CAPITAL ACCOUNT OPENNESS AND INFLATION
A PANEL DATA STUDY FOR THE 1990s
(Comments Welcome)

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ABSTRACT

This paper aims to look at the relationship between capital account openness and inflation in the 1990s. It argues that widespread capital account liberalization during the early 1990s appears to have contributed to the world-wide disinflation observed during that decade. The paper attempts to provide a theoretical and empirical evidence for a strong negative link between capital account liberalization and disinflation. Capital account openness appears to discipline monetary authorities, or to help them convince the private sector that they will be more disciplined in the future.

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Introduction

In the past decade the world observed two distinct international economic trends. Firstly, there was global disinflation with inflation rates falling rapidly even in countries, which had a history of high inflation like some Latin American countries. Secondly, several countries liberalized their capital account despite warnings of the risks of currency and banking crises. There have been several studies to verify whether these two developments are related.

Literature Review

Bartolini and Drazen (1997) argue that by liberalizing the capital account governments boost foreign and domestic investor confidence. On the other hand capital account liberalization directly raises the penalty for loose monetary policy. Easier access to foreign exchange raises the elasticity of demand for money and makes the Central Bank vulnerable to rapid reserve losses. In a flexible exchange regime, loss of reserves is not that important, but rapid currency depreciations can be inflationary. By raising the penalties for excess money creation, the Central Bank can alter private sector expectations regarding future monetary policy. The temptation to print money is reduced and the time consistent inflation rate falls as in the well-known model of Barro and Gordon (1983).

One of the factors that influences the extent of capital account liberalization is the degree of independence the Central Bank enjoys. Following Grilli, Masciandaro and Tabellini (1991), the overall independence of the Central Bank can be divided into two types. The first one is political independence (CBPN), which refers to the appointment procedure and the duration in office of the government body of the Central Bank. The less control the government has over the appointment procedure and composition of the board, and longer is the duration of the Central Bank officials, the greater is the political independence. On the other hand, economic independence (CBEN) refers to the obligations of the Central Bank regarding the financing of the budget deficit through money creation and/or interest rate manipulation. The freer is the Central Bank from this point of view the greater is the economic independence.

Within the sample of countries that they used it was found that capital controls were present in 79% of the cases in which the Central Bank had a low degree of political independence and in 61% of the cases for high degree of political independence. Economic independence appears to be even more important since capital controls were present in 79% of the cases of low economic independence but only in 23% of the cases of high economic independence.

This might suggest that capital controls are used by governments, who by controlling the monetary policy directly can impose a higher levy when capital controls are in place. They run regressions by taking inflation as the dependent variable and a host of variables including Central Bank independence on the right hand side. The coefficient for Central Bank independence turns out to be negative thereby suggesting an inverse effect of Central Bank independence on inflation. This along with their earlier conjecture implies that capital controls are associated with higher inflation rates. However, in this study, the authors only make a conjecture about the relationship between Central Bank independence and capital controls. They do not provide any empirical or theoretical support to this conjecture.

Another study, Grilli and Milesi-Ferretti (1995), look at a panel of 61 developing and developed countries. They conclude that restrictions on capital account transactions tend to be associated with higher inflation, a higher share of seignorage revenue in total revenue, and lower real interest rates.

Gruben and Mcleod (2001) look at the same sample of countries used by Romer (1993) and look at the relationship between capital account openness and inflation. They use cross section data and run both OLS and 2SLS with instrumental variables to take care of the problem that the choice of imposing capital controls may be endogenous. They conclude that capital account openness appears to lower inflation by disciplining monetary authorities. They also point out that sustained removal of even one capital or current account restriction can reduce average annual inflation by as much as 3%.

However, the strongest advocates of capital account liberalization recognize that liberalization can expose the vulnerabilities of a weak domestic financial system. To the extent that capital account liberalization places pressures on weak domestic banks, and to the extent that adequate prudential supervision is absent, liberalization can encourage

individually rational but socially harmful activities such as excessive risk-taking and "gambling for redemption" which can culminate in full-blown and costly banking crises. As a result, any benefits of capital account liberalization may easily be obscured by the costs of the greater financial fragility it brings, especially in economies with poorly-regulated financial sectors. More generally, one might expect the benefits of capital account liberalization to be more pronounced in countries characterized by a sound macroeconomic framework and strong institutions. If this is the case, the lack of strong empirical evidence on the benefits of capital account liberalization may simply be due to the fact that previous research has not considered the role of policies and institutions in intermediating the effects of capital account liberalization on growth or investment.

There have been several studies that have questioned the wisdom of financial openness, especially capital account convertibility. Rodrik (1998) undertook a study covering 100 countries over the period 1975-89 and looked at the relationship between capital account liberalization and three measures of economic performance: per capita GDP growth rate, investment as a share of GDP and inflation. He used initial per capita GDP, initial secondary enrollment rate, an index of quality of governmental institutions and regional dummies for East Asia, Latin America and sub Saharan Africa. The scatter plots show that there is no evidence that greater capital account convertibility is associated with lower inflation. Rodrik goes on to assert that in fact capital inflows undermine Central Bank's efforts to control inflation.

In another paper McKinnon and Mathieson (1981) argue for imposition of capital controls to reduce inflation. They point out that capital controls reduce opportunities of currency substitution and hence lower the interest elasticity of demand for domestic currency. This in turn reduces the inflation rate that is necessary to generate a given amount of seignorage revenue. Thus we see that both Bartolini and Drazen (1997) and McKinnon and Mathieson (1981) use the same argument to reach opposite conclusion. Both the papers agree that a decrease in capital controls will increase the elasticity of demand for money by increasing opportunities of currency substitution. However, while Bartolini and Drazen (1997) argue that this would raise the penalty for loose monetary policy and hence enforce a more disciplined monetary policy where the incentive to inflate is significantly lowered, McKinnon and Mathieson (1981) argue that it would raise the inflation rate required to generate a specific amount of seignorage revenue.

