program, when this decision reduces the likelihood of default on the external debt. If the borrowing constraint on private loans, $\overline{d}_t^* - \overline{f}$, turns out to be higher than it would be

[23] I thank Larry Schembri and Robert Lafrance, of the Bank of Canada, for suggesting these two other potential sources of consumption volatility in emerging economies.

in the absence of the IMF, then there is positive catalysis of private capital flows by IMF lending. In the above exercise, the opposite situation is observed (Table 4), since $\overline{d}_t^* - \overline{f}$ is lower for the case with IMF, regardless of whether the economy is participating in an IMF program at period $t-1$.

Table 4 shows that, considering the triplet $\left(IMF_{t-1}, f_{t-1}, \overline{g}^i\right)$, there is no difference in $\overline{d}_t^*$ between the model without the IMF and the model with the IMF when $IMF_{t-1} = 0$.[24] However, the borrowing constraint on total debt is less stringent when $IMF_{t-1} = 1$. Given the country's participation in IMF programs reported in Table 3, this means that in 56 per cent of the time, the economy has more room for consumption smoothing than it would if it did not have the option of seeking the Fund's assistance. In the constrained economies, as shown in Table 3, the lower volatility associated with the presence of the IMF is a result of this less stringent borrowing constraint. This also explains why the borrowing constraint binds less frequently in the IMF case, as shown in Table 4.[25]

Table 4: Results II

Model	IMF_{t-1}	f_{t-1} (% GDP)	$\overline{g}^i$ (% y^i)	$\overline{d}_t^*$ (% GDP)	$\overline{d}_t^* - \overline{f}$ (% GDP)	Binding $\overline{d}_t^*$ (%)
Constrained No IMF	–	0.0	∞	77.79	77.79	0.63
Constrained IMF	0	0.0	∞	77.89	75.30	0.58
	1	2.59	20.94	79.07	76.48	

Figure 2 shows how the baseline model changes when the conditionality rule on $\overline{g}^i$ becomes less stringent. In all four graphs, from left to right, the caps $\overline{g}^i$, $i = T, N$ imposed by the IMF are relaxed. Notice that, as conditionality is just slightly stronger (i.e., $\overline{g}^i$ is reduced by less than 0.012 per cent of the GDP) than our baseline case, IMF participation and IMF lending (upper left corner) are null. As we move to the right, and conditionality is relaxed, IMF participation and IMF lending increase, reducing the volatilities of C and Y (upper right corner), as well as the frequency with which the borrowing constraint binds (lower left corner).

The negative catalysis of IMF lending can also be seen in the lower right corner of Figure 2. Since the average d_t^*/Y_t is relatively unaffected as $\overline{g}^i$ increases, the higher average f_t/Y_t means that the average borrowing from private banks must be reduced. That is, d_t is crowded out by f_t because of the substitution of loans from private banks by cheaper loans from the IMF, as conditionality is relaxed and the economy's total borrowing needs are relatively unchanged.

[24] In the percentage of the GDP, the small difference is due to effects of the real exchange rate on the total GDP. The levels of $\overline{d}_t^*$ are the same in both cases.

[25] The debt limit as a proportion of the simulated average GDP, both with and without the IMF, is such that it corresponds to more than the lower bound of 47 per cent, given by the maximal level for the debt-output ratio observed in Brazil, over the period 1980Q1−2004Q4.

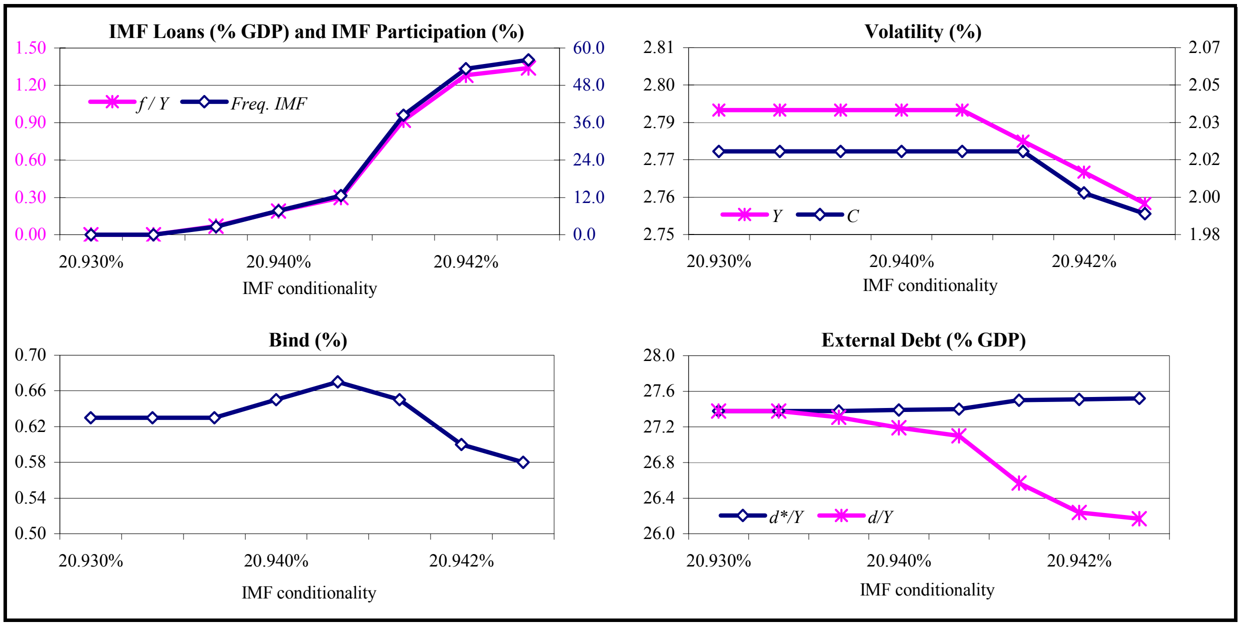

Figure 2: Effects of Changes in $\overline{g}_i$

It is important to understand why IMF lending does not catalyze private loans in this set-up. In general, positive catalysis of private lending occurs when there is a reduction in the likelihood of default induced by the IMF programs. If they can reduce the incentives of default, foreign lenders may relax their borrowing constraint. Strictly in terms of IMF lending, abstracting from the conditionality aspect of adjustment programs, its effect on the likelihood of default is ambiguous because of the lower interest rate charged on IMF loans, as explained in section 2.6.

