DEPARTAMENTO DE ECONOMIA

PUC-RIO

TEXTO PARA DISCUSSÃO
N.º 339

OPENNESS AND INFLATION : A NEW ASSESSMENT

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OUTUBRO 1994

Resumo:

Este artigo desenvolve e testa um modelo sobre como o grau de abertura de uma economia afeta sua taxa de inflação de equilíbrio. Considera-se uma economia pequena e aberta, onde o imposto de senhoriagem constitui uma parte significativa do total da receita do governo. Quanto mais fechada a economia, maior a depreciação real da taxa de câmbio necessária para que o superávit comercial financie o serviço da dívida externa do governo. A depreciação cambial, por sua vez, aumenta o valor do serviço da dívida em moeda doméstica. Consequentemente, quanto maior a depreciação cambial, maior será o valor do imposto inflacionário a ser recolhido. Haverá, portanto, uma relação negativa entre o grau de abertura da economia e inflação. As previsões da análise são comparadas com as do modelo de Romer (1993). Romer usa um modelo do tipo Barro-Gordon para argumentar que a abertura funcina como um desincentivo do governo a inflacionar, por causa da depreciação da taxa de câmbio induzida em uma economia aberta. Quanto mais aberta a economia, maior será o desincentivo a inflacionar. Os testes de Romer são reavaliados e mostra-se que o grau de abertura é um determinante significativo da inflação apenas em países altamente endividados, durante o período de crise da dívida externa. Os resultados empíricos indicam que o modelo de abertura e inflação aqui apresentado explica melhor os dados do que o modelo de Romer.

Abstract:

This paper develops and tests a model of how the degree of openness of an economy may affect its equilibrium inflation rate. A small open economy is considered, in which seignoriage taxes constitute an important part of the government's total revenue. The less open the economy is, the larger is the real exchange rate devaluation required to produce the trade surplus needed to finance the government's foreign debt repayments. The depreciation, in turn, increases the amount o debt service measured in local currency. Consequently, the larger the exchange depreciation, the larger will be the inflation tax to be collected. Hence, there will be a negative relation between openness and inflation. The predictions of the analysis are compared to those in the model in Romer (1993). Romer uses a Barro-Gordon type model to argue that openness puts a check on a government's incentive to engage in unanticipated inflation, because of induced exchange rate depreciation. Romer's tests are reevaluated, and it is shown that the degree of openness is only a significant determinant of inflation among highly indebted countries, during the debt crisis period. The empirical results indicate that the model of openness and inflation presented here explains the data better than Romer.

1. Introduction

A new view on how the degree of openness may affect the equilibrium inflation rate is presented in this paper, and an empirical study is performed to test its validity. The effect arises in an indebted small open economy in which seignorage constitutes an important part of the government's total revenue. The less open the economy, the greater is the effort to to produce the necessary trade surplus that equilibrates the balance of payments, which means that less open (indebted) economies will need a more devalued exchange rate. The exchange rate, on the other hand, affects the government's budget deficit, as it affects the local currency value of the debt service. Consequently, it will also affect the amount of inflation tax the government needs to collect. The result is that less open indebted economies will have higher inflation rates. The result is derived from a model economy where changes in nominal variables have no real effects, hence monetary policy does not affect the real exchange rate.

Romer (1993) offers a different explanation for a negative link between inflation and openness. He relates to the literature on the implications of the lack of precommitment in monetary policy on the equilibrium inflation rate in economies where monetary policy can affect real output (Kydland and Prescott (1977) and Barro and Gordon (1983) are classic references in this area). His starting point is Rogoff (1985), which shows that output increases generated by unanticipated monetary expansion causes real exchange rate depreciation, and the depreciation lowers the benefits of the expansion. This leads to the prediction that more open economies would tend to have lower inflation rates in the absence of precommitment in monetary policy. Romer (1993) tests empirically this prediction.

The most interesting part of this paper confronts the empirical findings in Romer (1993) with a new interpretation of the data. This paper shows that the model proposed here, and not the one in Romer (1993), is the most appropriate explanation for the behavior of the data. Romer (1993) shows that a regression of the degree of openness on inflation for a large sample of countries yields a negative and significant link between the two variables. This paper shows that

when the sample of countries is divided accordingly to indebtedness level, the negative link between inflation and openness disappears in all groups of countries, except for the group of highly indebted countries. Moreover, when the time frame studied is split between the pre-debt crisis and debt crisis periods, the relation is notably stronger during the latter.

The paper is organized as follows. Section 2 presents the new proposed view on the link between inflation and openness, while section 3 describes Romer's theoretical explanation for it. An empirical assessment of the two views is carried on in section 4. The empirical findings in Romer (1993) are described, and further scrutiny of the data is performed. The suitability of the theories for the description of the behavior of the data is discussed. Section 4 is self contained, so that readers interested in the empirical study may skip the first two sections.