O'Donnell (2001) looks at 60 countries over the period 1970-94. He uses an indicator *Cap Vol* to measure financial openness. This measure is different from the one used in most of the recent literature, which is based on IMF's Exchange Arrangements and Exchange Restrictions. *Cap Vol* is based on the average of the sum of the stock of inward and outward direct investment and the stock of portfolio equity and portfolio debt assets and liabilities, as a share of GDP over the period 1971-1994.

O'Donnell regresses the logarithm of the average annual CPI inflation rate and the logarithm of the standard deviation of the average annual CPI inflation rate on *CapVol*, using OLS. Certain control variables like the logarithm of initial per capita GDP (1971), the logarithm of the initial population level (1971), an index of the quality of government institutions, two alternative measures of the degree of Central Bank independence, trade openness and regional dummies for East Asia, Latin America, and sub-Saharan Africa are introduced to isolate their effect on volatility and the level of inflation. Finally five samples are considered: the full sample and four sub samples: non-OECD and OECD countries, a sub sample excluding countries with average inflation rates above 60 percent, and a sub sample excluding OECD countries and those with average inflation rates above 60 percent. The paper finds that there is some evidence to suggest that increasing financial openness and financial depth increases inflation particularly in countries with inflation rates less than 60%. However, overall *Cap Vol* does not affect inflation.

The main drawback with all these papers is that they fail to consider the fact that the choice of imposing or restricting capital controls may be endogenous. Firstly, inflation levels may influence the policy choice regarding the capital account. One generally expects countries to remove capital controls when inflation is reasonably under control. Thus, one would expect that any empirical results would be biased in the direction of finding a strong positive relationship between open capital accounts and reasonably low levels of inflation. Secondly, it may be difficult to accurately assess the benefits of capital account liberalization if capital controls are correlated with other fundamental determinants of inflation. Grilli and Milesi-Feretti (1995) find that open capital accounts are more likely to be found in countries with small public sectors and independent Central Banks. These, however, are factors, which may directly impact on inflation, thus

making it difficult to isolate the impact of financial liberalization on inflation levels or volatility.

Theoretical Framework

The government is made up of two branches: a fiscal authority and a monetary authority or a Central Bank. The fiscal authority runs an exogenously determined deficit. Suppose the Central Bank is entrusted with two functions. The Central Bank issues currencies by open market operations in domestic and foreign bonds. The Central Bank is also required to monetize a part of the fiscal deficit by buying a steady stream of government bonds. However, now the Central Bank has the ability to respond to shocks to the economy by altering the policy instrument, which is the level of money supply. This would in turn result in higher inflation and higher seignorage revenue. Let seignorage revenue be denoted by S, which is a function of inflation. The Central Bank is also entrusted with the task of intervening as necessary to defend the exchange rate. Thus here we have two contradictory objectives in an open economy. If the Central Bank wants to increase seignorage revenue by introducing an inflationary shock it faces a run on its reserves or a depreciation of the currency as the public wants to substitute domestic currency and hold foreign currency. We assume a quadratic cost of the inflation. Thus the Central Bank's welfare function can be written as

$$W_{CB} = S(\pi) - \psi \frac{1}{2}\pi^2 \qquad 1$$

where ψ is the weight that the Central Bank puts on the costs involved with increasing inflation like loss of reserves or depreciation of the currency vis a vis the gains from inflation in terms of seignorage revenue.

Let the demand for money be denoted by a Cagan money demand equation where nominal interest rates are dominated by nominal inflation.

$$m_t - p_t = -\eta(p_{t+1} - p_t) \qquad 2$$

$$\Rightarrow p_t = m_t + \eta\mu \qquad 3$$

Here η is the semi elasticity of the demand for real balances with respect to expected inflation while μ is the constant rate of growth of money supply. Opening up of

the capital account increases this semi elasticity as the public has the freedom to access foreign currency. Thus we have $\eta(\xi)$ which implies that the semi elasticity of demand for money is a function of the capital account openness with

$$\frac{\delta\eta}{\delta\xi} > 0 \qquad 4$$

With the demand for money given by equation 2, seignorage revenue is given by

$$\text{Seignorage} = \frac{M_t - M_{t-1}}{P_t}$$

$$\Rightarrow \text{Seignorage} = \mu(1+\mu)^{-\eta(\xi)-1} \qquad 5$$

In equilibrium the growth of the money supply μ is equal to the inflation rate π. The Seignorage Revenue maximizing money growth rate is given by the first order condition.

$$\frac{\delta\text{Seignorage}}{\delta\mu} = (1+\mu)^{-\eta(\xi)-1} - \mu(1+\eta(\xi))(1+\mu)^{-\eta(\xi)-2} = 0$$

$$\Rightarrow \pi^* = \mu^{\text{Max}} = \frac{1}{\eta(\xi)} \qquad 6$$

The above equation gives the optimal seignorage revenue-maximizing rate of inflation. Note that it depends inversely on the demand elasticity of money, which in turn depends directly on the extent of capital account liberalization. Thus liberalizing the capital account leads to lowering of the seignorage revenue maximizing rate of inflation. However, high inflation has several costs associated with it in terms of loss of reserves in a fixed exchange rate regime of depreciation of the currency in a flexible exchange rate.