As for the effect of IMF conditionality on positive catalysis, it depends on how much it increases the economy's ex ante propensity to save. To the extent that highly indebted economies can benefit more, instantaneously, from the higher current consumption that can be achieved in case of default, higher propensity to save and lower demand for debt means less incentive to default. Figure 3 illustrates how the ability of IMF conditionality in stimulating savings and program participation depends on the structural parameters.

To better understand this point, first note that the consumption of private goods is a strategic complement (substitute) to the consumption of public goods whenever $1+\nu$ is higher (lower) than γ. That is, if the elasticity of substitution between c and g is lower than the intertemporal elasticity of substitution, then the marginal utility of c_t^i is increasing in g_t^i, for $i = T, N$, implying that the consumption of public and private goods must change in the same direction. For the calibrated values used in the exercise, the relevant case is that of complementarity between c and g.

Second, let $g^i_{No\ IMF}\left(d^*_{t-1}, z_t\right)$, $i = T, N$, be the decision rule that determines the optimal consumption of public goods in the case with no IMF. If the IMF imposes caps $\overline{g}^i$ such that $g^i_{No\ IMF}\left(d^*_{t-1}, z_t\right) > \overline{g}^i$, then conditionality is too harsh relative to the first best, and there is a welfare cost of satisfying the IMF conditionality rule, since compliance implies suboptimal g_t^i. Agents can always substitute the (forced) reduction in their consumption of g_t^i by consuming more c_t^i, but there is a misallocation cost. On the one hand, when private and public goods are closer substitutes, this cost is lower and the relative incentives to adopt an IMF program are larger, but conditionality is not likely to increase savings and, as a consequence, the catalytic effect is not likely to occur. This is also true if the weight of g_t in the CES consumption aggregator is small.

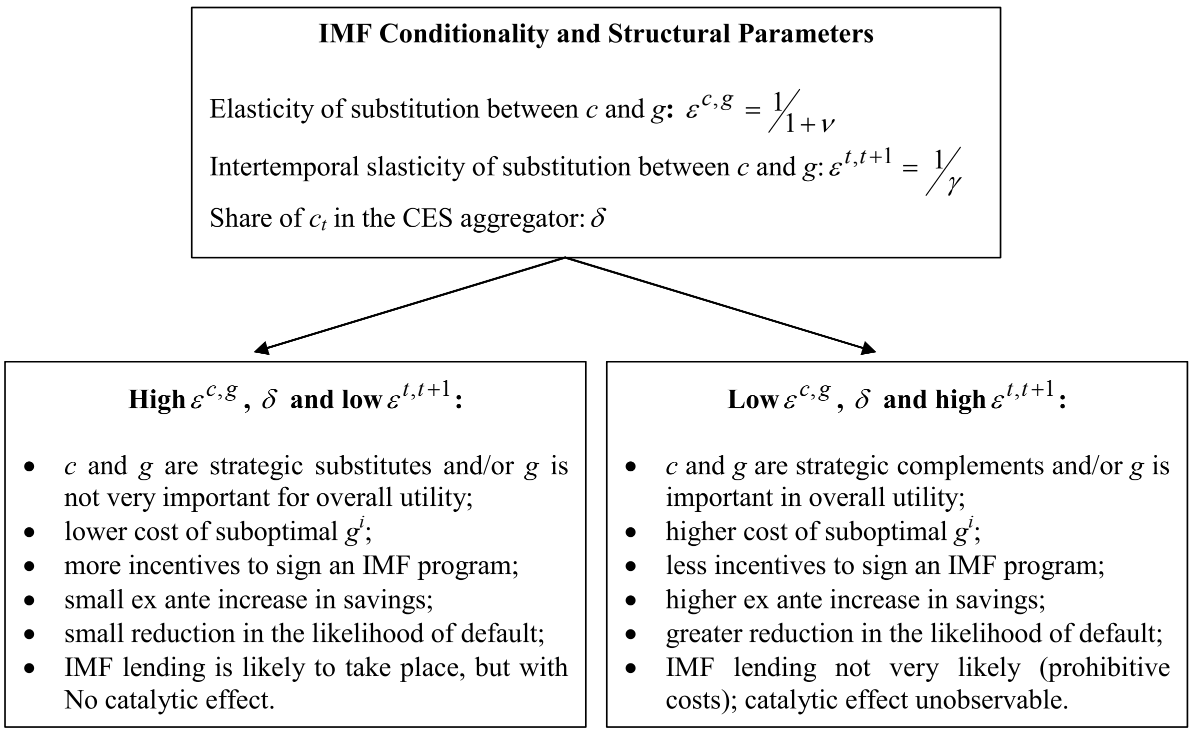

Figure 3: IMF Conditionality, Forced Savings, and the Catalytic Effect

On the other hand, complementarity between c and g implies that the lower level of g_t^i, compared with the case of no IMF, must be followed by a corresponding lower level of c_t^i. If the resulting oversaving is too costly for the country, it tends not to go to the IMF for assistance. As Figure 2 shows, the country always chooses $IMF_t = 0$ when $\overline{g}^i$ is set too low. Of course, where there is no IMF program participation, the catalytic effect is unobservable.

Consider the opposite situation, such that $g^i_{No\ IMF}\left(d^*_{t-1}, z_t\right) < \overline{g}^i$. Conditionality is "soft" and IMF participation will be positive for some $\overline{g}^i$, since the constraint $g_t^i \leq \overline{g}^i$ will not be binding and, at the same time, the country can still enjoy the benefits of cheaper IMF loans in case of need. In this situation, conditionality *is not* a real cost for the country, because optimal g_t^i is always achieved without violating the IMF conditionality. However, the country is not forced to save more (than it would do freely) and, as a consequence, for each realization of the shock there is no reduction in the likelihood of default and no positive catalytic effect takes place. On the contrary, the cheaper IMF lending compared with that of the private banks, combined with a non-binding conditionality rule, will induce the economy to consume more of both private and public goods. In particular, this is true for tradable goods, which leads to higher demand for external debt, forces private banks to be even more strict in their lending, and explains the negative catalytic effect on private lending reported above.