2. Openness and Inflation: the Model

This section presents a model economy which predicts that a negative link between inflation and openness arises in an open economy going through a debt crisis. In the model, changes in nominal variables have no real effects, hence monetary policy does not affect the real exchange rate. Inflation arises simply from the fact that the government has to resort to money creation to service its foreign debt.

Summarizing the main mechanisms of the model, the government has two instruments to finance its expenditures: foreign borrowing and money creation. Foreign credit is assumed to have an upper boundary, and when it is reached the government has to create money to pay for its outstanding debt service. The value of the foreign debt service in local currency affects the nominal exchange rate, hence the amount of money creation will depend on the nominal exchange rate. On the other hand, the equilibrium exchange rate depends on the degree of openness of the economy. The more tradable goods there are, the lower needs to be the surplus in the trade of each of the goods to attain the necessary overall trade surplus. Hence, the lower needs to be the real

exchange rate to equilibrate the balance of payments. Consequently, more open economies will have lower rate of money creation, resulting in a lower inflation rate.

First, the equilibrium inflation rate will be derived as a function of the ratio between the real exchange rate and real money balances. Then, the ratio between real exchange rate and real money balances will be shown to depend negatively on the degree of openness of the economy in an indebted country going through a debt crisis.

There are N goods in this economy divided into two sectors: goods $X_1,...,X_T$ are in the tradable goods' sector, and goods $X_{T+1},...,X_N$ in the non-tradable goods' sector. The country is small in the international goods market, so that the domestic price of each tradable good is $p_{t\tau} = E_\tau p^*_{t\tau}$, for $0 \le t \le T$, where E_τ is the nominal exchange rate at period τ, and $p^*_{t\tau}$ is the (exogenous) international price of the tradable good *t*, taken as being equal to 1 for every good.

Every firm in the economy faces perfect competition, and, for simplicity, every firm has the same production function. Let $e = p_t/p_n$ be the real exchange rate[1], and p_t and p_n are the prices of the tradable and non-tradable goods, respectively. Assuming full employment of the fixed factor endowments, the producer of each good chooses optimally its production point, resulting in the following supply functions for a representative tradable and non-tradable good, respectively[2]:

$$\begin{aligned} X_t^s &= X_t^s(e) \\ X_n^s &= X_n^s(e) \end{aligned} \qquad (1)$$

where X_t^s and X_n^s represent the supply of a tradable and a non-tradable good, and $\frac{dX_t^s(e)}{de} > 0$ and $\frac{dX_n^s(e)}{de} > 0$.

Consumers maximize utility, subject to their budget constraint. It is also assumed that their demand for goods depend positively on the amount of money they hold. Two possible ways to

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[1]The definition of the real exchange rate summarizes incentives that guides resource allocation between the two sectors of the economy.

[2]Time subscripts are omitted wherever it is not confusing to do so.

derive this assumption are either by a cash-in-advance constraint, or by putting money in the utility function. The demand for each type of good may be represented by:

$$\begin{aligned} X_t^d &= X_t^d(m,e) \\ X_n^d &= X_n^d(m,e) \end{aligned} \tag{2}$$

where X_t^d and X_n^d represent the demand for a tradable and a non-tradable good, respectively, real cash balances in terms of non-tradable goods[3] is $m \equiv M/p_n$, M is the nominal money stock, and p_n the price of non-tradable goods.

In equilibrium, the demand of non-tradable goods has to equal its domestic supply. The real money balances and real exchange rate have then to satisfy the following condition in equilibrium:

$$X_n^s(e) = X_n^d(m,e) \tag{3}$$

Furthermore, the country's resource constraint dictates that the variation in foreign debt, to which only the government has access, must equal the sum of interest payments on previously contracted foreign debt and the trade balance:

$$F_\tau - F_{\tau-1} = r F_{\tau-1} + T\left[X_{t,\tau}^d - X_{t,\tau}^s\right] \tag{4}$$

where r is the international interest rate, taken as being exogenous and constant over time, and F_τ is the amount of government external debt at period τ.

It is assumed that there is an upper limit of foreign credit available for the government, i.e., $F \le \overline{F}$. A debt crisis period can be represented as the government inheriting a debt equal to its upper limit, i.e., not able to borrow more. In a debt crisis, the resource constraint becomes:

$$r F_{\tau-1} = T\left[X_{t,\tau}^s - X_{t,\tau}^d\right]. \tag{5}$$

Equations (3) and (5) determine the equilibrium values of the real exchange rate and real money balances in the economy. They ensure that the domestic market is in equilibrium, and that

[3]The real money supply is defined in terms of the price of non-tradable goods for analytical convenience only. It will play no role in the model.

the trade surplus generates enough foreign resources for the country to meet its external financial obligations. These resources, however, are generated by the private sector, and the external debt is a public liability. Hence, how the resources are transferred from the private to the public sector has to be specified.