Hence the Welfare function of the Central Bank can be written as

$$W_{CB} = \pi(1+\pi)^{-\eta(\xi)-1} - \psi\frac{1}{2}\pi^2$$

The Central Bank would maximize this welfare function under discretion by choosing an optimal rate of inflation. The first order condition of the above expression is given as

$$\frac{\delta W}{\delta \pi} = (1+\pi)^{-(\eta(\xi)+1)} - (\eta(\xi)+1)\pi(1+\pi)^{-(\eta(\xi)+2)} - \pi = 0 \qquad 7$$

From this first order condition we want to obtain a relationship between the optimal inflation under discretion and the semi elasticity of demand for money. Using the implicit function theorem we get

$$\frac{d\pi}{d\eta} = -\frac{\left[\pi(1+\pi)+(1-\pi\eta)\log[1+\pi]\right]}{\left[2+\psi(1+\pi)^{(\eta+3)}+\eta\{2-\pi(1+\eta)\}\right]} \qquad 8$$

For reasonable values of the semi elasticity of demand for money $\eta > 1$[1] we get a negative sign for the above derivative once we impose the restrictions $\pi\eta < 1$ and $2 > (1+\eta)\pi$. Thus the optimal inflation under discretion is negatively related to the semi elasticity of demand for money, which in turn depends positively on the extent of capital account liberalization. Thus an increase in capital account liberalization increases the semi elasticity of demand for money, which in turn decreases the welfare maximizing inflation under discretion. Thus we follow Bartolini and Drazen (1997) as opposed to McKinnon and Mathieson (1981).

Econometric Analysis

In this section we use cross-country panel data to test the prediction of the theory that inflation will be lower in countries that have liberalized their capital account. We look at a sample of 105 countries for which the capital account openness index is available over the period 1990-99[2]. The National Accounts data are from the World Development Indicators of the World Bank.

[1] In the standard literature the value of η has been taken as 1.5 , 1.33 etc.

[2] Developed by Menzie Chinn and Hiro Ito (2001)

We also consider the log of average inflation instead of the level of inflation as a few countries in the sample have extremely high average inflation rates. Thus the parameter estimates from a linear regression would be determined almost by a handful of observations.

Table 1 summarizes the main results of the GLS estimate. The variable capital account openness continues to be highly significant across all specifications thereby implying a statistically significant negative relationship between capital account openness and inflation. In column 2 we add per capita GDP to the regression. This serves as a general measure of development and captures a variety of factors that may influence average inflation. The regression suggests that higher real per capita income is associated with a lower level of inflation. The estimated impact of capital account openness on inflation continues to remain unchanged.

In the next column we also include trade openness as a control variable. As shown in Romer (1993), opening up to trade reduces the incentive of the monetary authority to generate inflationary surprises. Consistent with the theory we get a negative and statistically significant relationship between trade openness and inflation. Column (II) and (III) also include a dummy variable for Latin American countries, the coefficient of which has not been reported in the above table. However, these coefficients confirm that there are significant differences between the Latin American countries and the rest of the world. The Latin American countries continue to be the most affected by inflation.

Several other factors have been known to influence the level of inflation in a country. Primary among them is the level of independence that the Central Bank enjoys. Intuitively a less independent Central Bank is associated with a higher rate of inflation. Central Bank Independence refers to the obligations of the Central Bank regarding the financing of the budget deficit through money creation and/or interest rate manipulation. The freer the Central Bank is from this point of view the lower is the inflation rate. A less free Central Bank will be forced to introduce inflationary shocks to generate seignorage revenue to finance the budget deficit. Moreover, a less free Central Bank is unable to pre commit to its policy choices and these results in higher inflation. Cukierman Neyapti

and Webb (1992) empirically show that inflation is higher in countries with lower Central Bank Independence.

In our analysis we use the index of Central Bank Dependence developed by Sturm and Haan (2001). This index is based on the turnover rate of the Central Bank governors in more than 80 developing countries. They calculate the turnover rate rates for two periods: 1980-89 and 1990-98.

The level of inflation is also affected by the extent of political stability that a country enjoys. Cukierman, Edwards and Tabellini (1991) show that inflation will be higher in countries, which are politically unstable because the policy maker lacks the ability to pre commit. We take the political stability index developed in Kaufmann et al (2002). The index has a range from –2.5 to 2.5 with higher or positive values indicating greater political stability.

We add political stability and Central Bank dependence as our control variables and the results are indicated in Column V and VIII in Table 1. The theoretical prediction is confirmed by the signs of the coefficients on political stability and Central Bank dependence. While political stability is negatively related to inflation, Central Bank dependence shows a positive relation to inflation. However, though Central Bank dependence turns out to be a significant predictor of inflation the political stability is an insignificant. predictor of inflation.

Finally in Column VI and XI we look at the interaction terms. The interaction term with political stability is insignificant thereby showing that political stability does not significantly impact the relationship between capital account openness and inflation. However, the interaction term with Central Bank dependence is quantitatively large and enters with a negative sign. Thus the negative relationship between capital account openness and inflation is much stronger in countries that have less independent Central Banks.

However as pointed out earlier the choice of imposing capital controls may be endogenous. Inflation levels influence the policy choice regarding the capital account. One generally expects countries to remove capital controls when inflation is reasonably

under control. Thus, one would expect that any empirical results would be biased in the direction of finding a strong positive relationship between open capital accounts and reasonably low levels of inflation. To overcome this problem we use instrumental variables with two stage least squares.

Johnson and Tamirisa (1998) investigate the empirical determinants of capital controls. They point out that the capital controls are motivated by (1) balance of payments concerns, (2) macroeconomic management, (3) the stage of the development of financial system and (4) prudential policy by the government to avoid financial crisis and (5) other reasons. Their findings suggest that countries tend to implement capital controls, the more prevalent the balance of payments concern are, the higher real interest rates and real exchanges rates and the larger the government deficit as a share of the GDP.