3.2 IMF programs as commitment devices

Consider a set-up, in which the planner does not choose g_t^i optimally. Instead, the consumption of public goods can take only two values, $g_t^i \in \{g_L^i, g_H^i\}$, $i = T, N$, where $g_L^i < g_H^i$, and the country cannot commit to the low level of consumption of public goods, g_L^i, even if it would be better for the representative agent to do so. In addition, assume that IMF programs can act as a commitment device that allows the country to choose $g_t^i = g_L^i$. That is, when the economy is not formally under an agreement with the IMF, it must choose $g_t^i = g_H^i$, because it cannot commit with the low-spending regime, and by adopting a program the planner would be forced to choose g_L^i, because of conditionality.

The above assumptions can be motivated by the idea that the IMF can affect the domestic political game in such a way that provides incentives for the country to implement "good" policies. For example, Corsetti, Guimarães and Roubini (2004), in discussing the IMF's role as international lender of last resort, cite two possibilities: (i) the conventional view on debtor moral hazard, whereby the IMF's assistance reduces the incentives for costly but socially desirable policies if it insulates the economy from crises, or (ii) the alternative view that some governments may be willing to undertake the domestic political cost of adjustment macroeconomic policies *only because* the IMF's assistance improves their chances of success. See also Marchesi and Thomas (1999) and Morris and Shin (2005).

Formally, in this alternative set-up, the planner's problem is identical to the original, as described in the previous section, except for conditionality rules (10) and (11). Given the new assumptions, those rules change into:

$$\text{if } IMF_t = 0 : \theta_t = \theta^0 = \left\{DEF_t \in \{0,1\}\,;\, d_t \in \boldsymbol{D};\; f_t = 0;\; g_t^i = g_H^i < y_t^i,\; i = T, N\right\}, \qquad (15)$$

$$\text{if } IMF_t = 1 : \theta_t = \theta^1 = \left\{DEF_t = 0;\; d_t \geq 0;\; 0 \leq f_t \leq \overline{f} < \infty;\; g_t^i = g_L^i < g_H^i,\; i = T, N\right\}. \qquad (16)$$

Note that, if we consider the situation where $g_{No\ IMF}^i\left(d_{t-1}^*, z_t\right) < g_L^i < g_H^i$, then the reduction from g_H^i to g_L^i as part of IMF conditionality will force the country to save more and, at the same time, push the country closer to what would be the optimal level of g_t^i. In this case, the catalytic effect follows through, as shown in Tables 5 and 6. These tables display similar information to Tables 3 and 4, respectively, but the results are derived using the modified model with the same basic calibration described previously for the original model. All parameters are the same, the only difference being that, instead of calibrated values for the caps $\overline{g}^i$, $i = T, N$, we have to calibrate values for the exogenous levels g_H^i and g_L^i.

For this calibration, let k_g^j be the average ratio of consumption of public goods to GDP when $IMF = j$, for $j = 0, 1$. In addition, let $\varkappa$ be the average reduction in the consumption of public goods as a percentage of the GDP required by IMF programs, implying that $k_g^0 = k_g^1 + \varkappa > k_g^1$. According to Killick, Malik, and Manuel (1995), the average reduction in government spending in IMF borrowers, when comparing before and after an IMF program, is approximately 1 per cent of the GDP. Given $\varkappa = 0.01$, we calibrate k_g^0 in order to approximate the target $\alpha = 51.02$ per cent for program participation. The resulting calibrated values for the exogenous consumption of public goods are $g_H^i = k_g^0 y^i = 0.2131$ when $IMF_t = 0$, and $g_L^i = k_g^1 y^i = 0.2031$ when $IMF_t = 1$, for $i = T, N$.

Table 5: Results III (Alternative model)

Calibration: $g_H^i/y^i = 21.3\%$; $g_L^i/y^i = 20.3\%$

Variable (%)	Data Brazil (1980Q1–2004Q2)	Model Constrained IMF	Model Constrained No IMF
σ_c	3.63	2.39	2.57
σ_y	2.76	3.14	3.21
G/Y	20.60	20.81	21.32
d^*/Y	27.33	28.81	22.25
d/Y	25.97	27.32	22.25
f/Y	1.36	1.49	–
α	51.02	51.23	–

Table 5 shows that, compared with the model with no IMF, the presence of the Fund implies: (i) a lower ratio of consumption of public goods to GDP, as required by IMF conditionality; (ii) a higher total external debt as a percentage of the GDP, as in the original model; (iii) lower volatilities, σ_c and σ_y; and, most importantly, (iv) a higher level of private loans as a proportion of the GDP, suggesting a positive catalytic effect of IMF lending that improves the country's access to international *private* loans (not only to total loans).

Table 6: Results IV (Alternative model)

Model	IMF_{t-1}	f_{t-1} (% GDP)	g^i (% y^i)	$\overline{d}_t^*$ (% GDP)	$\overline{d}_t^* - \overline{f}$ (% GDP)	Binding $\overline{d}_t^*$ (%)
Constrained No IMF	–	0.0	21.3%	79.56	79.56	0.36
Constrained IMF	0	0.0	21.3%	83.96	81.33	0.31
	1	2.63	20.3%	85.95	83.33	

Table 6 show evidence of the positive catalytic effect of IMF lending in this modified mode. Note that not only is the borrowing constraint for the total external debt higher when the IMF exists, but so is the borrowing constraint on private loans, $\overline{d}_t^* - \overline{f}$. As a consequence, the borrowing constraint binds less frequently in the model with the IMF.

The mechanism through which the positive catalysis takes place is based on the increase in the country's external payments position due to IMF conditionality that forces the country to adjust (reduce) its level of consumption of public goods from g_H^i to g_L^i. Since the consumption of private goods is not a perfect substitute for the consumption of and public goods, and given that agents care about their future levels of consumption, the reduction in g_t forces the country to save more. By locking countries into a program of reform that ultimately improves their external payments position, conditionality provides external investors and private banks with a high degree of assurance about the country's decision to repay past debt instead of defaulting. Thus, *ceteris paribus*, the reduced likelihood of default allows private banks to relax the borrowing constraint.

To summarize the results so far:

1. IMF lending helps relax the borrowing constraint on total debt and, as a consequence, reduces the volatility of private consumption and GDP.

2. When countries optimally choose their allocations of public goods, then IMF conditionality, based on restraining the consumption of public goods, does not catalyze private capital flows: when conditionality imposes a real cost in terms of suboptimal higher savings, countries choose not to sign IMF programs; when conditionality is not binding, countries will sign IMF programs but will not be forced to save more.