The government's budget constraint is added to this framework. Government expenditures are exogenously given. The two sources of government financing are credit creation and foreign borrowing, that is, either the government brings money from abroad, or it transfers money from the private sector through inflation tax. It yields the following budget constraint for the government:

$$E_\tau\left(F_\tau - F_{\tau-1}\right) + M_{\tau+1} - M_\tau = r E_\tau F_{\tau-1} + G_\tau, \tag{6}$$

where G is government's nominal expenditures.

The government is assumed to have two main objectives: to keep inflation as low as possible, and to maintain good reputation in the international financial markets, which translates here into always servicing the existing debt. For simplicity, let government expenditures equal zero. These assumptions imply that the government will always prefer to contract more debt to service old debt, and will print money only to the extent that the debt service exceeds the credit available for the country in the international financial market. Hence, during a debt crisis the government's budget constraint becomes:

$$M_{\tau+1} - M_\tau = E_\tau r F_{\tau-1} \tag{6'}$$

which implies:

$$\pi_\tau = \frac{e_\tau}{m_\tau} r F_{\tau-1} \tag{7}$$

where π_τ is the inflation rate. As shown in appendix, $\frac{M_{\tau+1} - M_\tau}{M_\tau} = \frac{p_{I\tau} - p_{I(\tau-1)}}{p_{I(\tau-1)}} = \pi_\tau$.

The intuition for equation (7) is as follows. To pay for its foreign debt service the government has to create money. The money creation increases the demand for all goods, as shown in equation (2). To offset this effect and restore the equilibrium real money supply, the

price of non-tradable goods increases. The higher price of non-tradable goods, in turn, causes an appreciation of the real exchange rate. Therefore the nominal exchange rate also increases to reestablish the equilibrium real exchange rate. The rate of money creation depends on the amount the government needs to colletct in local currency to meet its external financial obligations. The higher is the real exchange rate in relation to the real money balances necessary to maintain equilibrium in all markets, the higher will be the money creation necessary to pay for the foreign debt service, causing a higher inflation rate.

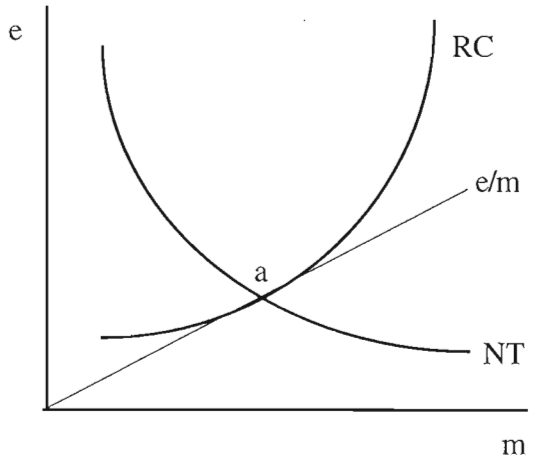

Figure 1

Figure 1 represents the equilibrium of the economy when the foreign debt is equal to its upper limit, i.e., in a debt crisis. The schedule NT represents the locus where the non-tradable goods market clears (equation (3)). The locus consistent with the country's resource constraint (equation (5)) is RC. The nominal exchange rate and the prices of the non-tradable goods adjust for the country's resource constraint to be satisfied and the market for non-tradable goods clear. In equilibrium the economy is at point "a" in figure 1, and the inflation rate depends positively on the ratio e/m at that point, accordingly to equation (7).

The next step is to derive the effect of the degree of openness on the equilibrium inflation rate in this model economy. Given the total number of goods, the degree of openness increases when more goods are tradable; hence the degree of openness in this model is the number of

tradable goods. The effect of the degree of openness on the equilibrium inflation rate can be assessed by deriving the effect of changes in the number of tradable goods on the equilibrium ratio of real money supply to the real exchange rate. That is, the effect on the non-tradable goods market equilibrium (equations (3)) and the external resources constraint (equation (5)), or, in terms of Figure 5, the movements in the NT and RC schedules.

The number of tradable goods has no effect on the equilibrium condition in the non-tradable goods market. As for the external resources constraint, the more tradable goods there are, the lower needs to be the trade surplus in each of them to generate a sufficient amount of resources to service the external debt. This is translated in figure 1 as a shift of the RC schedule to the left: point "a" would be a point of surplus in a more open economy.

Figure 2 represents the effect of openness on the equilibrium of the economy. The effect of openness on the equilibrium e/m ratio is negative. Therefore, according to equation (7), more open economies will have lower inflation rates, if they are producing trade surpluses.