Following Johnson and Tamirisa, we use reserves expressed in terms of the number of months of imports of goods and services which could be paid for as an instrument for capital account openness. We use a dummy for the Latin American countries to differentiate them from the rest of the world. To minimize the possibility of two way causality we lag the right hand side variable by one year. As a preliminary analysis we estimate the following equation using the annual data for the period.

$$KAOPEN^{i}_{t} = \beta_0 + \beta_1 IR^{i}_{t-1} + \varepsilon_t$$

The resulting estimate of β_1 is statistically significant with theoretically predicted signs i.e. $\beta_1 > 0$. The results of the two stage least square regression are summarized in Table 2

Comparing the GLS estimates with the 2SLS we find that the two-stage estimates tend to show a stronger impact of capital account liberalization on inflation. The coefficients are generally higher than the GLS coefficients and have the theoretically predicted negative sign. Even though the coefficients in 2SLS are less significant than under GLS estimation they still show that the coefficients are significant at the 1% level

in almost all the cases. Thus if anything, the GLS understate the importance of capital account opening.

Next, we divide the entire sample of countries on the basis of their level of indebtedness and level of per capita income. On the basis of level of indebtedness the overall sample can be divided into four groups, severely indebted countries (SICs), moderately indebted countries (MICs), low indebted countries (LICs) and other countries[3]. In our sample of 105 countries there are 26 severely indebted countries, 27 moderately indebted countries, 24 low indebted countries and 28 other countries. The last group is made up of mainly OECD countries. We run both the GLS and 2SLS regression on these four subsets and their results are reported in Table 3 to 10.

From the GLS estimation in Table 3, 5, 7 and 9 we find that capital account openness continues to be a significant predictor for disinflation across all four subset of countries. The coefficient on capital account openness is negative and significant at the conventional significance level for all the four groups. However, the coefficient for the SICs are the highest among the four groups implying that in these countries capital account liberalization has the maximum impact on inflation.

One explanation for this is the way the economy raises resources to repay the foreign debt. A country that is faced with an external debt can raise the resources to pay the debt either externally or internally. It can raise the resources externally in two different ways. Firstly it could undertake a devaluation which would make its exports more competitive and generate a trade surplus. Secondly it could open up the capital account by removing capital controls on foreign investment. This will pave the way for a more efficient allocation of savings and increase the country's attractiveness to foreign investors. In a fixed exchange rate regime this would generate foreign exchange reserves, which could then be used to repay the foreign debt. However, if the economy is closed then the government will have to raise the resources internally. This implies that resources will have to be transferred from the private sector to the government. If inflation tax is the major mechanism for this transfer then it will result in a higher inflation.

[3] Based on the classification in World Development Indicators 2002

This explains the strong negative relationship between capital account openness and inflation in the SICs.

Even though the coefficient on capital account openness is highest for the SICs, it is significant for all the four groups. Thus capital account openness continues to be a significant predictor of disinflation across all the four groups.

From these tables we can also infer that per capita GDP has a significant impact on inflation in the SICs and Other countries only. On the other hand trade openness has a significant impact on inflation only in the SICs and MICs. This conjecture is consistent with Terra's (1998) argument that the negative relationship between trade openness and inflation exists only in the highly indebted countries that see opening up trade as a way to earn foreign exchange and reduce foreign debt.

Finally, though political stability and Central Bank dependence do not have a direct effect on inflation, they do affect the way capital account openness influences inflation in the SICs. In this group the negative relationship between capital account openness and inflation is much stronger in countries that are less politically stable and have more dependent Central Banks.

Once we take into account the endogeneity (Table 4, 6, 8 and 10) we find that the coefficient on capital account openness is significant across all specifications for only the SICs. For the MICs and LICs the coefficient is significant only under certain specifications, while it is not significant across all specifications for Other countries. Thus once we take into account the endogeneity between capital account openness and inflation, the former acts as a significant predictor only in the case of SICs. Thus one can infer that the negative relationship between capital account openness and inflation for the overall sample is largely driven by the response of the SICs.

An alternate explanation could be the fact that it is precisely the SICs that lack pre commitment in their monetary policy. This would explain why the negative relation between capital account openness and inflation is stronger in these countries.

Conclusion

Overall capital account openness acts as a significant predictor of disinflation for the overall sample as well as the four sub groups. Within the four subgroups it is in the SICs that the negative relationship is strongest. However, once we take into account the endogeneity between liberalizing the capital account and inflation it is only in the SICs that capital account openness continues to be a significant predictor of disinflation across all specifications. This could be either due to response of the SICs to debt crises and/or lack of pre commitment in their monetary policy.

The spate of financial crises in Latin America and Asia in the 1990s has led many to question the benefits of capital account liberalization. Rodrik (1998) succinctly sums up the skeptics' view*: "Enshrining capital account convertibility in the IMF's articles of agreement is an idea whose time has not yet come. We have no evidence it will solve any of our problems, and some reason to think it will make them worse."* Despite these warnings the 1990s saw a concerted effort towards capital account liberalization. This paper tries to identify one potentially important benefit of such liberalization. Capital account openness appears to discipline monetary authorities, or to help them convince the private sector that they will be more disciplined in the future.