3. When countries use the IMF as a commitment device to reduce their spending on public goods, then IMF conditionality forces a higher level of savings, reduces the likelihood of default, and allows private banks to be less strict in their lending, which produces the positive catalytic effect on private loans, as the Fund claims.

The remaining question is: by how much does a less stringent borrowing constraint, due to the direct effect of IMF lending and/or a positive catalytic effect induced by conditionality, improve welfare?

3.3 Welfare analysis

In terms of the welfare implications of IMF programs, there are two forces at play. The potential cost of adopting a program is a requirement to adjust the country's domestic absorption to the conditionality clauses, meaning that the country has to face constraint (11)−and set g_t^T and g_t^N at potentially suboptimal levels−or rule (16), in the case of the alternative model. The benefits, besides the lower interest on IMF loans, are related to the additional amount of external funds available for borrowing, on top of $\overline{d}_t$, which will allow a higher degree of consumption smoothing.

To assess the welfare effects of IMF-supported programs, the consumption-equivalent approach is used. In particular, we compute the per cent increase in consumption across dates and states, such that the representative agent would receive the same utility, considering worlds with and without the IMF. Let ϑ be this equivalent variation in consumption allocations, and let the superscripts ^{IMF} and $^{No\ IMF}$ indicate the utility functions and value functions for the equilibrium values of consumption in worlds with and without the IMF, respectively. The value of ϑ can be computed from:

$$\int_{\boldsymbol{S}} \mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t u^{IMF} \left(qc_t^T, qc_t^N, qg_t^T, qg_t^N\right) d\phi = \int_{\boldsymbol{S}'} V_0^{No\ IMF}\ d\phi', \tag{17}$$

where $V_0^{No\ IMF} = \mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t u^{No\ IMF} \left(c_t^T, c_t^N, g_t^T, g_t^N\right)$ is the value function obtained under the assumption that there is no IMF in the world, and $q = 1 + \vartheta$.

The sets $\boldsymbol{S}$ and $\boldsymbol{S'}$ are the supports for the state of the economy in worlds with and without the IMF, respectively. Note that the IMF is welfare improving in the case that $q < 1$, meaning that the consumption in a world with the option of joining an IMF program has to be decreased by ϑ in order to generate the same level of welfare as that of a world without the IMF.

In the quantitative exercise, using the original model presented in section 2 to compare two economies that are identical except for the fact that one operates in a world with the IMF and the other in a world without the IMF, q is found to be equal to 0.9903. That is, in order to match the same welfare obtained in a world where there is no option of seeking the IMF's assistance, the consumption sequence observed in a world with the IMF has to be *decreased* by 0.97 per cent. In the alternative model, with no optimal choice of consumption of public goods, we find that $q = 0.9958$, implying a 0.42 per cent reduction in consumption required to compensate for the lower welfare observed in the same economy if it does not have the option of seeking the IMF's assistance. Therefore, results suggest that the IMF has an overall small positive effect on welfare.

4 Conclusion

This paper has presented a dynamic model of an endowment, two-goods, small open economy subject to an endogenous borrowing constraint, where the planner can optimally choose to join an IMF-supported adjustment program. The quantitative exercise consisted of a comparison between one economy, which has the option of seeking the IMF's assistance, and another economy, identical in all aspects to the first except that there is no IMF in the world (the counterfactual). The paper provides answers to two questions. First, can IMF conditionality, focused on the control of the consumption of public goods, generate a positive catalytic effect, as the Fund claims? Second, what is the welfare gain associated with IMF programs?

In terms of the numeric results, the answer to the first question depends on whether IMF conditionality can force the country to save more while offering enough compensation for these additional suboptimal savings that the country can actually decide to sign an IMF program. If the consumption of public goods is chosen optimally by the central planner, then whenever the conditionality rule is too strict (relative to the optimal level for the no-IMF case), the country will not participate in IMF programs. The oversaving implied by conditionality is too costly for the economy.

On the other hand, when conditionality clauses are redundant (because the country's optimal consumption of public goods is lower than the level determined by conditionality), not forcing the economy to save, then IMF participation is positive, but there is no improvement in the prospective for repayment of the external debt by the borrowing country. It is the opposite: since conditionality is not a real cost and the country can still borrow at a lower interest rate from the IMF, private banks must be more strict to avoid default. This generates a negative catalytic effect of IMF lending on private capital flows, although the borrowing constraint on total external debt may be relaxed.

Only by increasing a country's external payments position may the Fund help the country signal to foreign private lenders that the opportunity cost of defaulting has become higher, and the likelihood of debt repudiation reduced. This, in turn, allows international private creditors to relax their borrowing constraint. This situation can occur when the planner does not optimally choose the allocations of consumption of public goods. In that case, under the assumption that the IMF can act as a commitment device that allows the economy to operate with a lower level of consumption of public goods than it would otherwise, IMF conditionality produces a positive catalytic effect on private capital flows. Catalysis occurs because the reduction in consumption forces the country to save more and, at the same time, pushes the economy closer to what would be the optimal allocation. As a result, the likelihood of default is reduced and private banks can relax their borrowing constraints. Both the direct (additional source of loans) and indirect (positive catalysis on private loans) effects of IMF lending imply a less stringent borrowing constraint that allows more room for consumption smoothing.

A less stringent borrowing constraint, however, resulting from either direct lending or positive catalysis of private flows, is not a measure of the "success" or "failure" of IMF programs. The welfare effects associated with IMF lending do not seem to be very quantitatively important. It is true that the less stringent borrowing constraint allows the country easier access to international capital markets and, as such, improves the country's consumption-smoothing opportunities. The reduction in volatility does produce welfare improvements, but for the parametrization used in the calibration exercise, which was set to approximate the Brazilian economy during the 1980Q1−2004Q2 period, IMF lending generates improvements in welfare equivalent to less than 1 per cent in additional consumption.

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Appendix A: On IMF Programs

This appendix briefly describes the process of setting up an agreement between a member country and the IMF, and provides a summarizes the literature on evaluations of IMF-supported adjustment programs.