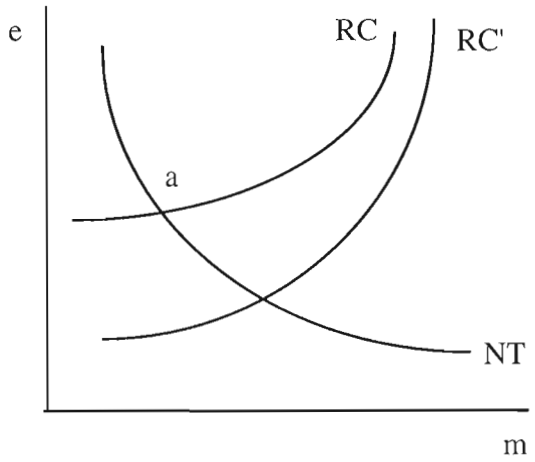

Figure 2

If some countries are running trade deficits, and others trade surpluses, then the theory presented above does not predict any particular link between inflation and openness among the countries. During the debt crisis, however, the severely indebted countries had one feature in common: they had to have trade surpluses to pay for the foreign debt service. Therefore, for the

severely indebted countries the theory predicts a negative link between inflation and openness over the debt crisis. The same link is not expected over different periods of time, or for different groups of countries. Empirical evidence of this result is presented in section 4.

The next section presents the link between inflation and openness suggested in Romer (1993).

3. Romer's Theory

Romer (1993) intends to study the empirical validity and relevance of precommitment in monetary policy on the equilibrium inflation rate. He tests one of the predictions of the theory, which is that more open economies would tend to have lower inflation rates. The theory goes as follows:

The economy has nominal stickiness in prices or wages, so that unanticipated monetary shocks have both nominal and real effects in the economy. Equation (10) represents departures of output (y) from its natural rate (y^*) as a linear function of the difference between the inflation rate (π) and the expected one (π^e), resulting from the nominal stickiness,

$$y = y^* + \delta(\pi - \pi^e) \tag{10}$$

where $\delta > 0$.

The policy maker's objective function include a positive function of changes of output above its natural rate, and a negative function of the inflation rate. The function may be written as:

$$W = -\frac{1}{2}\pi^2 + \phi y \tag{11}$$

for simplicity, for $\phi > 0$.

The policy maker chooses the rate of money growth so as to maximize his objective function, taking as given the rate of inflation expected by the private agents. But when the private agents form their inflation rate expectation, they take into account the problem the policy maker

will be facing, and form their expectations accordingly. The resulting equilibrium will be a (properly expected) positive inflation rate, with no real effects.

Rogoff (1985) includes one more piece in this framework: the effect of trade with the rest of the world is considered. With the same basic framework as before, the policy maker will be tempted to set the rate of money growth above the one consistent with zero inflation in an attempt to increase output above its natural rate. Two effects come into play in an open economy. First, the increase in domestic output relative to output abroad will reduce its relative price, provided they are not perfect substitutes. This will reduce the benefit of the output expansion, and the larger the fraction of goods imported, the lower will be the benefit of the monetary expansion. This effect will make ϕ be lower in more open economies. Second, as the increase in the domestic output is driven by the change in domestic prices, and real depreciation means that foreign prices increase more rapidly than domestic prices, so that a given domestic output increase will be associated with a higher inflation the more open the economy is. That is, the output/inflation trade off changes with the openness of the economy: increased openness reduces δ is equation (10). These two effects combined will lower the benefit of an unanticipated monetary expansion.

A result that can be drawn from this theory is that in an economy with nominal stickiness and no precommitment to monetary policy, the equilibrium inflation rate will be lower the more open the economy is. Romer (1993) tests this prediction in the data.

4. Empirical Evidence: Comparing the Two Theoretical Approaches

This paper proposes a new theoretical approach on how the degree of openness of an economy may affect its equilibrium inflation rate in an indebted economy where the government has to resort to credit creation to pay it foreign debt service. It shows that a negative link between inflation and openness should be observed among indebted countries going through a debt crisis, defined as the international credit available to the country being insufficient to cover the

outstanding debt service. No such relation is expected among other groups of countries and/or when there is no debt crisis.

A different approach is offered in Romer (1993). Accordingly to it, openness and inflation should be negatively related among economies in which monetary policy has real effects due to some kind of price stickiness, and when there is no precommitment in monetary policy.

The theoretical approaches for the negative link between inflation and openness proposed in this paper will be compared to Romer (1993) in the light of the data. Romer's empirical findings will be described, and further scrutiny of the data will be performed to investigate the appropriacy of the two theories. Basically, it will be shown that the negative link between inflation and openness found in Romer (1993) over a large sample of countries and a broad time frame is actually caused by a sub-sample of the countries over a limited time period, more specifically, it is caused by the severely indebted countries over the debt crisis period.

The national accounts data used in this paper is from the International Financial Statistics of the International Monetary Fund[4]. To account for the theory presented in this paper, the right measure for the degree of openness should be the ratio between the value of tradable goods and GDP, whereas for Romer's theory it should be the ratio between imports and total consumption. The ratio between imports and GDP is used as a proxy for openness in the two cases. Inflation is measured as the annual change in the logarithm of GDP.