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Appendix A: Derivation of Some Key Equations in the Text

Cagan Money Demand

The Cagan Money Demand is given as

$$m_t - p_t = -\eta\left(p_{t+1} - p_t\right) \qquad \text{A1}$$

$$\Rightarrow \left(1+\eta\right) p_t = \eta\left(p_{t+1}\right) + m_t$$

$$\Rightarrow p_t = \frac{\eta}{\left(1+\eta\right)}\left(p_{t+1}\right) + \frac{1}{\left(1+\eta\right)} m_t$$

Solving it by forward iteration we get

$$p_t = \frac{1}{1+\eta}\sum_{s=t}^{\infty}\left(\frac{\eta}{1+\eta}\right)^{s-t} m_s \qquad \text{A2}$$

Assume that the money is growing at a constant percentage rate μ per period.

$$m_t = \bar{m} + \mu t \qquad \text{A3}$$

$$m_s = m_t + \mu\left(s-t\right) \qquad \text{A4}$$

Replacing this in A2 we get

$$\Rightarrow p_t = m_t + \frac{\mu}{1+\eta}\eta\left(1+\eta\right)$$

$$\Rightarrow p_t = m_t + \eta\mu \qquad \text{A5}$$

Seignorage Revenue

The Seignorage revenue is given as

$$\text{Seignorage} = \frac{M_t - M_{t-1}}{P_t} \qquad \text{A6}$$

$$\Rightarrow \text{Seignorage} = \frac{M_t - M_{t-1}}{M_t}\left(\frac{M_t}{P_t}\right) \qquad \text{A6'}$$

Equation A1 can be written in level form as

$$\left(\frac{M_t}{P_t}\right)=\left(\frac{P_{t+1}}{P_t}\right)^{-\eta} \qquad \text{A1'}$$

Using A1' in A6' we get

$$\text{Seignorage} = \frac{M_t - M_{t-1}}{M_t}\left(\frac{P_{t+1}}{P_t}\right)^{-\eta}$$

$$\Rightarrow \text{Seignorage} = \frac{M_t - M_{t-1}}{M_{t-1}}\left(\frac{M_{t-1}}{M_t}\right)\left(\frac{P_{t+1}}{P_t}\right)^{-\eta}$$

$$\Rightarrow \text{Seignorage} = \mu\left(\frac{1}{1+\mu}\right)(1+\mu)^{-\eta}$$

$$\Rightarrow \text{Seignorage} = \mu(1+\mu)^{-\eta-1} \qquad \text{A7}$$

The **first order condition** for maximizing revenue is

$$\frac{\delta \text{Seignorage}}{\delta \mu} = (1+\mu)^{-\eta-1} - \mu(1+\eta)(1+\mu)^{-\eta-2} = 0$$

$$\Rightarrow (1+\mu)^{-\eta-1} = \mu(1+\eta)(1+\mu)^{-\eta-2}$$

$$\Rightarrow (1+\mu) = \mu(1+\eta)$$

$$\Rightarrow (1+\mu) = \mu + \mu\eta$$

$$\Rightarrow 1 = \mu\eta$$

$$\Rightarrow \mu^{\text{Max}} = \frac{1}{\eta} \qquad \text{A8}$$

The Welfare function for the Central Bank is given as

$$W = \pi(1+\pi)^{-(\eta+1)} - \psi\frac{1}{2}\pi^2 \qquad \text{A9}$$

Under discretion, the Central Bank maximizes the above objective function. The first order condition is

$$\frac{\delta W}{\delta \pi} = (1+\pi)^{-(\eta+1)} - (\eta+1)\pi(1+\pi)^{-(\eta+2)} - \psi\pi = 0 \qquad \text{A10}$$

From this we need to find the relationship between inflation and the semi elasticity of the demand for money.

$$S = (1+\pi)^{-(\eta+1)} - (\eta+1)\pi(1+\pi)^{-(\eta+2)} - \psi\pi = 0$$

Using Implicit function theorem

$$S = \frac{\delta S}{\delta \pi} d\pi + \frac{\delta S}{\delta \eta} d\eta = 0$$

$$\Rightarrow \frac{\delta S}{\delta \pi} d\pi - \frac{\delta S}{\delta \eta} d\eta$$

$$\Rightarrow \frac{d\pi}{d\eta} = -\frac{\frac{\delta S}{\delta \eta}}{\frac{\delta S}{\delta \pi}}$$ A!!

$$\frac{\delta S}{\delta \eta} = -\pi (1+\pi)^{-(\eta+2)} - (1+\pi)^{-(\eta+1)} \log[1+\pi] + \pi (1+\pi)^{-(\eta+2)} (\eta+1) \log[1+\pi]$$

and

$$\frac{\delta S}{\delta \pi} = \psi + 2(1+\pi)^{-(\eta+2)} (\eta+1) - \pi (1+\pi)^{-(\eta+3)} (\eta+1)(\eta+2)$$

which implies

$$\frac{d\pi}{d\eta} = -\frac{\left[-\pi (1+\pi)^{-(\eta+2)} - (1+\pi)^{-(\eta+1)} \log[1+\pi] + \pi (1+\pi)^{-(\eta+2)} (\eta+1) \log[1+\pi]\right]}{\left[\psi + 2(1+\pi)^{-(\eta+2)} (\eta+1) - \pi (1+\pi)^{-(\eta+3)} (\eta+1)(\eta+2)\right]}$$

simplifying the above equation yields

$$\frac{d\pi}{d\eta} = \frac{\left[(1+\pi)(-\pi) + (\pi\eta - 1)\log[1+\pi]\right]}{\left[2 + \psi (1+\pi)^{(\eta+3)} + 2\eta - \pi\eta - \pi\eta^2\right]}$$

$$\Rightarrow \frac{d\pi}{d\eta} = -\frac{\left[\pi(1+\pi) + (1-\pi\eta)\log[1+\pi]\right]}{\left[2 + \psi (1+\pi)^{(\eta+3)} + \eta\{2 - \pi(1+\eta)\}\right]}$$ A12