A.1 Setting Up an IMF Program

The Fund has a mandate to offer financial and technical assistance to members experiencing external account imbalances on the condition that the recipient country agrees to implement specific economic policy measures intended to improve the country's overall economic situation and reduce its vulnerabilities. These agreed-upon policy actions are known as *IMF conditionality* and usually include intermediate goals that must be undertaken as a condition for the country to receive subsequent tranches over the duration of the program, usually one to three years. These targets are often related to fiscal and monetary austerity measures, aimed at reducing domestic absorption. Although it is beyond the scope of this study to provide a rationale of the IMF's behaviour, one possible reason for this observed reaction is the Fund's primary goal of improving the external payments position of its members, as stated in its Articles of Agreement.[26] In that sense, these policies may be understood as a way to force borrowing countries to save more in order to improve their current account balances.

A country that wishes to withdraw funds up to 25 per cent of its own quota within the IMF (in the so-called first credit tranche programs) can do so almost automatically, with only minimal requirements and no discussion or commitment to specific economic policy measures. To use the Fund's resources beyond that threshold, countries must almost always sign a formal agreement and accept conditionality. Mussa and Savastano (1999) describe the underlying process for signing an IMF-supported program as consisting of six broadly defined phases. First, in the inception phase, a country member explicitly requests the Fund's assistance. Then a blueprint is prepared by the Fund's staff to be used as a basis for the negotiation process. After an agreement is reached, a letter of intent summarizes the outcome of the negotiations and all aspects of the program. The letter of intent is sent to the Executive Board for approval. Disbursements of the credit tranches follow automatically if the agreed-upon performance clauses are met as assessed by the Fund's monitoring of the country's situation. This phase lasts until the completion of the program.[27]

[26] Available at http://www.imf.org/external/pubs/ft/aa/index.htm.

[27] Edwards (1989) summarizes the steps leading to the final design of an IMF program, starting with the evaluation of the country's situation, defining the target variables, and envisaging the course of policy actions.

A.2 Evaluating IMF Programs

Many studies have tried to evaluate IMF programs using reduced-form econometric models, applied to cross-country samples. The two most common methodological problems in evaluating the IMF's performance based on cross-country econometric studies are both the difficulty in finding a good *counterfactual* against which to compare IMF programs and the need to control for *selection bias* due to self-selection of countries that seek a program. The counterfactual issue arises because the proper standard for measuring program effects, in terms of key variables, should be a comparison of the macroeconomic outcomes under a program with the outcomes that would have emerged in the absence of a program, which is unobservable and must be approximated. Unfortunately, as Dicks-Mireaux, Mecagni and Schadler (2000) point out, results are very sensitive to the different techniques used to approximate the counterfactual.

In terms of the selection bias problem, since countries self-select to IMF programs, the outcome observed after a program is likely to be a consequence of both the initial conditions and the program itself. These pre-program conditions would probably be very different in a country that ended up seeking IMF assistance, compared with the (counterfactual) situation in which the same country decided not to adopt an IMF program. If the two effects cannot be disentangled, the results will be biased.[28]

These cross-country reduced-form econometric studies provide some "stylized facts" regarding IMF-supported stabilization programs. Tables A.1, A.2 and A.3 summarize the results found in the literature regarding the pre-program characteristics of countries that seek the IMF's assistance, the effects of IMF programs on some selected macroeconomic variables,[29] and the catalytic effect, respectively. They suggest the following:

1. countries that seek the IMF's assistance have different initial, pre-program, conditions than those that do not seek the Fund's help;

2. IMF programs seem to help countries improve their external payments positions;

3. inflation rates are not affected by the implementation of an IMF program, while the evidence is mixed for growth; and,

4. there is no strong evidence that IMF lending acts as a "catalyst" to other (private) capital flows, but there is good indirect evidence that IMF programs can help countries improve their access to international private capital markets.

[28] The preferred approach in current econometric studies to approximate the counterfactual is the so-called generalized evaluation estimator (GEE), first suggested by Goldstein and Montiel (1986), and further popularized by Khan (1990), Conway (1994), and Hutchison (2001), among others. Although not without criticism (Dicks-Mireaux, Mecagni, and Schadler 2000; Barro and Lee 2002), the GEE approach also tries to control for the potential selection-bias problem.

[29] Table A.2 is a modified and updated version of Table 1 in Haque and Khan (1998).

Regarding the first point, evidence that program countries differ from non-program countries in terms of initial conditions isprovided by Joyce (1992), Edwards and Santaella (1993), Santaella (1995), Bird (1996), and Knight and Santaella (1997), among others. Table A.1 summarizes pre-program characteristics of countries that seek the IMF's financial assistance according to 12 independent econometric studies. Seven out of eight studies find that a worse current account position increases the likelihood of a country adopting an IMF program, and four out of five studies find the same in terms of the overall balance of payments. In general, prior to entering a program, IMF borrowers experience—besides worse external payments positions—higher external debt, lower level of international reserves, more overvalued currencies and lower levels of both GDP per capita and/or GDP growth rates. IMF borrowers also tend to follow more expansionary economic policies.

Table A.1
Pre-Program Characteristics of Countries that Seek the IMF's Financial Assistance

				Effects on the likelihood of an IMF program									
Study	No. of progs.	No. of countries	Sample period	*BoP*	*CA*	*R*	d^*	π	*e*	*G*	*M*	*y*	Past IMF
GM (1986)	68	58	1974–81	–*	–*	…	…	+*	…	…	…	–*	…
ES (1992)	48	31	1954–71	…	–	–*	…	…	+	+*	+*	–*	…
Joyce (1992)	72	45	1980–84	…	–*	–*	–	+	…	+*	+*	–*	…
Conway (1994)	217	73	1976–86	…	+*	–*	+*	…	…	…	…	–*	+*
Santaella (1995)	324	78	1973–91	–*	–*	–*	+*	+*	–*	+*	0	–*	…
Bird (1996)	…	…	…	–	…	–	?	…	+	…	…	–	+
KS (1997)	…	91	1973–91	+	–*	–*	+*	–	+*	+*	+*	–*	+*
PV (2000)	678	135	1951–90	–*	…	–*	+*	…	…	+*	…	…	+
Edwards (2000)	…	106	1979–95	…	…	–*	…	–*	…	–	+*	–*	…
Hutchison (2001)	461	67	1975–97	…	–	…	…	+	…	+	+	–*	…
BL (2002)	…	80	1975–99	…	…	–*	…	…	…	…	…	+ / –*	…
BHJ (2004)	371	90	1980–96	…	–*	–*	+*	0	…	–*	0	–*	…
			Expected sign:	–	–	–	+	+	+	+	+	–	+
			Right sign:	4/5	7/8	10/10	5/7	4/7	3/4	6/8	5/7	11/11	4/4
			Significant and right sign:	3/5	5/8	9/10	5/7	2/7	1/4	5/8	4/7	10/11	2/4

Note: (*) = results are statistically significant at standard levels; (?) = results are inconclusive; and (0) = no effect.