4.1. Empirical Results from Romer (1993)

Romer (1993) regresses inflation rates on the degree of openness for as large a sample of countries as possible. He has a sample of 114 countries, and uses the average of inflation rate and the degree of openness beginning in 1973. Romer observes that because "the Bretton Woods

[4]Romer (1993) uses alternative data sources for some of his data. Refer to that paper for a thorough description of the data used.

system limited countries' ability to pursue independent monetary policies, the post-1973 regime appears to provide a better setting to test the theory". His basic regression yields a promising result: the coefficient of the degree of openness is negative and significant, with a t-statistic of -3.8. Then, he includes in the regression real income per capita, dummies for alternative sources of data, and regional dummies. The link between inflation and openness remains negative and significant.

Further robustness tests are performed. First, he includes in the regression central bank independence and political instability as measures of the central bank's ability to precommit to its monetary policy. Cukierman, Webb and Neyapti (1992) show that inflation is generally higher in countries with less independent central banks, and in Cukierman, Edwards and Tabellini (1992) inflation is found to be on average higher in countries that are less politically stable. Romer's basic argument is that "the incentives to expand are low in highly open economies, and then that inflation will be low in these countries *even in the absence of precommitment*. Thus, the argument predicts that the link between openness and inflation will be weaker in countries that are more stable and have more independent central banks". The basic results are robust to the inclusion of these measures.

The next step was to test for the robustness across subsamples. The first 3 subsamples studied are: countries with average inflation higher than 30% excluded, countries without independent monetary policy excluded, and a sample only with countries with good data[5]. The coefficient on openness is negative and significant for these subsamples.

The sample is then divided by region: OECD (as a region), Africa, South America, Central America and Asia. The estimated coefficients on openness are all negative, but the null hypotheses that they are equal to zero cannot be rejected (except for South America). Romer claims that the insignificance of the coefficients is due to the small number of observations in these regressions.

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[5] Those are the countries "whose national accounts received a rating of "C" or better from Summers and Heston (1988), for which alternative measures of inflation and the import share did not have to be used, and which are not major oil producers".

The regression including only the eighteen wealthiest countries in the sample other than the major oil producers shows virtually no link between inflation and openness, and the average inflation is low, whereas outside this group average inflation rates are much higher and the negative link between inflation and openness is significant. According to Romer this result indicates that "there is a group of approximately fifteen to twenty highly developed countries that have largely solved the problem of dynamic inconsistency of optimal monetary policy".

4.2. A New Interpretation of the Data

Looking at the world events through the period studied by Romer, one is struck by the action in the international markets. The adverse terms of trade effect of the two oil price shocks that occurred in the 1970's led to contractionist policies in the first world, whereas less developed countries chose to continue their growth process taking advantage of the high liquidity of the international financial markets. In the early 1980's the situation changed considerably and unexpectedly. The capital inflow into the third world dropped and international interest rates rose substantially. The less developed countries, by then indebted, were facing a sudden increase of the service on their foreign debt and lower capital inflow. They had to change their trade balances from recurrent deficits to large surpluses to meet their international financial obligations.

The relation between inflation and openness as predicted by the precommitment theory depends crucially on the effect of monetary policy on the equilibrium real exchange rate. Even if the precommitment theory actually describes a valid argument that may be relevant to policy making, it is reasonable to state that the relation between inflation and openness as explained by it may have been overwhelmed by the effects of all the action described in the previous paragraph during the time frame studied. Other considerations that enters the policy maker's objective function may have dominated the effects on the incentive to manipulate monetary policy to provoke departures from the "natural rate" of output.

An important goal to the policy maker may be to continue as a player in the international financial market. A real exchange rate depreciation may help it to achieve that objective, as it may improve the country's trade balance (see Gylfason and Risager (1984) for a discussion and empirical evidence of how the exchange rate depreciation improves the current account). Countries with higher debt will have a higher impact from the decrease in international financial liquidity, and therefore a stronger effort will have to be made to meet its international financial duties.

Turning back to the data, from the 20 countries with average inflation greater than 20% over the period, 18 were considered severely or moderately indebted by the World Bank criteria.[6]

The generation of sub samples accordingly to regional location of the countries made by Romer does not rely on any economic difference among the countries that would predict differences in their economic behavior. It is actually a random division of the sample with respect to economic fundamentals. The level of indebtedness, on the other hand, is a criteria that embodies an important difference among the countries regarding its economic environment.

The sample of countries is divided into less indebted, moderately indebted, and severely indebted countries, according to the classification made by the World Bank in the *World Development Report* (1993). Using the data presented in Romer (1993) the regression was run for the different groups of countries separately, and the results are presented in table 1. The last two columns of the table present the regression for the group of countries in Romer (1993) that are not classified by indebtedness level. The odd numbered columns of the table shows the results of the regression for the different groups of countries including only openness as explanatory variable for inflation, whereas the even numbered columns also include the logarithm of real income and dummy variables for alternative data sources[7]. The null hypotheses that the coefficient on openness is equal to zero cannot be rejected at 95% of significance level for the groups of less and

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[6] *World Bank Development Report* (1993), p.328-329.