Appendix B: Key Results

Table 1: Generalized Least Squares/Random Effects for the Entire Sample

	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(V!!!)	(IX)
Constant	1.974 (21.94)	3.512 (8.66)	4.058 (8.87)	4.084 (8.67)	3.852 (6.52)	3.751 (6.28)	4.620 (6.66)	4.264 (6.25)	4.533 (6.60)
Capital Account Openness	-0.372*** (11.30)	-0.322*** (9.49)	-0.329*** (9.51)	-0.339*** (9.65)	-0.340*** (9.73)	-0.337*** (9.57)	-0.376*** (9.49)	-0.376*** (9.51)	-0.144** (2.14)
Per Capita GDP		-0.222 (4.30)	-0.207 (3.78)	-0.214 (3.83)	-0.190 (2.66)	-0.173 (2.35)	-0.278 (2.88)	-0.266 (2.86)	-0.291 (3.10)
Trade Openness			-1.618 (4.68)	-1.483 (4.15)	-1.350 (3.78)	-1.348 (3.79)	-1.326 (3.39)	-1.210 (3.15)	-1.118 (2.91)
Political Stability					-0.024 (0.18)	-0.030 (0.23)			
Political Stability times Openness						-0.032 (0.74)			
Central Bank Dependence								1.263 (2.26)	-0.710 (1.24)
Central Bank Dependence times Openness									-0.877 (4.26)
Sample Size	967	958	879	832	824	824	559	559	559
R^2	0.204	0.314	0.328	0.348	0.368	0.371	0.212	0.243	0.258

The t statistic is in the parentheses. A "***", "**", and "*" indicate significance at the 1, 5 and 10 percent level
The regressions include a dummy variable for Latin American countries

Table 2: Two Stage Least Squares for the Entire Sample

	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(V!!!)	(IX)
Constant	2.381 (5.20)	-2.112 (0.90)	-1.950 (0.74)	-2.099 (0.71)	-2.572 (0.65)	-0.898 (0.39)	-2.805 (1.65)	2.635 (1.70)	2.214 (1.83)
Capital Account Openness	-1.606*** (4.30)	-1.745*** (3.53)	-1.620*** (3.02)	-1.626*** (2.69)	-1.913* (1.93)	-1.593*** (2.67)	-1.188*** (4.58)	-1.148*** (4.46)	-1.339** (2.02)
Per Capita GDP		0.572 (1.76)	0.547 (1.66)	0.556 (1.50)	0.614 (1.23)	0.377 (1.38)	0.123 (0.56)	-0.115 (0.58)	-0.076 (0.61)
Trade Openness			-0.060 (0.07)	-0.211 (0.22)	0.396 (0.35)	0.182 (0.21)	-0.134 (0.18)	-0.176 (0.25)	-0.640 (1.41)
Political Stability					0.378 (1.07)	0.293 (1.15)			
Political Stability times Openness						0.160 (1.38)			
Central Bank Dependence								0.801 (0.85)	-2.819 (2.48)
Central Bank Dependence times Openness									2.169 (1.83)
Sample Size	967	958	879	832	824	824	559	559	559
R^2	0.204	0.146	0.174	0.188	0.182	0.203	0.136	0.122	0.122

The t statistic is in the parentheses. A "***", "**", and "*" indicate significance at the 1, 5 and 10 percent level
The regressions include a dummy variable for Latin American countries

Table 3: Generalized Least Squares/Random Effects for Severely Indebted Countries

	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(V!!!)	(IX)
Constant	2.317 (11.09)	5.198 (4.56)	6.384 (4.80)	6.344 (4.54)	6.105 (4.12)	5.714 (4.14)	6.663 (3.81)	6.397 (3.74)	6.9125 (4.44)
Capital Account Openness	-0.480*** (4.76)	-0.491*** (5.11)	-0.514*** (5.21)	-0.553*** (5.47)	-0.556*** (5.48)	-0.704*** (6.03)	-0.713*** (6.93)	-0.696*** (6.72)	-0.105 (0.54)
Per Capita GDP		-0.530 (2.87)	-0.587 (2.91)	-0.747 (2.71)	-0.555 (2.57)	-0.513 (2.57)	-0.565 (2.15)	-0.542 (2.16)	-0.614 (2.70)
Trade Openness			-2.171 (2.19)	-2.146 (2.11)	-2.032 (1.94)	-1.890 (1.91)	-2.643 (2.34)	-2.471 (2.23)	-1.499 (1.44)
Political Stability					-0.156 (0.50)	-0.385 (1.29)			
Political Stability times Openness						-0.449 (2.59)			
Central Bank Dependence								0.375 (0.24)	-1.0551 (0.71)
Central Bank Dependence times Openness									-1.631 (3.37)
Sample Size	223	223	212	197	197	197	145	145	145
R^2	0.032	0.229	0.242	0.245	0.250	0.305	0.301	0.305	0.388

The t statistic is in the parentheses. A "***", "**", and "*" indicate significance at the 1, 5 and 10 percent level
The regressions include a dummy variable for Latin American countries

Table 4: Two Stage Least Squares for Severely Indebted Countries

	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(V!!!)	(IX)
Constant	2.023 (6.36)	3.968 (2.49)	4.893 (3.09)	5.152 (3.05)	4.703 (2.60)	4.180 (2.47)	5.922 (2.17)	4.845 (2.20)	4.449 (1.82)
Capital Account Openness	-1.147** (2.33)	-1.536** (2.41)	-1.337** (2.46)	-1.268*** (2.58)	-1.270*** (2.57)	-1.533** (2.48)	-1.263*** (3.31)	-1.303*** (2.95)	-1.728* (1.87)
Per Capita GDP		-0.429 (1.82)	-0.465 (2.15)	-0.479 (2.03)	-0.442 (1.83)	-0.385 (1.78)	-0.512 (1.32)	-0.348 (1.12)	-0.292 (0.85)
Trade Openness			-1.464 (1.33)	-1.610 (1.39)	-1.377 (1.15)	-1.269 (1.19)	-2.373 (1.50)	-1.699 (1.26)	-2.792 (1.90)
Political Stability					-0.269 (0.79)	-0.821 (1.94)			
Political Stability times Openness						-1.147 (2.20)			
Central Bank Dependence								0.996 (0.49)	1.169 (0.52)
Central Bank Dependence times Openness									1.814 (0.91)
Sample Size	223	223	212	197	197	197	145	145	145
R^2	0.030	0.150	0.175	0.191	0.197	0.276	0.279	0.263	0.182