Legend:

BoP = Balance of Payments; *CA* = Current Account; *R* = reserves; d^* = total external debt; π = inflation; *e* = exchange rate (increase = depreciation); *G* = government spending or deficit; *M* = money or credit creation; *y* = per capita GDP or GDP growth.

GM = Goldstein and Montiel (1986); ES = Edwards and Santaella (1993); KS = Knight and Santaella (1997); PV = Przeworski and Vreeland (2000); BL = Barro and Lee (2002); BHJ = Bird, Hussain, and Joyce (2004)

The second item in the list is the strongest empirical regularity found in the cross-country studies. Both the current account and the balance of payments seem to improve following an agreement with the Fund, which seems to be consistent with the idea that improving the borrower country's external payments situation would be the Fund's principal objective and the focus of its analytical approach.[30] According to Table A.2, the balance of payments improves in 7 out of 9 studies and the current account in 8 out of 11.

[30] See Mussa and Savastano (1999) and Mody and Saravia (2003).

In the case of the effects on inflation, only 2 out of 15 studies manage to find a negative and significant effect of IMF programs on inflation, while one study finds a significant positive effect. Several studies indicate a negative effect, but regression coefficients are generally not statistically significant at standard levels. In terms of the growth effects of IMF programs, results are mixed and not robust to the methodology, period covered, and types of countries and programs being analyzed. Although 10 out of 19 studies find positive effects of IMF programs on growth and/or per capita GDP, only 3 studies report statistically significant effects (Table A.2).

Table A.2
Effects of IMF Programs on Selected MacroeconomicVariables

Study	No. of Progs.	No. of countries	Sample period	Effects of IMF program on: *BoP*	*CA*	*π*	*G*	*M*	*y*
Before - After									
RS (1978)	79	…	1963–72	0	…	0	…	–*	+
Connors (1979)	31	23	1973–77	…	+	0	0	…	0
Pastor (1987)	…	18	1965– 81	+*	0	+*	…	…	0
Edwards (1989)	34	34	1983	…	+	+	0	–	– / +
Schadler et al. (1993)	…	19	1983–93	+	–	–	–	?	+
KMM (1995)	…	16	1979–85	+*	+*	–*	–	–	– / +
With - Without									
Donovan (1981)	12	12	1970–76	…	…	–	…	…	+
Donovan (1982)	78	44	1971–80	+	+	–	…	…	–
Gylfason (1987)	32	14	1977–79	+*	…	0	…	0 (–*)	0
ES (1992)	48	31	1954–71	+*	+*	–	…	–	– / +
Generalized evaluation									
GM (1986)	68	58	1974–81	–	–	+	…	…	–
Khan (1990)	259	69	1973–88	+*	+*	–	…	…	–*
Conway (1994)	217	73	1976–86	…	+*	–	–*	+	– / +*
PV (2000)	678	135	1951–90	…	…	…	…	…	–*
D-MMS (2000)	…	61	1986–91	…	…	–	…	…	+*
Hutchison (2001)	461	67	1975–97	…	…	…	…	…	–*
IV Estimation									
BL (2002)	…	80	1975–99	…	…	…	…	…	0 / –*
Easterly (2005)	…	…	1980–99	…	…	…	…	…	+
Other									
BMO (2004)	…	29	1980–02	…	+*	–*	…	…	+*
			Right sign:	(+) 7/9	(+) 8/11	(–) 9/15	(–) 3/5	(–) 5/7	(+) 10/19
			Significant and right sign:	5/9	5/11	2/15	1/5	2/7	3/19

Note: (*) = results are statistically significant at standard levels; (?) = inconclusive results; and (0) = no effect.

Legend:

BoP = Balance of Payments; *CA* = Current Account; *π* = inflation; *G* = government spending or government deficit; *M* = money or credit creation; *y* = per capita GDP or GDP growth.

RS = Reichmann and Stillson (1978); KMM = Killick, Malik, and Manuel (1995); ES = Edwards and Santaella (1993); GM = Goldstein and Montiel (1986); PV = Przeworski and Vreeland (2000); D-MMS = Dicks-Mireaux, Mecagni, and Schadler (2000); BL = Barro and Lee (2002); BMO = Bordo, Mody, and Oomes (2004).

The last point, regarding the catalytic effect of IMF programs, is more directly related to this paper. In the literature, this expression is used to broadly characterize the ability of the IMF to facilitate access to international capital markets (Cottarelli and Giannini 2002, 5–7). The Fund claims that positive catalysis is a very important feature of its lending, since it provides only a small portion of a country's external financing requirements and the attached conditionality clauses help to reassure investors and the official community, acting as an important lever, or catalyst, for attracting other funds.[31]

Table A.3
Evidence of the Catalytic Effect of IMF Lending

Study	No. of progs.	No. of countries	Sample period	Catalysis?	Dependent variable
Emprirical					
Ozler (1978)	…	26	1968–81	Negative *	Spreads on bank loans
KMM (1995)	…	16	1979–85	Negative	Net capital flows
Rodrik (1996)	…	…	1970–93	Negative	Net private capital flows
BR-1 (1997)	…	90	1974–89	Negative	New lending commitments
BMR (2000)	17	17	1970s–1990s	?	
Edwards (2000)	…	106	1979–95	Negative, ?	Net capital flows
BR-2 (2002)	…	117	1977–99	Negative, ?	Net capital flows
Marchesi (2003)	…	87	1983–95	Positive *	Commercial debt rescheduling
MS (2003)	259	69	1973–88	Positive *	Bond issuance and spreads
BMO (2004)	…	29	1980–02	Positive *	Gross capital flows
EKM (2005)	678	135	1991–02	Positive	Bond spreads
Theoretical					
CGR (2004)				possible	
M-Shin (2005)				possible	

Note: (*) = results are statistically significant at standard levels; (?) = inconclusive results.