[7]The data on income is from Summers and Heston (1988). For countries for which data on inflation and openness could not be found in the IMF's International Financial Statistics, Romer (1993) used alternative data sources, and dummy variables try to capture possible differences in the measurement of the different sources of data.

moderately indebted countries, and for the countries not classified by indebtedness. For the group of severely indebted countries, however, the coefficient on openness is negative and significant, with a t-statistics of -3.1.

Table 1

	Level of Indebteness						Other countries	
	Severely		Moderately		Less			
	(1)	(2)*	(3)	(4)*	(5)	(6)*	(7)	(8)*
Openness	-2.14	-2.05	-1.04	-0.69	-0.65	-0.87	-0.24	0.67
Standard Error	*0.70*	*0.71*	*0.74*	*0.59*	*0.32*	*0.37*	*0.41*	*0.76*
t-statistics	*-3.05*	*-2.87*	*-1.41*	*-1.18*	*-0.17*	*-2.36*	*-0.59*	*0.88*
Log Income		0.31		0.45		-0.03		0.00
Standard Error		*0.17*		*0.10*		*0.11*		*0.19*
t-statistics		*1.76*		*4.31*		*-0.32*		*-0.01*
Constant	-1.04	-3.19	-1.73	-5.06	-1.96	-1.64	-2.38	-2.62
Standard Error	*0.26*	*1.25*	*0.23*	*0.80*	*0.18*	*0.86*	*0.20*	*1.66*
t-statistics	*-3.97*	*-2.53*	*-7.47*	*-6.33*	*-10.79*	*-1.90*	*-11.64*	*-1.60*
R2	0.23	0.32	0.07	0.48	0.17	0.25	0.01	0.10

(*)These regressions include dummies for alternative data sources (see Romer, 1993)

The group of countries not classified by indebtedness shows virtually no link between inflation and openness. In the regression including only openness as explanatory variable, the R-square is only 0.01, the t-statistics is very low, and the coefficient on openness is negative, but very close to zero. When income is included in the regression the coefficient becomes positive. The coefficient on openness is more negative and the t-statistics is higher (in absolute value) the more indebted the group of countries is, in the regression including only openness. Hence, the negative link between inflation and openness is stronger among more indebted countries, which is in accord with the theory presented in this paper. The theory also predicts that indebted countries going through a debt crisis should have higher inflation rates. The average inflation for the group of less indebted countries is 10.9%, for the moderately indebted countries it is 15.4%, and, finally, 28.2% for the severely indebted countries.

Figure 3 presents the scatter plot of the logarithm of average inflation since 1973 against the degree of openness for each group of countries separately. The figure shows clearly that the negative link between inflation and openness exists only among the severely indebted countries.

Table 2

Severely Indebted Countries

	73-90		Pre-Debt Crisis		Debt Crisis	
	(1)	(2)	(3)	(4)	(5)	(6)
Openness	-1.77	-2.32	-1.14	-1.20	-3.07	-3.25
Standard Error	*0.63*	*0.69*	*0.46*	*0.44*	*1.00*	*1.01*
t-statistics	*-2.81*	*-3.36*	*-2.47*	*-2.73*	*-3.06*	*-3.22*
Log. Income		0.27		0.22		0.26
Standard Error		*0.15*		*0.10*		*0.24*
t-statistics		*1.79*		*2.21*		*1.05*
Constant	-1.04	-2.71	-1.27	-27.53	-0.68	-23.71
Standard Error	*0.25*	*1.11*	*0.18*	*0.73*	*0.38*	*1.81*
t-statistics	*-4.19*	*-2.45*	*-7.09*	*-3.77*	*-1.80*	*-1.31*
R2	0.22	0.40	0.18	0.35	0.26	0.34

It is important to note that the time period over which the data is studied incorporates two distinct economic environments in the world. As mentioned earlier, the developing countries were contracting their debt during the 1970's, and the debt crisis started in 1982. The data is studied for these two time periods separately, for each group of countries according to indebtedness level. The countries in this sample are the ones for which data on GDP and the level of imports could be found in International Financial Statistics[8]. The average of inflation rates and openness are taken for the whole time frame (since 1973), for the pre-debt crisis period (1973-1981) and for the debt crisis period (1982-1990), for each group of countries separately.

[8]In the group of severely indebted countries Burundi, Jamaica, Somalia, Sudan and Uganda are the countries that are in Romer's sample of countries but are not included here, whereas Myanmar is included here but not in Romer (1993). The moderately indebted countries group does not include Bangladesh, Central African Republic and Gambia, but adds Hungary which is not in Romer (1993). Finally, the less indebted countries group does not include South Africa, but adds Cape Verde, Czechoslovakia, Grenada and Solomon Islands.