The t statistic is in the parentheses. A "***", "**", and "*" indicate significance at the 1, 5 and 10 percent level
The regressions include a dummy variable for Latin American countries

Table 5: Generalized Least Squares/Random Effects for Moderately Indebted Countries

	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(V!!!)	(IX)
Constant	2.202	3.069	3.381	3.507	3.732	3.741	4.404	4.350	4.432
	(11.94)	(2.38)	(2.84)	(2.83)	(2.69)	(2.64)	(3.64)	(3.46)	(3.43)
Capital Account Openness	-0.223***	-0.227***	-0.200***	-0.209***	-0.210***	-0.213***	-0.212***	-0.215***	-0.201
	(3.99)	(4.06)	(3.67)	(3.84)	(3.85)	(3.85)	(4.32)	(4.37)	(2.35)
Per Capita GDP		-0.156	-0.017	-0.049	-0.074	-0.073	-0.188	-0.204	-0.218
		(0.84)	(0.10)	(0.28)	(0.39)	(0.37)	(1.11)	(1.17)	(1.21)
Trade Openness			-2.939	-2.643	-2.708	-2.727	-1.792	-1.725	-1.696
			(4.33)	(3.80)	(3.72)	(3.72)	(2.80)	(2.65)	(2.57)
Political Stability					0.077	-0.069			
					(0.30)	(0.26)			
Political Stability times Openness						-0.026			
						(0.34)			
Central Bank Dependence								0.709	-0.738
								(0.61)	(0.62)
Central Bank Dependence times Openness									-0.079
									(0.23)
Sample Size	254	254	254	240	240	240	196	196	196
R^2	0.070	0.092	0.235	0.232	0.226	0.226	0.263	0.267	0.261

The t statistic is in the parentheses. A "***", "**", and "*" indicate significance at the 1, 5 and 10 percent level
The regressions include a dummy variable for Latin American countries

Table 6: Two Stage Least Squares for Moderately Indebted Countries

	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(V!!!)	(IX)
Constant	2.139	-0.659	-1.092	-6.615	-1.069	-9.133	2.815	2.327	2.401
	(3.73)	(0.17)	(0.25)	(0.35)	(0.15)	(0.27)	(1.47)	(1.81)	(2.35)
Capital Account Openness	-1.869**	-2.477	-2.531	-5.130	-4.422	-6.993	-1.306**	-0.978**	-1.600
	(2.16)	(1.04)	(1.12)	(0.51)	(0.61)	(0.20)	(2.20)	(2.42)	(1.82)
Per Capita GDP		0.311	0.295	0.559	0.124	0.403	-0.087	-0.048	0.007
		(0.61)	(0.74)	(0.49)	(0.22)	(0.26)	(0.35)	(0.31)	(0.07)
Trade Openness			1.237	8.501	4.089	12.546	-0.052	-0.552	-0.723
			(0.29)	(0.38)	(0.35)	(0.22)	(0.04)	(0.50)	(0.58)
Political Stability					1.552	2.735			
					(0.55)	(0.25)			
Political Stability times Openness						-0.804			
						(0.27)			
Central Bank Dependence								2.564	0.291
								(1.86)	(0.40)
Central Bank Dependence times Openness									5.038
									(1.70)
Sample Size	254	254	254	240	240	240	196	196	196
R^2	0.070	0.107	0.088	0.086	0.077	0.065	0.081	0.125	0.132

The t statistic is in the parentheses. A "***", "**", and "*" indicate significance at the 1, 5 and 10 percent level
The regressions include a dummy variable for Latin American countries

Table 7: Generalized Least Squares/Random Effects for Low Indebted Countries

	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(V!!!)	(IX)
Constant	1.899 (12.94)	3.587 (4.46)	3.479 (3.72)	3.136 (3.30)	3.162 (3.01)	3.230 (3.02)	3.479 (3.72)	3.454 (3.57)	3.508 (3.51)
Capital Account Openness	-0.253*** (5.09)	-0.242*** (5.10)	-0.224*** (5.06)	-0.237*** (5.28)	-0.237*** (5.24)	-0.241*** (5.33)	-0.224*** (5.06)	-0.223*** (5.02)	-0.260*** (3.51)
Per Capita GDP		-0.243 (2.29)	-0.202 (1.61)	-0.158 (1.23)	-0.162 (1.16)	-0.174 (1.23)	-0.202 (1.61)	-0.206 (1.60)	-0.217 (1.63)
Trade Openness			-0.282 (0.77)	-0.183 (0.48)	-0.187 (0.47)	-0.155 (0.38)	-0.282 (0.77)	-0.289 (0.78)	-0.308 (0.82)
Political Stability					0.007 (0.03)	-0.010 (0.05)			
Political Stability times Openness						-0.076 (1.15)			
Central Bank Dependence								0.347 (0.59)	0.500 (0.78)
Central Bank Dependence times Openness									0.149 (0.62)
Sample Size	223	220	200	192	192	192	200	200	200
R^2	0.209	0.360	0.231	0.174	0.173	0.174	0.231	0.229	0.225

The t statistic is in the parentheses. A "***", "**", and "*" indicate significance at the 1, 5 and 10 percent level
The regressions include a dummy variable for Latin American countries