Legend:

KMM = Killick, Malik, and Manuel (1995); BR-1 = Bird and Rowlands (1997);
BMR = Bird, Mori, and Rowlands (2000); BR-2 = Bird and Rowlands (2002); MS = Mody and Saravia (2003);
BMO = Bordo, Mody, and Oomes (2004); EKM = Eichengreen, Kletzer, and Mody (2005);
CGR = Corsetti, Guimarães, and Roubini (2004); M-Shin = Morris and Shin (2005).

Table A.3 reports the results found in 11 empirical and 2 theoretical studies regarding the catalytic effect of IMF programs. Earlier studies, such as Ozler (1993), Killick, Malik, and Manuel (1995), Bird and Rowlands (1997, 2001) and Edwards (2000), find no evidence of a strong positive catalytic effect. Overall, six studies, among which five try to measure catalysis through the response of net capital flows following IMF programs, find negative, often not significant, effects. However, more recent papers seem to be more successful in finding signs of positive catalysis by IMF programs, in terms of facilitating private debt rescheduling (Marchesi 2003), by allowing more frequent and more favourable (lower spreads) bond debt issuance by sovereign countries (Mody and Saravia 2003; Eichengreen, Kletzer, and Mody 2005), and keeping capital flows in program countries (Bordo, Mody, and Oomes 2004). Theoretical predictions by Morris and Shin (2005) and Corsetti, Guimarães, and Roubini (2004) suggest that, although IMF programs cannot catalyze capital flows to countries in severe distress, they can help countries in a vulnerable but not insolvent condition. Bordo, Mody, and Oomes (2004) and Mody and Saravia (2003) empirically confirm these predictions.

[31] See "What Is The IMF?" at http://www.imf.org/external/pubs/ft/exrp/what.htm.

Appendix B: Calibration

This appendix provides a more detailed description of the calibration process shown in Table 2 (section 3 of the main text).

The artificial economy is calibrated for the Brazilian data and refers to a normalized, long-run path for the system, in which $\mathrm{E}(z_t) = 0$ and the values of the tradable endowment and the real exchange rate are $y^T = p = 1$. On this reference path, the economy is assumed to participate in an IMF program with frequency α. For instance, the frequency at which Brazil was under an IMF program during the period of reference was 50 out of 98 quarters, which implies $\alpha = 0.5102$.

Let $Y = y^T + py^N$, d and f be the long-run average levels of the total endowment, private and IMF loans, in units of tradable goods, respectively. In addition, denote g^T and g^N as the long-run average values for the consumption of public goods in tradable and non-tradable goods, respectively. The normalized values for y^T and p, combined with the long-run ratios $k_T = y^T/Y$, $k_d = d/Y$, $k_f = f/Y$, and $k_g = \left(g^T + pg^N\right)/Y$ taken from the data (Table 1), imply the calibrated long-run averages $Y = 1/k_T = 2.4722$, $y^N = 1/k_T - 1 = 1.4722$, $d = k_d/k_T = 0.6420$, and $f = k_f/k_T = 0.0336$. Under the additional assumption that the share of tradables in total consumption of public goods is also equal to k_T, then $g^T = k_g = 0.2057$ and $g^N = k_g\left(1/k_T - 1\right) = 0.3028$.

The discrete approximation of the state-space $\boldsymbol{S} = [\boldsymbol{D} \times \Omega_Z \times \boldsymbol{F} \times \{0,1\}]$, which is the support for the state $\left\langle d^*_{t-1}, S_t \right\rangle$, such that $d_t, d^*_t \in \boldsymbol{D} \subseteq \mathcal{R}$, $z_t \in \Omega_Z$, $f_t \in \boldsymbol{F} \subseteq \mathcal{R}^+$, and $IMF_t \in \{0,1\}$, relies on the discrete sets $\widetilde{\boldsymbol{D}}$, $\widetilde{\Omega}_Z$, and $\widetilde{\boldsymbol{F}}$. To capture the potential movements of the simulated series for the external debt, $\boldsymbol{D}$ is approximated by $\widetilde{\boldsymbol{D}} = \{d^*_t : d^*_{\min} \leq d^*_t \leq d^*_{\max}\}$, an evenly spaced d^*−grid (except for $d^*_t = 0$ and $d^*_t = d + f$) with $N_d = 602$ points. Given the average Y, the limits $d^*_{\min} = -1.0$ and $d^*_{\max} = 7.0$ imply debt-to-output ratios approximately in the range $[-0.4, 2.83]$, and are appropriately chosen to include the ergodic space. Negative values represent assets instead of liabilities.

To calibrate the exogenous stochastic process for the tradable endowment shock, we proceed as follows. First, we detrend the data on tradable output by removing a smooth trend with an HP filter and a smoothing parameter of 1600, for quarterly data. Then, we estimate a first-order autoregressive process of the type $z_t = \rho z_{t-1} + \varepsilon_t$, with $\varepsilon_t \backsim N(0, \sigma_\varepsilon)$, using ordinary least squares (OLS) on the HP-detrended data against its one-period lagged value. The autocorrelation (ρ) and the volatility (σ_ε) parameters obtained from the regression are $\rho = 0.7188$ and $\sigma_\varepsilon = 0.0229$, respectively.[32] Finally, the estimated stochastic process is discretized into a five-point Markov

[32] Using data on tradable output $\left(gdp^T\right)$, the following regression is estimated:

$$\left(gdp^T_t - HPgdp^T_t\right) = \alpha_0 + \rho\left(gdp^T_{t-1} - HPgdp^T_{t-1}\right) + \varepsilon_t,$$

with $R^2 = 0.5227$ and estimated parameters (p-values in parentheses) $\widehat{\alpha}_0 = -0.0272$ (0.9073), $\widehat{\rho} = 0.7188$ (0.000), and $\widehat{\sigma}_\varepsilon = 0.0229$.

chain, using Tauchen's (1986) procedure, resulting in an evenly spaced grid $\widetilde{\Omega}_Z = \{z_1, ..., z_5\}$, such that $z_3 = 0$, $z_1 = -z_5 = 0.0989$, and $z_2 = -z_4 = 0.0494$,[33] and in an underlying probability transition matrix given by:

$$\Pi = \begin{bmatrix} 0.3423 & 0.5984 & 0.0591 & 0.0002 & 0.0000 \\ 0.0467 & 0.5669 & 0.3744 & 0.0120 & 0.0000 \\ 0.0016 & 0.1611 & 0.6746 & 0.1611 & 0.0016 \\ 0.0000 & 0.0120 & 0.3744 & 0.5669 & 0.0467 \\ 0.0000 & 0.0002 & 0.0591 & 0.5984 & 0.3423 \end{bmatrix}.$$