Table 3

Moderately Indebted Countries

	73-90		Pre-Debt Crisis		Debt Crisis	
	(1)	(2)	(3)	(4)	(5)	(6)
Openness	-1.32	-1.09	-0.66	-0.71	-1.58	-1.44
Standard Error	*0.78*	*0.62*	*0.78*	*0.63*	*0.93*	*0.74*
t-statistics	*-1.68*	*-1.74*	*-0.85*	*-1.13*	*-1.70*	*-1.96*
Log. Income		0.34		0.33		0.44
Standard Error		*0.10*		*0.10*		*0.11*
t-statistics		*3.65*		*3.15*		*3.99*
Constant	-1.46	-3.98	-1.56	-3.84	-1.55	-4.72
Standard Error	*0.25*	*0.73*	*0.25*	*0.79*	*0.29*	*0.83*
t-statistics	*-5.80*	*-5.47*	*-6.21*	*-4.88*	*-5.34*	*-5.73*
R2	0.11	0.45	0.03	0.36	0.11	0.49

Figure 4 presents the scatter plot of inflation and openness for the severely indebted countries, for different time periods. The negative link between inflation and openness is very weak during the 1970's and early 1980's, when those countries were mainly contracting their debt and did not have balance of payments problems. During the debt crisis period, inflation and openness have a strong negative link. The countries were facing severe balance of payments constraints, due to the increase in the world interest rates that led to higher debt service payments combined with a lower capital inflow. The graphs show that the negative link between the two variables that is observed over the whole time frame studied is considerably weaker before the debt crisis, and is strikingly strong during the debt crisis.

The regressions corresponding to the graphs in Figure 4 are presented in Table 2. The odd numbered columns of the table show the results of the regression of inflation on openness only, whereas the even numbered ones also include the logarithm of income as independent variable. The coefficients of openness are negative and significant at 95% of significance level for all the regression in Table 2. The slope, however, is much steeper for the debt crisis period (when the coefficient of openness equals -3.07) compared to the earlier period (when the coefficient is -1.14). The t-statistics is higher for the debt crisis period, and so is the R-square. During the debt

crisis period, openness accounted for 25 percent of the cross-country variation in average inflation rates in this group of countries, compared to 19 percent before the crisis. When income is included in the regression, the coefficient of openness increases for the three periods of time considered, and so does the t-statistics. But they are still higher for the debt crisis period.

Figures 5 and 6 present the scatter plot of inflation and openness for the moderately and less indebted countries, respectively. The scatter plot is generated for the different time periods studied. The graphs in the two figures do not show any clear negative relationship between the two variables for any of the samples. Tables 3 and 4 presents the regression corresponding to Figures 5 and 6 respectively.

Table 4

Less Indebted Countries

	73-90		Pre-Debt Crisis		Debt Crisis	
	(1)	(2)	(3)	(4)	(5)	(6)
Openness	-0.20	-0.24	-0.03	-0.23	0.32	-0.23
Standard Error	*0.32*	*0.24*	*0.37*	*0.25*	*0.52*	*0.52*
t-statistics	*-0.63*	*-1.04*	*-0.09*	*-0.91*	*0.61*	*-0.44*
Log. Income		-0.08		0.14		-0.58
Standard Error		*0.08*		*0.08*		*0.20*
t-statistics		*-1.08*		*1.84*		*-2.97*
Constant	-1.97	-1.21	-1.76	-2.65	-2.50	2.21
Standard Error	*0.19*	*0.62*	*0.21*	*0.60*	*0.31*	*1.60*
t-statistics	*-10.52*	*-1.97*	*-8.19*	*-4.42*	*-8.05*	*1.38*
R2	0.02	0.11	0.00	0.19	0.02	0.36

Similarly to Table 2, the odd numbered columns in Tables 3 and 4 represent the regression of inflation on openness only, and the even numbered ones also include income in the regression. The null hypotheses that the coefficient on openness is equal to zero cannot be rejected in any of the regressions in Tables 3 and 4, at significance level of 95%. Nevertheless, the estimated coefficient of openness is more negative during the debt crisis period than during the early period for the moderately indebted countries. No such relation exists for the less indebted countries.

Moreover, the regressions not including income yield a much lower R-square among moderately and less indebted countries compared to the same regression among severely indebted countries.

The empirical study described in this section indicates that the negative link between inflation and openness is negative and significant only among the severely indebted countries. Moreover, if the time frame studied is split between the pre-debt crisis and debt crisis periods, the relation is notably stronger during the latter.

5. Conclusion

This paper offers a novel explanation for a negative link between inflation and openness. The link occurs in a situation where the government inherits some foreign debt from previous governments, and has to service it. If the amount of debt owed by the government has reached an upper boundary, it has to resort money creation to pay the debt service. The rate of increase of money creation is a direct function of the equilibrium ratio between the real exchange rate and the real money supply. Moreover, the more open the economy is the lower will be the exchange rate for a given money stock necessary to equilibrate the balance of payments, and, therefore, the lower will be the rate of increase of money. Hence, inflation will be lower in more open economies during a debt crisis.