Table 8: Two Stage Least Squares for Low Indebted Countries

	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(V!!!)	(IX)
Constant	1.978 (10.86	2.137 (0.58)	-0.401 (0.11)	1.546 (1.17)	1.399 (1.05)	0.210 (0.08)	-0.401 (3.09)	0.822 (0.36)	1.269 (0.60)
Capital Account Openness	-0.800 (1.21)	-1.277 (1.36)	-0.949** (2.03)	-0.486 (1.36)	-0.454* (1.64)	-0.759** (2.44)	-0.949** (2.03)	-0.723* (1.60)	-1.295 (1.53)
Per Capita GDP		2.317 (0.58)	0.245 (0.57)	0.023 (0.16)	-0.039 (0.26)	0.145 (0.46)	0.245 (0.57)	-0.098 (0.37)	-0.019 (0.09)
Trade Openness			0.646 (0.71)	0.267 (0.61)	-0.332 (0.71)	0.937 (1.04)	0.646 (0.71)	0.344 (0.53)	0.064 (0.11)
Political Stability					-0.163 (0.91)	-0.307 (0.74)			
Political Stability times Openness						-0.144 (1.53)			
Central Bank Dependence								0.267 (0.38)	2.806 (1.35)
Central Bank Dependence times Openness									2.805 (1.29)
Sample Size	223	220	200	192	192	192	200	200	200
R^2	0.209	0.010	0.156	0.161	0.173	0.147	0.156	0.184	0.129

The t statistic is in the parentheses. A "***", "**", and "*" indicate significance at the 1, 5 and 10 percent level
The regressions include a dummy variable for Latin American countries

Table 9: Generalized Least Squares/Random Effects for Other Countries

	(I)	(II)	(III)	(IV)	(V)	(VI)
Constant	1.391 (10.32)	8.040 (3.54)	11.139 (4.93)	11.333 (4.57)	11.689 (4.71)	11.41 (4.51)
Capital Account Openness	-0.328*** (6.19)	-0.318*** (5.41)	-0.405*** (7.21)	-0.393*** (6.67)	-0.348*** (6.07)	-0.250** (2.07)
Per Capita GDP		-0.661 (2.84)	-0.922 (4.02)	-0.944 (3.78)	-0.960 (3.75)	-0.936 (3.60)
Trade Openness			-0.606 (1.19)	-0.602 (1.14)	-0.801 (1.55)	-0.733 (1.39)
Political Stability					-0.194 (0.86)	-0.148 (0.63)
Political Stability times Openness						-0.099 (0.92)
Central Bank Dependence						
Central Bank Dependence times Openness						
Sample Size R^2	267 0.152	261 0.285	213 0.475	203 0.405	195 0.436	195 0.436

The t statistic is in the parentheses. A "***", "**", and "*" indicate significance at the 1, 5 and 10 percent level

Table 10: Two Stage Least Squares for Other Indebted Countries

	(I)	(II)	(III)	(IV)	(V)	(VI)
Constant	1.420 (3.38)	29.49 (1.69)	14.376 (3.97)	21.642 (2.15)	10.761 (5.60)	10.309 (3.71)
Capital Account Openness	-1.330 (1.22)	1.139 (1.07)	-0.001 (0.01)	-0.349 (0.50)	-0.105 (0.49)	1.108 (0.81)
Per Capita GDP		-3.070 (1.58)	-1.329 (3.25)	-2.081 (1.88)	-0.904 (4.39)	-0.893 (3.14)
Trade Openness			-0.323 (0.89)	-1.697 (1.40)	-0.259 (0.79)	0.170 (0.19)
Political Stability					-0.449 (1.67)	-0.061 (0.18)
Political Stability times Openness						-1.167 (1.09)
Central Bank Dependence						
Central Bank Dependence times Openness						
Sample Size R^2	267 0.151	261 0.021	213 0.287	203 0.250	195 0.382	195 0.128

The t statistic is in the parentheses. A "***", "**", and "*" indicate significance at the 1, 5 and 10 percent level

Appendix C: Classification of Countries According to Debt Level

Severely Indebted	Moderately Indebted	Low Indebted	Others
Argentina	Algeria	Bahrain	Australia
Benin	Belize	Bangladesh	Austria
Brazil	Bolivia	Botswana	Bahamas, The
Burundi	Burkina Faso	Costa Rica	Barbados
Cameroon	Chile	Dominican Republic	Belgium
Central African Republic	Colombia	Egypt, Arab Rep.	Canada
Chad	Gambia, The	El Salvador	Cyprus
Congo, Rep.	Ghana	Fiji	Denmark
Cote d'Ivoire	Haiti	Guatemala	Finland
Ecuador	Honduras	India	France
Gabon	Jamaica	Iran, Islamic Rep.	Greece
Indonesia	Kenya	Korea, Rep.	Iceland
Jordan	Malaysia	Lesotho	Ireland
Madagascar	Mali	Mexico	Israel
Malawi	Mauritius	Morocco	Italy
Mauritania	Panama	Nepal	Japan
Nicaragua	Papua New Guinea	Oman	Kuwait
Niger	Philippines	Paraguay	Malta
Nigeria	Senegal	Saudi Arabia	Netherlands
Pakistan	Thailand	Seychelles	New Zealand
Peru	Togo	South Africa	Norway
Rwanda	Tunisia	Sri Lanka	Portugal
Sierra Leone	Turkey	Swaziland	Singapore
Syrian Arab Republic	Uganda	Trinidad and Tobago	Spain
Tanzania	Uruguay		Sweden
Zambia	Venezuela, RB		Switzerland
	Zimbabwe		United Kingdom
			United States