As for the IMF loans, we use the set $\widetilde{\boldsymbol{F}} = \{0, \overline{f}\}$, consisting of only two possible choices. The economy gets $f_t = 0$ when the planner chooses $IMF_t = 0$. As previously mentioned, the assumption that $r > r^*$ ensures that $f_t = \overline{f}$ whenever $IMF_t = 1$, which allows $\widetilde{\boldsymbol{F}}$ to have only two points and substantially reduces the dimension of the state-space and the computational cost of the numerical solution discussed below. The IMF standard loan, $\overline{f}$, is calibrated to match the average value of IMF loans as a proportion of the GDP, given by k_f. Notice that, since the country will participate in an IMF program with frequency α, the long-run average IMF loan, f, has to be equal to $\alpha\overline{f}$. Given the values of α and f defined above, $\overline{f}$ is set to 0.0659, which corresponds to approximately 2.7 per cent of the targeted average total output, Y. Accordingly, the caps $\overline{g}^i$, $i = T, N$, to be satisfied as the conditionality rule when $IMF_t = 1$, are calibrated to approximate the frequency α. They are set to $\overline{g}^T = 0.2094$ and $\overline{g}^N = 0.3087$, which correspond to about 21 per cent of the endowments.

The value for the reciprocal of the intertemporal elasticity substitution (or, equivalently, for the CRRA case, the risk-aversion parameter) is set to $\gamma = 1.5$, which is standard.[34] The exogenous interest rate is set at the average level that the Brazilian government pays on its sovereign debt, as represented by the Federative Republic of Brazil's C bonds. Here, r is considered to be the quarterly equivalent of the average real annual rate on the U.S. government bonds ($r^* = 4.$ per cent per year, or 0.81 per cent per quarter, using the U.S. CPI inflation rate) plus the average spread paid on the C bonds (803.4 basis points, or $\zeta \simeq 8$ per cent per year).[35] The result is $r = r^* + \zeta = 2.82$ per cent per quarter. In addition, the parameter ν is set to 2.15, which is inside the range of values usually observed in empirical studies (Bouakez and Rebei 2003), and implies an elasticity of substitution

[33] In the OLS estimation, we normalize the data on tradable output $\left(gdp^T\right)$ such that the sample average is equal to 1. Although, the points $z_1, ..., z_5$ cannot be interpreted as percentage deviations of the trend, they are such that $y_t^T > 0$ at all times, since we impose $y^T = 1$. The use of $\log\left(gdp^T\right)$ in the OLS estimations produces similar results in terms of percentage deviations of the HP trend.

[34] For instance, the value used here is the mid-range value of two very common alternatives, $\gamma = 1.001$ or $\gamma = 2$, used by Greenwood Hercovitz, and Huffman (1988) and Mendoza (1991), for example. Issler and Piqueira (2000) estimate $\gamma = 1.7$, using Brazilian data and the same type of utility function used in this paper. The results of the simulation of the model are virtually the same if one uses this value instead of $\gamma = 1.5$.

[35] For the average risk-free real interest rate, the 10-year-maturity U.S. government bond is used, since its maturity is comparable to that of the C bonds. Because of data limitations, the average spread for the C bonds refers to the period 1995Q1−2004Q2.

between c and g equal to 0.3175.

Following the traditional hypothesis used in the small open-economy literature, in order to avoid a unit root in the current account, the subjective discount factor must satisfy $\beta(1+r) = 1$ and, thus, is set to $\beta = 0.9713$. This value of β is consistent with estimations by Issler and Piqueira (2000), using the same utility function used here, for the Brazilian economy.

The share of private consumption goods in the CES composite consumption index is calibrated to $\delta = 0.9850$ in order to match the average of total government consumption as a proportion of the GDP, k_g. The parameter governing the output loss observed in default states is set to $\lambda = 0.9750$, which implies output losses of 2.50 per cent during default episodes and helps to approximate the target k_d. This value is (roughly) in line with the empirical findings by Chuhan and Sturzenegger (2003).

For known values of k_T, k_d, and k_g, the normalized version of condition (12), computed at the long-run average target path, implies a one-to-one relationship between ω_c and μ_c.[36] Because of the non-linear nature of the model, which in principle should induce agents to react asymmetrically to positive and negative shocks, a "deterministic steady state" may not be relevant to reflect the long-run average state of the system. Ideally, in this case, a more precise method of calibration should be carried out through the solution of the whole model for a given set of parameters (all of them), and successive improvements should be made until the target average values are obtained. However, this non-linearity does not seem to be important here and the calibration procedure used, based on a deterministic steady state, is able to generate the target averages quite accurately. Among the different possible combinations of ω_c and μ_c that satisfy that relationship, $\omega_c = 0.0893$ and $\mu_c = 4.66$ (which imply an elasticity of substitution between c^T and c^N equal to 0.1767) are chosen in order to match the total output volatility $\sigma_y = 2.76$ per cent observed in the Brazilian data.[37] The corresponding parameters for g^T and g^N are set to $\mu_g = \mu_c$, and $\omega_g = \omega_c$, by symmetry.

[36] At the long-run average, given the two resource constraints and the normalized version of condition (12), the implied relationship between ω_c and μ_c is:

$$\omega_c \approx \left\{ 1 + \left[\frac{(1-k_T)(1-k_g)}{k_T(1-k_g) - rk_d - r^* k_f} \right]^{(1+\mu_c)} \right\}^{-1}.$$

[37] In principle, both parameters, ω_c and μ_c, are important to the volatility of the real exchange rate, p. However, since the business cycle statistics are usually computed on the log-variables to control for scale effects, only μ_c will have an impact on the volatility of (the log of) p. For instance, by taking the logarithm on both sides of equation (12), it is easy to see that $VAR(\log p_t) = (1+\mu_c)^2 \, VAR(\log c_t^T)$, implying that the ratio between the volatilities of (the logs of) p_t and c_t^T, as measured by their standard deviations, must be constant and equal to $(1+\mu_c)$. Because of its effect on the volatility of p, the parameter μ_c has an influence on the volatilities of total output, $Y_t^T + p_t Y^N$, and the total consumption of private $(C_t = c_t^T + p_t c_t^N)$ and public goods $(G_t = g_t^T + p_t g_t^N)$.