A negative relation between inflation and openness is also a prediction of models in which lack of precommitment in monetary policy leads to excessive inflation. In those models, however, the relation should be observed over all countries, and not only the one with large external debt as in the model presented here. Romer (1993) tests this prediction and concludes the data is consistent with the theory, i.e., that average inflation rates are smaller in more open economies. Therefore, his findings suggest that "models in which the absence of precommitment in monetary policy leads to inefficiently high average levels of inflation are essential to understanding inflation in most of the world".

This paper shows that a further scrutiny of the data studied in Romer (1993) indicates that the negative link between inflation and openness observed cannot be used as an indication of the relevancy of absence precommitment in monetary policy in understanding inflation. The data suggests that this behavior is due to other factors, captured in the model presented in this paper.

The division of the sample of countries accordingly to indebtedness level shows that the negative link between inflation and openness is negative and significant only among the severely indebted countries. Moreover, within that group of countries, the relation is strikingly stronger during the debt crisis period. The "precommitment models" do not account for this behavior of the data. One argument in favor of those models as supportive of the data could be that the degree of indebtedness may be correlated with the degree of precommitment in monetary policy. Countries that "over-borrowed" would also be the ones with less precommitment in monetary policy, and therefore the negative link between inflation and openness should be stronger among them.

The argument, however, fails to address the fact that during the debt crisis the link between inflation and openness was strikingly more negative and significant compared to other time periods. The data suggests that the debt crisis triggered some phenomena responsible for the behavior observed, and it does not rely on the mechanisms suggested in the "precommitment models".

As for policy implications, Romer's theoretical explanation for the behavior of the data implied that international economic integration and cooperation would not be desirable, as it would eliminate one disincentive for governments to inflate, and therefore would lead to inefficiently higher inflation rates. The alternative explanation proposed in this paper has no such implication. Quite on the contrary: if economic integration would result in increased quantity of tradable goods in the economy, it would actually help lowering the inflation rate in an indebted economy going through a debt crisis.

Appendix

The demand function for goods and the velocity of money are derived in this appendix. All consumers have identical utility functions. The representative consumer maximize a Cobb-Douglas utility function:

$$\sum_{\tau=\nu}^{\infty} \delta^{\nu-\tau}\left[\sum_{i=1}^{N}(1/N)\log X_{j\tau}^{d}\right] \tag{A1}$$

where δ is the discount factor, $X_{j\tau}^{d}$ is the amount of good j demanded at time τ.

The consumer's budget constraint dictates that the amount spent on consumption plus the cash balance carried to the next period cannot exceed income plus cash balances carried in the beginning of the period. The constraint is represented by:

$$\sum_{j=1}^{N} p_{j\tau} X_{j\tau}^{d} + M_{\tau+1} \le Y_{\tau} + M_{\tau} \tag{A2}$$

where M_{τ} is the amount of money carried by the consumer in the beginning of period τ, and Y_{τ} is nominal income.

In addition to the budget constraint, a cash-in-advance constraint is imposed to the consumer.

$$\sum_{j=1}^{N} p_{j\tau} X_{j\tau}^{d} \le M_{\tau} \tag{A3}$$

Equations (A4.a-d) represent the first order conditions for the consumer's maximization problem, given that the constraints the consumer faces are binding. The multipliers for the budget and cash-in-advance constraints are λ_{τ} and γ_{τ}, respectively.

$$\frac{\delta^{\nu-\tau}}{N X_{j\tau}^{d}} - p_{j\tau}(\lambda_{\tau} + \gamma_{\tau}) = 0 \tag{A4.a}$$

$$\lambda_{\tau+1} + \gamma_{\tau+1} - \gamma_{\tau} = 0 \tag{A4.b}$$

$$\sum_{j=1}^{N} p_{j\tau} X_{j\tau}^{d} + M_{\tau+1} = Y_{\tau} + M_{\tau} \tag{A4.c}$$

$$\sum_{j=1}^{N} p_{j\tau} X_{j\tau}^{d} = M_{\tau} \tag{A4.d}$$

The value of the budget constraint multiplier is derived by combining equations (A4.a) and (A4.b), and substituting into equation (A4.d):

$$\lambda_{\tau-1} = \frac{\delta^{v-\tau}}{M_{\tau}} \tag{A5}$$

Substituting the multiplier back into the combination of equations (A4.a) and (A4.b), the demand for good j at period τ is:

$$X_{j\tau}^{d} = \frac{M_{\tau}}{N p_{j\tau}}. \tag{A6}$$

Equations (A4.c) and (A4.d) imply that the amount of money carried to the next period is equal to income, which can be written as:

$$M_{\tau+1} = p_{I\tau} y_{\tau} \tag{A7}$$

where $p_{I\tau}$ is the price index and y_{τ} is real income at period τ.

Therefore, the velocity of money is constant and equals one:

$$\frac{M_{\tau+1} - M_{\tau}}{M_{\tau}} = \frac{p_{I\tau} - p_{I(\tau-1)}}{p_{I(\tau-1)}} = \pi_{\tau} \tag{A8}$$

where π_{τ} is the inflation rate at period τ.

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